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April 29, 2022

Via electronic filing
Rosemary Chiavetta, Secretary
Pennsylvania Public Utility Commission
Commonwealth Keystone Building
400 North Street
Harrisburg, PA 17120

A-2021-3026132-AEL-5/3/22

RE: Docket No. [redacted]2 – Application of Aqua Pennsylvania Wastewater, Inc. to Acquire the Wastewater System Assets of East Whiteland Township

Dear Secretary Chiavetta:

We are counsel to East Whiteland Township in the above-referenced proceeding. Pursuant to 52 Pa. Code § 5.412a, the following pre-served statements of testimony admitted into the record at the evidentiary hearing on March 31, 2022 are enclosed:

- Direct Testimony of John Nagel, Aqua Statement No. 3
- Rebuttal Testimony of John Nagel, Aqua Statement No. 3-R
- Direct Testimony of Jerome C. Weinert, Aqua Statement No. 5
- Rebuttal Testimony of Jerome C. Weinert, Aqua Statement No. 5-R

All parties and the presiding officer have been served previously with the testimony.

Respectfully submitted,

Matthew S. Olesh

cc: The Honorable Marta Guhl, Administrative Law Judge (via e-mail, w/o encl.)
All parties of record (via e-mail, w/o encl.)

4894-0046-5421 v1-3/28/22

CERTIFICATE OF SERVICE

I, Matthew S. Olesh, Esq., hereby certified that I have served a true and correct copy of the foregoing letter upon the following parties by electronic mail:

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/s/ Matthew S. Olesh

Dated: April 29, 2022

EXHIBIT W

TESTIMONY OF JOHN NAGEL

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

In re: Application of Aqua Pennsylvania Wastewater, Inc.	:	Docket No. A-2021-3026132

TOWNSHIP OF EAST WHITELAND
AQUA STATEMENT NO. 3

DIRECT TESTIMONY OF

JOHN NAGEL

TOWNSHIP MANAGER

TOWNSHIP OF EAST WHITELAND

With Regard To
A General Overview of the Transaction

East Whiteland's Wastewater Collection and Treatment System and Operations
Benefits of the Proposed Transaction

East Whiteland's Rates

July 2021

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I. <u>INTRODUCTION</u>

Q. Please state your name and business address.

A. My name is John Nagel. My business address is 209 Conestoga Road, Frazer, PA 19355.

Q. In what capacity are you affiliated with the Township of East Whiteland?

A. I am the Township Manager for the Township of East Whiteland (the "Township" or "East Whiteland"). The Township Manager is appointed by the East Whiteland Board of Supervisors (the "Board") and is responsible to the Board for the execution of its policies. The Manager is designated as the Chief Administrative Officer of the Township and directs all administrative departments, prepares the annual budget and recommends other policies and procedures to the Board.

Q. Please provide a brief description of your education and work experience.

A. I attended the Temple University, where I received a bachelor's degree in accounting. I have served as the Township Manager since April 2015. As Manager, I oversee all day-to-day operations and staff for all Township departments. I work to implement the policies of our elected Board and coordinate with staff to bring the Board's goals to fruition. Additionally, I administer an annual budget of $28.9 million including $13.8 million in General Funds and $7.3 million of Sewer Funds. Prior to my current position, I served as the Director of Finance for Whitpain Township from September 2011 to April 2015, the Director of Administrative Services for the City of Reading, PA from February 2011 to September 2011, a Financial Advisor for Public Financial Management from

October 2010 to December 2010, and Township Manager for the Montgomery Township August 1999 to August 2010.

Q. Have you testified before the Pennsylvania Public Utility Commission ("PUC" or the "Commission") before?

A. No.

Q. On whose behalf are you testifying in this proceeding?

A. My testimony is on behalf of the Township and in support of the application of Aqua Pennsylvania Wastewater, Inc. ("Aqua") to purchase the Township's wastewater collection and conveyance system (the "System") that provides sanitary wastewater service to various customers in The Township.

Q. What is the purpose of your direct testimony and summarize the key points?

A. The purpose of my testimony is as follows: (1) to provide a description of the System, (2) to describe the anticipated benefits of the sale of the System assets to Aqua under and in accordance with an Asset Purchase Agreement dated January 8, 2021 between the Township and Aqua (the "Proposed Transaction"), and (3) to describe how Township sets its annual rates.

In particular, I will focus on the numerous benefits of the Proposed Transaction that are most important to the Township and the customers who use the System, including:

- The Township can exit the sanitary sewer business and instead focus its resources on other core government functions while ensuring safe, reliable, and professional service at affordable rates for its residents;
- Receipt of sale proceeds will permit the Township to allocate these funds to various projects in the Township;
- Benefits from Aqua's expertise, long-standing capital improvement programs, and its experience in improving systems throughout the Commonwealth to address capital improvements needed over time in the Township;
- Township residents will benefit from enhanced customer service and operational functions through expanded customer service hours, additional payment options (including by phone or online), access to Aqua's Helping Hand low-income assistance program, and Aqua's team of experienced water and wastewater professionals;
- Aqua's capability to make long-term investments in necessary capital improvements to the wastewater system;
- Aqua's proven record of environmental stewardship for the operation of wastewater systems;
- Regulation of the service provided to Township's customers will fall under PUC jurisdiction, which will ensure regulatory oversight, require approval for all rate increases, and provide significant consumer protections; and
- Enabling the Township to reallocate its administration time to focus on other key initiatives of the Township.

Q. Are you sponsoring any Exhibits with your testimony?

A. No.

II. DESCRIPTION OF THE TOWNSHIP AND ITS WASTEWATER SYSTEM

Q. Please provide a general overview of the Township of East Whiteland.

A. The Township of Whiteland was founded in 1704. In 1732, Whiteland was divided into East Whiteland and West Whiteland. The Township is located in Chester County, and consists of approximately 10.9 square miles. The Township is governed by its five-member Board. Presently, there are approximately 14,720 residents in the Township.

Q. Please provide a description of the Township's wastewater system.

A. The Township owns and operates the System, which consist of twelve (12) pump stations, about 329,072 linear feet of gravity and force mains, approximately 1,506 manholes, associated infrastructure and appurtenances, and related land and land rights. The System's pump stations are: Deer Run; Flat Road; Hillbrook Circle; King Road; Lapp Road; Lee Boulevard; Malvern Hunt; Meadowview; Mill Lane; Planebrook Road; Westgate; and Wilburdale.

The System currently provides service to 3,895 residential and commercial customers, and services approximately 7,908 Equivalent Dwelling Units ("EDU"). EDUs are estimated to increase by nearly 2,500 EDUs through 2025.

East Whiteland is responsible for the safe collection and transmission of over 1.062 million gallons of wastewater per day that is generated in southeastern Pennsylvania. The System accepts flows and collects sewer rental fees from the adjoining municipalities of East Goshen Township, Charlestown Township and Malvern Borough. In turn, the Township pays sewer rental fees to neighboring Tredyffrin Township and East Goshen Township, and a company for conveyance and to the Valley Forge Sewer Authority Wastewater Treatment Plant—where the Township has purchased capacity.

Q. Please provide an overview of any compliance issues with the wastewater system experienced by the Township.

A. The Township currently has an Act 537 plan with the Pennsylvania Department of Environmental Protection (the "DEP") originally dated May 2, 1995, and subsequently amended as recently as March 2020.

From 2013 to 2014, the Township was under a Corrective Action Plan ("CAP") with the DEP that required various improvements to be made to the Mill Lane and Sidley Collection System, the Lee Boulevard Pump Station, and the sanitary sewer on Conestoga Road. Additionally, the Township installed approximately 3,780 linear feet of new piping to replace the existing deteriorating sewer. In 2015, the DEP lifted the CAP once the Township completed the gravity sewer main replacement from the Mill Lane Pump Station to Lee Boulevard. Lastly, in the past five (5) years, the Township has experienced only three (3) sanitary sewer Overflows (SSO's). All were immediately addressed.

III. SALE PROCESS

Q. Please describe the Township's decision process in concluding that a sale of the wastewater system was in the best interest of the Township.

A. The decision to sell the System was the result of deliberate consideration by the Township, its administration and our residents. Beginning in April 2019, we undertook a thorough process, along with capable outside experts, to review the System, assess future costs of capital and revenue requirements, evaluate the ongoing time commitments of Township personnel to address System issues, and carefully consider from various stakeholder points of view the numerous qualitative and quantitative factors that weigh in favor of or against the Township keeping the System. We weighed and balanced issues at numerous public meetings and working sessions that addressed the Proposed Transaction.

Ultimately, the decision to sell resulted from two primary goals. First, the Township wanted to exit the business of providing sanitary sewer service and instead focus on its core governmental functions while simultaneously ensuring that our residents would have safe and reliable service at affordable rates. The System's aging infrastructure will require additional investment over time, which we project will cause increases in rates if the System remains with the Township. Second, the Township desired to address other Township purposes with the sale proceeds.

After the Board made the decision to sell the System based on these considerations, we issued a Request for Qualifications and a Request for Bids. Once we reviewed the responses, we determined that Aqua submitted a bid that was in the best interest of, and provided the greatest value to, the Township and its residents, and accepted that bid.

Q. Did the Township request public input on the sale?

A. Yes. The deliberative process undertaken by the Township in deciding to sell the System was public and involved an opportunity for public comment at the November 11, 2020 meeting where the Township, its financial advisors, and Aqua all presented the goals and benefits of the Proposed Transaction.

Q. Please describe the process by which the Township solicited bids for the System.

A. On January 31, 2020, the Township released its Request for Qualifications, and received the responses on February 20, 2020. The Township held various management meetings and asset tours throughout mid-July 2020. The Township continued its due diligence through August 2020, and pre-qualified four (4) potential bidders based on industry established criteria for the possible execution of an agreement for the sale of the System. On September 15, 2020, the Township issued its Request for Bids, and received the responses on October 13, 2020.

After receiving the bids, the Board conducted a public meeting on November 11, 2020. At this meeting, the Township Manager and its financial advisors presented to the Board and the public the reasons the Township explored the sale of the System and the benefits that Township residents may realize from the sale, including uses of the sale proceeds. The Township stated that it would discuss the specific uses of the proceeds in the coming nine (9) to twelve (12) months. After careful consideration of the bids and public participation, the Township decided that the sale was in the best interest of the Township, and the Board unanimously voted to accept Aqua's bid at the November 11, 2020 meeting.

Q. Please describe the process that the Township used to hire a Utility Valuation Expert for the transaction.

A. When the Board approved the sale on November 11, 2020, it also authorized me to seek proposals from and select a Utility Valuation Expert. On May 27, 2021, the Township received a proposal from AUS Consultants ("AUS"), which was accepted that same day after review and consideration. AUS is not affiliated with the Township.

IV. <u>BENEFITS OF THE PROPOSED TRANSACTION</u>

Q. Please describe the benefits of the Proposed Transaction for the Township.

A. The Township will benefit from the Proposed Transaction as it will transfer its wastewater assets to a long-standing and well-run public utility – Aqua. There are two key benefits of the Proposed Transaction to the Township and its residents. The sale will (1) permit the Township to exit the business of providing sanitary sewer service and instead focus on its core governmental functions while simultaneously ensuring that our residents would have safe and reliable service at affordable rates, and (2) the sale proceeds will allow the Township to address improvements and projects throughout the Township and benefit the Township's overall financial position.

First, given the time and economic impact on the Township of dealing with the System, the Proposed Transaction permits the Township to reallocate its time to focus on other key initiatives of the Township. For example, due to additional investment required for our aging System, we project that wastewater rates will increase in the coming years regardless if the Township retains ownership of the System. As such, we believe that the sale to Aqua provides the best opportunity for the Township to focus its resources on other core government function while ensuring safe, reliable, and professional service at affordable rates for its residents.

Additionally, the Proposed Transaction will provide the Township with the ability to make improvements within the Township. The Township has identified, *inter alia*, the following potential uses for the proceeds: the reduction of debt; development of the Township Campus, including the construction of a new police station, renovation of the current administration building, etc.; and the implementation of roadway projects to improve traffic flow in the Township.

Q. Please describe any further benefits from the Proposed Transaction.

A. The Township will realize many additional benefits from the sale of its wastewater system to Aqua. These benefits include, but are not limited to, the following:

- The Township will benefit from Aqua's capital improvement programs, and its experience in improving and correcting systems with compliance issues.
- Township residents will benefit from enhanced customer service and operational functions through expanded customer service hours, additional payment options (including by phone or online), access to Aqua's Helping Hand low-income assistance program, and Aqua's team of experienced water and wastewater professionals;

- Aqua's capability to make long-term investments in necessary capital improvements to the aging System; and
- Aqua's proven record of environmental stewardship for the operation of wastewater systems.

Q. Do you believe that the Proposed Transaction provides affirmative public benefits and is in the public interest?

A. Yes. For the reasons set forth above, I believe that the Proposed Transaction provides substantial affirmative public benefits and is in the public interest. I urge the Commission to promptly approve the Proposed Transaction.

V. <u>RATES</u>

Q. How does Township set the rates it charges customers for wastewater treatment and collection?

A. Rates are governed by the Township Code. Pursuant to the Code, the Township is currently divided into five sanitary sewer districts based on geographic boundaries. The Board may establish additional districts by ordinance. The applicable rate for any given district is established by resolution of the Board, and may be amended as the Board deems appropriate. While the rates throughout any given district must be uniform, the rates may vary from district to district. Furthermore, the Township establishes distinct sewer rates for any commercial or industrial user whose total quarterly sewage or water consumption exceeds 100,000 gallons, also referred to as "high volume customers."

Q. How frequently does Township adjust rates?

A. Rates have only been increased when necessary. For example, the rates for Districts A through E were last raised in 2016 and the rates for "high volume customers" were last raised in 2018.

VI. CONCLUSION

Q. Does this conclude your testimony?

A. Yes, it does. However, I reserve the right to file additional testimony at a later date as may be necessary or appropriate.

BEFORE THE PENNSYLVANIA PUBLIC UTILITY COMMISSION

Application of Aqua Pennsylvania Wastewater, Inc. under Section 1102(a) of the Pennsylvania Public Utility Code, 66 Pa. C.S. § 1102(a), for approval of (1) the transfer, by sale, of East Whiteland Township's wastewater system assets situated within the Township of East Whiteland, Chester County, Pennsylvania, to Aqua Pennsylvania Wastewater, Inc., (2) the rights of Aqua Pennsylvania Wastewater, Inc. to begin to offer or furnish wastewater service to the public in East Whiteland Township, Chester County, Pennsylvania; and (3) an order approving the acquisition that includes the ratemaking rate base of the East Whiteland Township wastewater system assets pursuant to Section 1329(c)(2) of the Public Utility Code; (4) approval of contracts, including assignment of contracts, between Aqua and East Whiteland Township, pursuant to Section 507 of the Public Utility Code; and (5) approval of a contract between affiliated interests, pursuant to Section 2102 of the Public Utility Code.	Docket No. A-2021-3026132

AQUA STATEMENT NO. 3-R

REBUTTAL TESTIMONY OF
JOHN NAGEL
TOWNSHIP MANAGER FOR
THE TOWNSHIP OF EAST WHITELAND

March 18, 2022

Q. Please state your name and business address.

A. My name is John Nagel. My business address is 209 Conestoga Road, Frazer, 19355.

Q. Have you previously submitted direct testimony in this proceeding?

A. Yes, I submitted direct testimony (Aqua Statement No. 3) in support of Aqua Pennsylvania Wastewater, Inc.'s ("Aqua") Application filed with the Pennsylvania Public Utility Commission ("PUC" or the "Commission") for approval of its acquisition of East Whiteland Township ("East Whiteland" or the "Township") wastewater system assets (the "System").

Q. What is the purpose of your rebuttal testimony?

A. The purpose of my rebuttal testimony is to respond to the direct testimony of Noah D. Eastman from the Office of the Consumer Advocate. Specifically, I will respond to Mr. Eastman's assertions that the Proposed Transaction does not provide substantial public benefits.

Q. What is your response to Mr. Eastman's assertion that the benefits you identified are "vague and unquantified"?

A. I disagree. As Mr. Eastman specifically stated in his direct testimony, the Township – as a provider of wastewater services – has a duty to make necessary investments to improve the System and ensure compliance with ever-evolving regulatory requirements. Therefore, after consulting with capable legal, financial, and engineering experts, the East Whiteland Board of Supervisors ("Board") ultimately determined that a sale of the

System to a PUC-regulated public utility with a greater expertise and manpower to address the future costs and improvements to maintain the System was in the best interests of the Township and its residents. Those benefits are not "vague" or "unquantified." For example, pursuant to section 7.12 of the Asset Purchase Agreement, Aqua agreed to complete specific sewer projects within one year of closing or receipt of all necessary permits and approvals for the projects, whichever is later. Thus, if the Proposed Transaction is approved, the Township customers can realize a concrete benefit from the Proposed Transaction as soon as one (1) year into Aqua's ownership and maintenance of the System.

Additionally, Aqua estimated that it will invest $16.92 million in sewer extensions, upgrades to pump station, and force main/gravity collection system rehabilitation and replacement for the System over the next (10) years. Regardless of Mr. Eastman's opinion that these anticipated improvements are not "urgent" and "normal improvements expected as a wastewater system ages," this estimated budget for improvements to the System is neither vague nor unquantifiable.

Q. What is your response to Mr. Eastman's assertion that the Township is financially fit to make necessary investments to improve the System?

A. The Township certainly does not dispute that it is in an overall healthy financial position. However, the goal of the Township – like any municipality – is to maintain and improve that position. The Proposed Transaction achieves just that. For example, the 3,895 East Whiteland customers will become part of a larger overall wastewater utility that provides the benefit of dedicated wastewater experts, and the ability to share in future capital improvements of the system.

Further, the proceeds from the Proposed Transaction can be used to reduce debt and fund various other important projects in the Township that would otherwise require an increase of taxes for its residents. Notably, the Township has committed itself to avoid increasing taxes for its residents, and the Proposed Transaction will significantly contribute to that goal.

Q. What is your response to Mr. Eastman's assertion that East Whiteland customers already receive safe and reliable service from the Township; therefore, the continuation of safe and reliable service from Aqua to Township customers should not be considered an affirmative public benefit of the Proposed Transaction?

A. In my direct testimony, I specifically stated that one of the primary benefits of the Proposed Transaction is that it allows the Township to "exit the business of providing sanitary sewer service and instead focus on its core governmental functions *while simultaneously* ensuring that our residents would have safe and reliable service at affordable rates." Thus, Mr. Eastman's direct testimony reviews the benefit of safe and reliable service in a vacuum.

Nonetheless, the Township agrees that it currently provides safe and reliable service to its customers. Additionally, this safe and reliable service to its customers monopolizes a significant amount of time and attention of the Township's already lean staff. For example, the Director of the East Whiteland Public Works Department currently dedicates approximately fifty percent (50%) of his time to managing and operating the System – leaving only half of his time to tend to his various other responsibilities such as maintenance of East Whiteland's roads, parks, and traffic. Notably, there are three (3) full-time employees that currently dedicate one hundred (100%) of their time to sewer operations as well. However, if the Proposed Transaction is approved, the Director and the three (3) full-time employees can focus their time and efforts on other core functions of the Public Works Department *while simultaneously* ensuring the continued safe and reliable service under Aqua's ownership. The Township and its residents will undeniably benefit from the reallocation of the time and resources of the Public Works Department to the maintenance of East Whiteland's roads, parks, and traffic.

Q. Is there anything further you would like the Commission to consider when analyzing the Proposed Transaction?

A. Yes. First, Mr. Eastman assessed each benefit that the Township and Aqua provided with the Application in a vacuum, which undermines the benefit of the Proposed Transaction as a whole. Conversely, East Whiteland's duly elected Board carefully considered the qualitative and quantitative factors weighing in favor and against the Township's continued operation of the System with the assistance of capable outside experts. Due to the future capital costs and future increasing environmental regulations associated with the System, the Board ultimately concluded that the Proposed Transaction to a PUC-regulated public utility was in the best interests of the Township and its residents in both the short and long term. More specifically, the Board determined that Aqua – a Class A utility in the Commonwealth – is in a better position than the Township to operate the

System and complete the necessary capital improvements for the System in the near future.

Further, Mr. Eastman's analysis of the Application and the stated benefits of the Proposed Transaction seemingly discourages elected officials from selling their wastewater systems unless or until the system becomes aged and decrepit or the municipality is in imminent financial distress. However, I have been advised by legal counsel that the Public Utility Code does not require a system to be distressed or residents to suffer from poor operational management before a municipality is permitted to sell its system. Instead, the Commission will approve a sale that affirmatively promotes the service, accommodation, convenience or safety of the public. As illustrated from my testimony and the direct and rebuttal testimony of William C. Packer and Mark J. Bubel, Sr. from Aqua, this Proposed Transaction certainly achieves that.

CONCLUSION

Q. Does this conclude your rebuttal testimony?

A. Yes, it does. However, I reserve the right to file additional testimony at a later date as may be necessary or appropriate.

VERIFICATION

I, John Nagel, the Township Manager for the Township of East Whiteland, hereby verify that the statements of fact made in the foregoing *Rebuttal Testimony* are true and correct to the best of my knowledge, information and belief and that I expect to be able to prove the same at a hearing held in this matter. I understand that the statements made herein are subject to the penalties of 18 Pa. C.S. § 4904 (relating to unsworn falsification to authorities).

John Nagel

Dated: March 18, 2022

EXHIBIT Y

TESTIMONY OF JEROME C. WEINERT

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

AQUA PENNSYLVANIA WASTEWATER, INC.

DOCKET NO. A-2021-3026132

AQUA STATEMENT NO. 5

DIRECT TESTIMONY OF
JEROME C. WEINERT, PE, ASA, CDP
UTILITY VALUATION EXPERT
SELECTED BY
EAST WHITELAND TOWNSHIP, PENNSYLVANIA

Date: July 2021

DIRECT TESTIMONY OF JEROME C. WEINERT

Q. Please state your name, business address, and occupation.

A. My name is Jerome C. Weinert. My business address is 8555 West Forest Home Avenue, Suite 201, Greenfield, WI 53228. I am a Principal and Director of AUS Consultants, Inc. ("AUS Consultants"). This testimony was prepared by me.

Q. Please describe your qualifications and indicate if you are registered as a Utility Valuation Expert with the Pennsylvania Public Utility Commission.

A. My curriculum vitae ("CV") is attached to my report and this testimony. AUS Consultants is a registered Utility Valuation Expert with the Pennsylvania Public Utility Commission ("PUC"). We obtained that registration in 2016 and were informed of our latest renewal by the PUC's Secretary on January 12, 2021.

Q. What is the purpose of your testimony?

A. This direct testimony provides clarification and explanation of the appraisal I provided to East Whiteland Township, Pennsylvania ("EWT"), the Selling Utility pursuant to 66 Pa. C.S. § 1329(a)(5) and in accordance with the Uniform Standards of Professional Appraisal Practice ("USPAP") (2020-2021 Edition).

Q. Are you advocating for any party or outcome?

A. No. The Ethics Rule of the USPAP, applicable here pursuant to 66 Pa. C.S. § 1329(a)(3), requires that I perform the appraisal with impartiality, objectivity, and independence, and without accommodation of personal interests. In addition, the USPAP Ethics Rule requires that I not perform the assignment with bias, that I must not advocate the cause or interest of any party or issue and that I must not accept an assignment that includes the reporting of predetermined opinions and conclusions.

Q. Do you have any affiliation with either the Acquiring Utility or the Acquiring Public Utility or Entity?

A. No. Other than the current assignment to provide the subject appraisal, I have no business or personal relationships with any party to the proposed acquisition.

Q. What is your fee arrangement to deliver the appraisal?

A. A copy of the fee arrangement is included with the Application as **Exhibit S2**. In summary, AUS Consultants are to receive $25,000 to $27,000 plus expenses in compensation for our appraisal, which represents approximately 0.47% of the appraised value.

Q. Will you receive that fee regardless of whether the Commission approves the proposed transaction or whether it closes?

A. Yes. 66 Pa. C.S. § 1329(a)(3) mandates that I comply with the USPAP when developing my appraisal. Under the USPAP, I cannot perform the appraisal with bias and acceptance of a fee contingent on a particular outcome like closing or Commission approval would violate that Ethics Rule.

Q. Have you prepared any exhibits, schedules, or appendices to accompany your direct testimony?

A. Yes. The appraisal I submitted to the Seller pursuant to Section 1329(a)(5) is included in the Application as **Exhibit R**. The appraisal includes a narrative and supporting exhibits in sections. All were prepared under my supervision and control. Also, as stated above, attached to this testimony as **Appendix A** is my CV.

Q. Please summarize your results of the application of the cost, market, and income approaches to valuation.

A. The summary results of the cost, income, and market approaches is presented below.

Appraisal Approach	Value Indicator	Weight	Wtd Value Indicator
Cost	59,847,171	50%	29,923,586
Income	55,600,045	40%	22,240,018
Market	56,178,539	10%	5,617,854
Appraisal Conclusion			57,781,458

Q. Please describe any assumptions, extraordinary assumptions, hypothetical conditions, and/or limiting conditions that you applied to the valuation.

A. The major assumptions and limiting conditions used in preparing our appraisal of the East Whiteland's Wastewater Collection System and Purchased Treatment Capacity are described in our appraisal report "Fair Market Appraisal Report of East Whiteland Township, Pennsylvania's (PA) Wastewater Collection System and Purchased Treatment Capacity, as of January 8, 2021." Beyond the above-described assumptions, there are no extraordinary[1] or hypothetical[2] assumptions (as defined in the 2020-2021 edition of USPAP).

Q. How was each assumption used and what was its result?

A. The assumptions are detailed in my appraisal report and are discussed further in this testimony.

Q. How did you develop the weighting applied to each approach in your appraisal and why are the individual weights you chose appropriate for this proposed transaction?

A. For the cost approach I chose a weighting of 50%. It is my opinion that this weighting is appropriate for the cost approach because the major purpose of this appraisal is to be an input to the Commission's establishment of cost for future ratemaking and the cost approach conclusion is directly reflective of the property cost.

For the market approach, I chose a weighting of 10%. It is my opinion that this weighting is appropriate for the market approach because while the market approach provides some information as to the value of the property, establishing comparability between the individual sales to the subject property is difficult and uncertain therefore requiring less weight of the market approach and the 10% weight accomplishes that objective.

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1 Extraordinary assumption: an assignment-specific assumption as of the effective date regarding uncertain information used in an analysis which, if found to be false, could alter the appraiser's opinions or conclusions. 2020-2021 USPAP page 4.

2 Hypothetical condition: a condition, directly related to a specific assignment, which is contrary to what is known by the appraiser to exist on the effective date of the assignment results, but used for the purpose of analysis. 2020-2021 USPAP page 4.

For the income approach, I chose a weighting of 40%. It is my opinion that this weighting is appropriate for the income approach because the income approach reflects the value of the property's return to the property's owner. The 40% weight accomplishes that objective.

Q. Did you conduct an on-site inspection of the Selling Utility assets, and if so, what was its result on the appraisal?

A. No. AUS Consultants relied on the aging of the investment provided in the Engineer's Assessment to assess the condition of the system.

Q. What Utility Earnings Report was used to create the capital structure used in your appraisal?

A. I used a market required capital structure (detailed in the Cost of Capital / Required Return portion of our appraisal report). Information used in developing the market capital structure was obtained from financial statistics reported in Value Line Investment Survey for the water / wastewater industry published in their January 1, 2021 issue.

Q. What capital structure was used in your appraisal?

A. The capital structure used in my appraisal is included below.

Water and Wastewater Cost of Capital
First Quarter 2021 (0-01-2021)

As an Investor-Owned Utility

Weighted Cost of Capital (Discount Rate)

(1)	(2)	(2a)	(3)	(3a)	(4)	(4a)	(5)
	Portion of Capital	Type of Data	Capital Cost	Type of Data	Tax Rate	Tax affect on cost of capital	After-tax Market Capital Cost
	AUS Input		AUS Input				(2)*(3)*(4a)
Debt	29%	Market	2.79%	Market	28.89%	71.11%	0.58%
Equity	71%	Market	9.85%	Market	0.0%	100.0%	6.99%
Total Capital r	**100.0%**						**7.57%**
Growth (g)							**1.82%**
Rate without Growth: [(1+r)/(1+g)]-1							**5.65%**

Cost Approach

Q. Regarding your application of the cost approach, what method did you use to determine the cost approach result (e.g. original cost, replacement cost, reproduction cost)?

A. I used the replacement cost method.

Q. Please explain why you chose the replacement cost method.

A. I chose the replacement cost method because it is considered the proper starting point for a cost approach. Replacement cost reflects the appraisal date cost of providing the property's functionality and capacity at the appraisal date using recognized materials and labor costs.

Q. What index did you use for that method?

A. I used the Handy Whitman Index of Public Utility Construction Costs for the Water Industry (Northeastern US Region), AUS Telephone Index (General Plant), and various United States Bureau of Labor Statistics cost index series.

Q. Under your application of the cost approach what assets did you value or trend differently from other assets and why was that necessary?

A. I costed each property account with cost trends appropriate for the property contained in the account. As such, the costing of each property account may differ from account to account. It is my opinion that an accurate appraisal requires each property account be costed with cost trends reflective of the property contained in the account. For the assets associated with Land and Land Rights, appraisal date costs were estimated. For the appraisal date cost of obtaining and registering the easement with the Register of Deeds, estimates were developed based on the time and cost associated with developing the easement, contacting the property owner and registering the easement.

East Whiteland Township's property, as detailed in the Pennoni Associates, Inc. "Engineer's Assessment" of $43,447,309.24, including purchase treatment capacity, was determined to have a replacement cost new of $85,964,664 summarized as follows:

East Whiteland Township, Pennsylvania
East Whiteland Township's Wastewater Collection System and Purchased Treatment Capacity
Wastewater Collection System and Purchased Treatment Capacity
Investor-Owned Utility
As of January 8, 2021

Replacement Cost New (RCN)

(1)	(2)	(3)	(9)	(10)	(13)	(14)	(15)	(16)
Account	Account	Asset Description	Original Cost	Costing Parameter	Cost Translator	Reproduction Cost New (RCN)	Reproduction Cost New (RCN) to Replacement Cost New (COR)	Replacement Cost New (COR)
			OC $s			RCN $s	COR $s / RCN $s	COR $s
Input	Input	Input	Input	Input	Calculation	Calculation	Input	Calculation
Eng Assmt	AUS Input	East Whiteland Township Wastewater Assets Detail by Pennoni Associates, Inc.	Eng Assmt	AUS Input			AUS Input	Col (14) * (15)
NARUC Code	NARUC Code	Asset Description	Original Cost	Cost Index Table	Translator	RCN	COR / RCN Factor	COR
353.20	353.20	Land & Land Rights - Original Basin	668.00	USBLS1	2.87	1,920	375.01	720,020
353.30	353.30	Land & Land Rights - Pumping	13.00	USBLS1	2.08	27	498.82	13,468
354.30	354.30	Stuctures & Improvements - Pumping	8,005,275.38	HWW-18	1.52	12,142,235	1.00	12,142,235
360.21	360.21	Collection Sewers - Force - Mains	2,304,354.55	HWW-144	2.59	5,971,267	1.00	5,971,267
361.21	361.21	Collection Sewers - Gravity - Mains	10,767,737.96	HWW-144	2.84	30,582,161	1.00	30,582,161
361.23	361.23	Collection Sewers - Gravity - Manholes	4,350,867.01	HWW-145	2.32	10,108,723	1.00	10,108,723
363.20	363.20	Service Laterals	6,619,976.03	HWW-139	1.85	12,259,833	1.00	12,259,833
365.20	365.20	Flow Measuring Installations Meter Pits	78,670.00	HWW-140	4.95	389,338	1.00	389,338
354.20	354.20	Stuctures & Improvements - Treatment	11,085,241.50	HWW-115	1.22	13,511,701	1.00	13,511,701
390.70	390.70	Office Furniture and Equipment	21,550.00	AUST-115	1.16	25,084	1.00	25,084
391.70	391.70	Transportation Equipment	212,955.81	AUST-14	1.13	240,834	1.00	240,834
		Grand Total	43,447,309.24		1.96	85,233,123	1.01	85,964,664

These results are detailed in Application **Exhibit R** (AUS Appraisal) under the Cost Approach section.

Q. Under your application of the cost approach, what date did you use for calculating the depreciation or condition of the property?

A. I used the date of January 8, 2021.

Q. How did you determine the depreciation parameters of survival/retirement characteristics and service lives for the utility property under the cost approach?

A. I determined those parameters based on our review of the depreciation studies filed by Pennsylvania-American Water Company ("PAWC") and Aqua Pennsylvania Wastewater, Inc. ("Aqua") in support of their depreciation parameters (Iowa-type Survival Characteristics and Service Lives) and the resultant depreciation expense and rate base (net book) in their recent General Rate Cases (R-2017-2595853, R-2020-3019371 and R-2018-3003561) and AUS Consultants' experience in preparing depreciation studies for the water and wastewater industry and our experience appraising water and wastewater properties. The following table summarizes those studies and AUS Consultants' review of the depreciation parameters:

Summary of PAWC & Aqua Depreciation Studies Prepared for Rate Case

Account	Account Description	Iowa Curves			Service Life		
		PAWC	PAWC	Aqua	PAWC	PAWC	Aqua
		12/31/2016	12/31/2019	3/31/2018	12/31/2016	12/31/2019	3/31/2018
					years	years	
354.20	STRUCTURES AND IMPROVEMENTS - COLLECTION	R3	R3	S0.5	45	45	55
354.30	STRUCTURES AND IMPROVEMENTS - SPP	R2.5	S0	S1.0	50	55	60
354.40	STRUCTURES AND IMPROVEMENTS - TDP	R2	S0	R2.0	65	55	50
354.70	STRUCTURES AND IMPROVEMENTS - GENERAL	S1	S1	R3.0	35	35	50
355.00	POWER GENERATION EQUIPMENT	R2.5	S0.5		35	35	
360.10	COLLECTION SEWERS - FORCE MAINS	S2	R3	R2.5	70	75	75
361.10	COLLECTION SEWERS - GRAVITY MAINS	R2.5	R2.5	R2.5	70	80	75
361.20	MANHOLES	S1.5	S2.5		50	50	
363.00	SERVICES	R3	R3	R4.0	38	47	70
364.00	FLOW MEASURING DEVICES	L3	L2.5		20	15	
365.00	FLOW MEASURING INSTALLATIONS	S1.5	S2		30	25	
370.00	RECEIVING WELLS	R3	R3		50	50	
371.00	PUMPING EQUIPMENT	SO	S0.5	L0.5	40	30	25
380.00	TREATMENT EQUIPMENT	5-R2	S1.5	S0.0	45	35	40
381.00	PLANT SEWERS	R3	R3	R1.5	50	50	40
382.00	OUTFALL SEWER LINES	R3	R3	R2.5	50	50	40
389.10	OTHER PLANT AND MISCELLANEOUS EQUIPMENT - INTANGIBLES	52.5	S2.5		20	20	
389.60	OTHER PLANT AND MISCELLANEOUS EQUIPMENT - CPS	SQ	SQ	L3.0	20	5	20
390.00	OFFICE FURNITURE AND EQUIPMENT	L4	SQ	SQ	15	20	20
391.00	TRANSPORTATION EQUIPMENT	SQ	L4		25	14	
392.00	STORES EQUIPMENT	SQ	SQ		20	25	
393.00	TOOLS, SHOP AND GARAGE EQUIPMENT	SQ	SQ	SQ	15	20	20
394.00	LABORATORY EQUIPMENT	L2.5	SQ	SQ	16	15	25
395.00	POWER OPERATED EQUIPMENT	SQ	R2		15	22	
396.00	COMMUNICATION EQUIPMENT	SQ	SQ		15	15	
397.00	MISCELLANEOUS EQUIPMENT		SQ			15	
398.00	OTHER TANGIBLE PLANT		SQ			25	

Q. Why are those parameters appropriate?

A. Those parameters are appropriate because the parameters reflect the actual service life experienced by Aqua in serving wastewater customers in the Commonwealth of Pennsylvania and which were adjudicated by the PUC in PAWC's 2017 General Rate Case, PAWC's 2020 General Rate Case (Docket Nos. R-2020-3019369 and R-2020-30193371, respectively), and Aqua's 2018 General Rate Case (Docket No. R-2018-3003561). The parameters in the following table also reflect AUS Consultants' experience of the survival / retirement characteristics of normal and functional service lives of wastewater properties:

9 10 11 12 13

East Whiteland Township, Pennsylvania
East Whiteland Township's Wastewater Collection System and Purchased Treatment Capacity
Wastewater Collection System and Purchased Treatment Capacity
Investor-Owned Utility
January 8, 2021

Summary of Account Costing and Depreciation Parameters Used in the Depreciation Original Cost and the Depreciated Replacement Cost New Studies

(1)	(2)	(4)		(5)	(6)	
		(4a)	(4b)		(6a)	(6b)
Account Number	Description	Iowa Survivor / Retirement Curve	Normal Service Life	Economic Obsolescence	Tax Depreciation	
			years	% of CORLD	Table	Life
353.20	Land & Land Rights - Original Basin	ZNonDep	0.00	0.00%	Non-Depr	0.00
353.30	Land & Land Rights - Pumping	ZNonDep	0.00	0.00%	Non-Depr	0.00
354.20	Stuctures & Improvements - Treatment	R4.0	55.00	0.00%	MACRS	25.00
354.30	Stuctures & Improvements - Pumping	R4.0	45.00	0.00%	MACRS	25.00
360.21	Collection Sewers - Force - Mains	R3.0	75.00	0.00%	MACRS	25.00
361.21	Collection Sewers - Gravity - Mains	R2.5	80.00	0.00%	MACRS	25.00
361.23	Collection Sewers - Gravity - Manholes	R2.5	80.00	0.00%	MACRS	25.00
363.20	Service Laterals	R3.0	70.00	0.00%	MACRS	25.00
365.20	Flow Measuring Installations Meter Pits	S2.0	30.00	0.00%	MACRS	25.00
390.70	Office Furniture and Equipment	R3.0	12.00	0.00%	MACRS	12.00
391.70	Transportation Equipment	R3.0	10.00	0.00%	MACRS	10.00

Also, due the age of East Whiteland Township's early property installations, the maximum depreciation was limited to 85% of the cost new.

Q. What was the result of the application of the depreciation parameters to the previously described replacement cost new of $85,964,664?

A. With the application of the above-described depreciation parameters, the replacement cost new of $85,964,664 results in a replacement cost new less depreciation of $58,078,339 determined as follows:

East Whiteland Township, Pennsylvania
East Whiteland Township's Wastewater Collection System and Purchased Treatment Capacity
Wastewater Collection System and Purchased Treatment Capacity
Investor-Owned Utility
As of January 8, 2021

Replacement Cost New less Depreciation (RCNLD)

(18)	(19)	(21)	(22)	(23)	(24)	(28)	(29)	(30)	(31)
Account	Description	Age at January 8, 2021 Appraisal Date	Replacement Cost New (COR)	Retirement Dispersion Iowa-type	Normal Service Life (NSL)	Normal Remaining Life	Total Life Expectancy	Condition	Preliminary Cost Approach (COR less Normal Depreciation)
		years	COR $s		years	years	years	% of COR	CORLD $s
Input	Input	Calculation	Calculation	Input	Input	Calculation	Calculation	Calculation	Calculation
Eng Assmnt	East Whiteland Township Wastewater Assets Detail by Pennoni Associates, Inc.		Col (16)	AUS Input	AUS Input		Col (21) + (28)	Col (28) / (29)	Col (22) * (30)
Account	Description	Age	RCN	Iowa	NL	Rem Life	Total Life	Condition	CORLD
353.20	Land & Land Rights - Original Basin	31.62	720,020	ZNonDep	-	-	-	-	720,020
353.30	Land & Land Rights - Pumping	20.27	13,468	ZNonDep	-	-	-	-	13,468
354.30	Stuctures & Improvements - Pumping	14.58	12,142,235	R4.0	45.00	31.23	45.82	45.00	8,379,553
360.21	Collection Sewers - Force - Mains	29.95	5,971,267	R3.0	75.00	47.21	77.16	75.00	3,669,861
361.21	Collection Sewers - Gravity - Mains	33.23	30,582,161	R2.5	80.00	50.80	84.03	80.00	18,623,208
361.23	Collection Sewers - Gravity - Manholes	32.21	10,108,723	R2.5	80.00	51.66	83.87	80.00	6,272,518
363.20	Service Laterals	22.75	12,259,833	R3.0	70.00	48.95	71.70	70.00	8,428,787
365.20	Flow Measuring Installations Meter Pits	44.50	389,338	S2.0	30.00	4.50	49.00	30.00	58,401
354.20	Stuctures & Improvements - Treatment	6.78	13,511,701	R4.0	55.00	48.11	54.89	55.00	11,842,733
390.70	Office Furniture and Equipment	12.50	25,084	R3.0	12.00	2.20	14.70	12.00	3,763
391.70	Transportation Equipment	11.45	240,834	R3.0	10.00	2.91	14.35	10.00	66,027
Grand Total		24.57	85,964,664		68.23	46.41	70.71	0.68	58,078,339

The above replacement cost new less depreciation represents the cost approach of the tangible assets of East Whiteland Township's wastewater system. In addition to the above-described tangible assets, are intangible assets; in East Whiteland Township's case, which consist of the contracts associated with its wastewater treatment contracts held with the following communities:

Municipality	2020 YTD Projected
Charlestown Township	
Treatment Charge	80,068
Subtotal Charlestown Twp	80,068
Malvern Borough	
Treatment Charge	150,300
Subtotal Malvern Borough	150,300
East Whiteland Service Revenues	
Total Revenues	3,761,787

These contracts represent value assets which are included in the overall income and market approaches which are not specifically addressed in the cost approach of the tangible assets; therefore, in order to make the cost approach comparable to the income and market approaches these intangible assets were separately appraised and included in the cost approach totals. AUS Consultants developed an income approach estimate to the value which was relied upon for the contract values.

The 2020 budget estimate the revenues and expenses of the wastewater treatment contracts were used in order to develop the estimated operating income as a surrogate for the cash flows associated the wastewater treatment contracts. The estimated cash flows were next discounted to appraisal date values using the cost of capital of 5.65% i.e., the cost of capital of 6.99% with the embedded growth rate of 1.82% removed; the development of which is described in the Cost of Capital section of the workpapers. The income approach to the wastewater treatment contracts was developed as follows:

East Whiteland Township, Pennsylvania
East Whiteland Township's Wastewater Collection System and Purchased Treatment Capacity
Wastewater Collection System and Purchased Treatment Capacity
Investor-Owned Utility
As of January 8, 2021

Income Approach to Trearment Agreements Valuation

Municipality	2020 YTD Actual	2021 Projected		Expenses	Operating Income	Value Capitalized @ 5.65%
						5.65%
Charlestown Township						
Treatment Charge	80,068					
Subtotal Charlestown Twp	80,068	80,068	1.39%	45,324	34,744	614,938
Malvern Borough						
Treatment Charge	150,300					
Subtotal Malvern Borough	150,300	150,300	2.61%	85,105	65,195	1,153,894
Total East Whiteland Revenues						
Total Revenues	5,428,667	5,759,816		3,260,709		1,768,832

Based on the Income Approach analysis, the wastewater treatment contracts were determined to have a value of $1,768,832 which was included in the final cost approach to value as follows:

East Whiteland Township's Wastewater Collection System and Purchased Treatment Capacity
Wastewater Collection System and Purchased Treatment Capacity
Investor-Owned Utility
As of January 8, 2021

	Column Reference in OCLD & RCNLD	Amount in $s
Depreciated Replacement Cost (RCNLD)		
Original Cost (OC)	(9)	43,447,309
Replacement Cost New (RCN)	(16)	85,964,664
Replacement Cost New less Depreciation (RCNLD)	(31)	58,078,339
Intangible Assets - Treatment Contracts		1,768,832
Fair Market Vaue (FMV)	(41)	59,847,171

This conclusion which was tested for economic obsolescence based on the results of the income and market approaches which will be described in the remainder of this testimony. Based on our review of the preliminary cost approach and the results of the income and market approaches, no economic obsolescence exists at the preliminary cost approach conclusion of $59,847,171; therefore, the final cost approach conclusion was determined to be $59,847,171. These results are detailed in Application **Exhibit R** (AUS Appraisal) under the Cost Approach section.

Market Approach

Q. Regarding your application of the market approach, what methods did you use to determine the market approach result?

A. I used the comparable sales of water and wastewater properties in the Commonwealth of Pennsylvania subsequent to the passage of Section 1329 and financial market value ratios of publicly traded water and wastewater companies as reported in the January 1, 2021, issue of Value Line Investment Survey.

Q. What assumptions, analyses, and/or adjustments did you make under each method?

A. Under the comparable sales method, it is my opinion that sales amount to depreciated replacement cost is the best indicator in arriving at the appraised value of physical assets operating as a wastewater collection system. Under the financial ratios method, I believe that an accurate result depends on using the weighted mean of the ratio of the market debt and equity to book debt and equity.

Q. What were the results of each analysis you performed?

A. The comparable sales analysis produced a result of $56,178,539 detailed as follows:

East Whiteland Township, Pennsylvania
East Whiteland Township's Wastewater Collection System and Purchased Treatment Capacity
Wastewater Collection System and Purchased Treatment Capacity
Investor-Owned Utility
As of January 8, 2021

Comparable Sales Approach

Market Sales Data

Central Tendancy and Reliability Analysis

Market Sales Analysis - PP/OCLD

		Simple	Weighted	
Mean		1.7594	1.8494	
Standard Deviation		0.5882	0.4204	
Median		1.49	1.4355	
Mode	1.4418		1.4418	
Conclusion			1.8494	AUS Input
East Whiteland Township's Wastewater Collection System and Purchased Treatment Capacity OCLD			35,172,804	Cost Approach - OCLD
Market Value Indication			**65,048,584**	

Market Sales Analysis - PP/CORLD

		Simple	Weighted	
Mean		0.8087	0.9337	
Standard Deviation		0.1746	0.1695	
Median		0.8229	0.7558	
Mode	0.6918		0.6918	
Conclusion			0.9387	AUS Input
East Whiteland Township's Wastewater Collection System and Purchased Treatment Capacity CORLD			59,847,171	Cost Approach - CORLD
Market Value Indication			**56,178,539**	

Market Sales Analysis - PP/Customer

	Simple	Weighted	
Water Tretment & Distribution			
Mean	6,123	10,962	
Standard Deviation		4,613	
Median	5,021	4,963	
Wastewater Collection & Treatment		16,785	
Mean	9,579		
Standard Deviation		-	AUS Input
Median	8,754		
Wastewater Collection			
Mean	6,507		
Standard Deviation			
Median	6,636		
Watewater Treatment Only			
Mean	3,072		
Standard Deviation			
Median	2,118		
East Whiteland Township's Wastewater Collection System and Purchased Treatment Capacity Customers		3,918	AUS Input
Wastewater Collection & Treatment PP/Customer		8,754	AUS Input
Collection and Treatement Customers Market Value I		**34,298,172**	
Treatement Only Market Value Indication			
Treatment Only PP/customer		2,118	AUS Input
Treatment Only Customers		-	AUS Input
Market Value Indication Treatment Only		-	
Total Market Value Indication		**34,298,172**	

Financial Basis[1]

Financial Markets	Market Value per Share to Book Value per Share	
Market to Book (equity)	3.40	
Market to Book (equity and debt)	2.11	
Use (equity and debt)	2.11	AUS Input
East Whiteland Township's Wastewater Collection System and Purchased Treatment Capacity OCLD	33,403,972	Cost Approach - OCLD
Market Value Indication	**70,482,381**	

Market Sales Analysis - PP/Cash Flows (EBITDA Period 1-5)

	Simple	Weighted	
Mean	17.48	15.32	
Standard Deviation	5.71	5.10	
Median	17.41	18.13	
Mode	Not Applicable	Not Applicable	
Forecast			
Conclusion		18.00	AUS Input
East Whiteland Township's Wastewater Collection System and Purchased Treatment Capacity Cash		2,396,686	Income Approach
Market Value Indication		**43,140,348**	

Market Sales Analysis - PP/Cash Flows (EBITDA Period 1-13)

	Simple	Weighted	
Mean	11.62	11.45	
Standard Deviation	2.67	2.14	
Median	11.65	12.07	
Mode	Not Applicable	Not Applicable	
Forecast			
Conclusion		12.00	AUS Input
East Whiteland Township's Wastewater Collection System and Purchased Treatment		3,264,195	Income Approach
		39,170,336	

Summary of Market Analyses

Indicators	
OCLD	65,048,584
CORLD	56,178,539
Customers	34,298,172
Cash Flows	
EBITDA Periods 1-5	43,140,348
EBITDA Periods 1-13	39,170,336
Value Line	70,482,381
Mean	51,386,393
Median	49,659,444
Conclusion	**56,178,539**

Q. What was your market approach result?

A. I used the results of $56,178,539 because I believe those results represent an accurate assessment and it was based on the relationship of market comparable sales to the replacement cost new less depreciation of those properties. These results are detailed in Application **Exhibit R** (AUS Appraisal) under the Market Approach section.

Q. What was the calculation you used to determine your overall market approach results?

A. I used the weighted mean of the purchase price to replacement cost less depreciation.

Q. What comparable transactions or comparable sales did you evaluate to develop your market approach?

A. I examined the following transactions to develop the result of my market approach:

East Whiteland Township, Pennsylvania
East Whiteland Township's Wastewater Collection System and Purchased Treatment Capacity
Wastewater Collection System and Purchased Treatment Capacity
Investor-Owned Utility
As of January 8, 2021

Comparable Sales Approach

Market Sales Data

RowID	Approximate Date	Buyer	Seller	County	Type of Facility	Initial Purchase Price	Final Purchase Price[1]	Number of Total Customers	Relationship to the passage of Section 1329
1	9/1/2016	PA American Water	City of McKeesport	Allegheny	Wastewater Collection and Treatment	156,000,000	159,000,000	21,953	Post
2	8/1/2016	Aqua PA	New Garden Twp. SA	Chester	Wastewater Collection and Paid for and Owned Treatment	29,500,000	29,500,000	2,106	Post
3	11/16/2016	Aqua PA	Limerick Township	Montgomery	Wastewater Collection and Treatment System	75,100,000	64,373,378	5,434	Post
4	12/10/2017	Aqua PA	East Bradford Township	Chester	Wastewater Collection and paid for treatment	5,000,000	5,000,000	1,248	Post
5	4/20/2018	SUEZ	Mahoning	Carbon	Water Distribution System	4,734,800	4,734,800	1,186	Post
6	4/20/2018	SUEZ	Mahoning	Carbon	Wastewater Collection	4,765,200	4,765,200	1,451	Post
7	6/1/2018	Aqua PA	Cheltenham	Montgomery	Wastewater Collection	50,250,000	50,250,000	10,500	Post
8	11/14/2018	PA American Water	Steelton	Dauphin	Water Distribution and Treatment	22,500,000	21,750,000	2,325	Post
9	1/1/2017	PA American Water	Sadsbury	Chester	Wastewater Collection	9,250,000	8,600,000	998	Post
10	5/28/2018	PA American Water	Exeter	Berks	Wastewater Collection and Treatment	96,000,000	93,500,000	9,000	Post
11	10/29/2018	Aqua PA	East Norriton	Montgomery	Wastewater Collection	21,000,000	21,000,000	4,950	Post
12	9/30/2018	PA American	Kane	McKean	Wastewater Collection and Treatment	17,560,000	17,560,000	2,006	Post
13	12/10/2019	PA American	Royersford	Montgomery	Wastewater Collection and Treatment	13,000,000	13,000,000	1,596	Post
14	12/17/2019	PA American	Valley	Chester	Water Treatment and Distribution System	7,325,000	7,325,000	1,459	Post
15	12/17/2019	PA American	Valley	Chester	Wastewater Collection System	13,950,000	13,950,000	1,644	Post
16	12/31/2019	Aqua PA	Delaware County Regional \	Delaware	Wastewater Collection and Treatment	276,500,000	276,500,000	16,473	Post
17	4/28/2020	PA American Water	Upper Pottsgrove	Montgomery	Wastewater Collection	13,750,000	13,750,000	1,428	Post
18	9/17/2020	Aqua PA	Lower Makefield	Bucks	Wastewater Collection and Purchased Treatment Capacity	53,000,000	53,000,000	11,151	Post

Income Approach

Q. Regarding your application of the income approach, what method did you use to determine the income approach result?

A. I used the discounted cash flow method.

Q. What assumptions did you employ to develop your income approach result?

A. Under the income approach, it is my opinion that the results of the future operations of the East Whiteland Township's Wastewater Collection System and Purchased Treatment Capacity must be considered. I believe that an accurate result depends on adjusting recent results of the systems operation to better reflect how those results will migrate over future periods under the operation as a rate regulated wastewater system regulated by the PUC.

Q. What discount rate did you use to calculate your income approach?

A. I used a discount rate of 7.57% and 5.65% capitalization rate.

Q. Please explain how you developed the discount rate.

A. In each case, the discount rate was a market discount rate at the appraisal date and was determined using the weighted average cost of capital ("WACC") of both debt and equity. The inputs to the WACC determination, capital structure, cost of debt, cost of equity, and income tax rate (state and federal) were determined based on an analysis of Value Line Investment Surveys and the Ibbotson Stock, Bonds, Bills, and Inflation ("Ibbotson SBBI") 2021 Edition (SBBI activity over the period 1926 through 2020). The cost of debt was determined at January 1, 2021, based on the Value Line Selected Yields publication. The cost of equity was based on the capital asset pricing model ("CAPM") and the Dividend Growth Model ("DGM"), two recognized cost of equity estimating models and the PUC's Bureau of Technical Utility Services' Report on Quarterly Earnings of Jurisdictional Utilities for Year-ending December 31, 2020. The above-described data for the East Whiteland Township appraisal can be found in the exhibits to my appraisal report in the section entitled Cost of Capital / Required Return.

Q. What capital structure inputs differ from those identified in capital structure set forth earlier in your testimony?

A. None. As described in the previous discussion of the capital structure, we utilized a market required capital structure based on analysis of the water / wastewater industry's market capital structure as defined by analysis of market financials as published in Value Line Investment Survey (January 1, 2021). The theory in appraisal is to estimate the value of a property in an arm's length transaction wherein the purchaser finances the purchase with capital (debt and equity) available in the financial markets at the appraisal date. Those are the current (appraisal date) financial markets.

Q. What is the source and basis of the alternative input you propose in the income approach?

A. As discussed above, we had used Value Line Investment Survey to develop a market required capital structure. Please see Application **Exhibit R** (AUS Appraisal) Income Approach section for the cost of capital of the Income Approach and Cost of Capital / Required Return section for the basis of the Cost of Capital / Required Return.

Q. If you used a terminal value in your discounted cash flow analysis what is the number of years over which the cash flows are considered?

A. I considered those cash flows over 19 periods with period 20 representing all future periods.

Q. What is the basis for using this number of years?

A. It is my opinion that the use of 19 periods is a reasonable number of periods for the forecast revenues and expenses to stabilize.

Q. What is your Income Approach conclusion?

A. AUS Consultants' income approach conclusion was determined to be $55,600,045 detailed as follows:

East Whiteland Township, Pennsylvania
East Whiteland Township's Wastewater Collection System and Purchased Treatment Capacity
Wastewater Collection System and Purchased Treatment Capacity
Potential Purchaser: Investor-Owned Utility
As of January 8, 2021
Discounted Cash Flow Analysis

Discount Rate:			7.57%										
Capitalization Rate:			5.65%										
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Period	Age	Revenues	O&M Expenses	Tax Depreciation	Cash Flow from Operations	Taxable Income before State & Federal Taxes	State and Federal Taxes @ 28.89%	Capital Expenditures	Change in Working Capital	Net Cash Flows	Period Present Worth Factor (PW)	PW of Cashflow	Accumulated PW of Cashflows
					(3)-(4)	(6)-(5)	(7) *28.89%			(3)-(4)-(8)-(9)-(10)		(11)*(12)	Sum (13)
1	0.5	5,759,816	3,305,486	2,193,634	2,454,330	260,696	75,315	806,090	(78,093)	1,651,018	0.964	1,591,581	1,591,581
2	1.5	5,759,816	3,371,594	2,218,239	2,388,222	169,983	49,108	812,135	-	1,526,979	0.896	1,368,173	2,959,754
3	2.5	5,759,816	3,439,026	2,243,274	2,320,790	77,516	22,394	818,227	-	1,480,169	0.833	1,232,981	4,192,735
4	3.5	7,775,752	3,507,806	2,268,741	4,267,946	1,999,205	577,570	824,363	(27,334)	2,893,347	0.775	2,242,344	6,435,079
5	4.5	7,775,752	3,577,962	2,294,647	4,197,790	1,903,143	549,818	830,547	-	2,817,425	0.720	2,028,546	8,463,625
6	5.5	9,719,690	3,649,522	2,320,996	6,070,168	3,749,172	1,083,136	836,776	(26,356)	4,176,612	0.669	2,794,153	11,257,778
7	6.5	9,719,690	3,722,512	2,315,050	5,997,178	3,682,128	1,063,767	721,779	-	4,211,632	0.622	2,619,635	13,877,413
8	7.5	9,719,690	3,796,962	2,338,381	5,922,728	3,584,347	1,035,518	727,193	-	4,160,017	0.579	2,408,650	16,286,063
9	8.5	10,691,659	3,872,902	2,362,106	6,818,757	4,456,651	1,287,526	732,647	(13,178)	4,811,762	0.538	2,588,728	18,874,791
10	9.5	10,691,659	3,950,359	2,386,228	6,741,300	4,355,072	1,258,180	738,141	-	4,744,979	0.500	2,372,490	21,247,281
11	10.5	10,691,659	4,029,366	2,410,754	6,662,293	4,251,539	1,228,270	743,679	-	4,690,344	0.465	2,181,010	23,428,291
12	11.5	11,333,159	4,109,952	2,435,686	7,223,207	4,787,521	1,383,115	749,257	(8,698)	5,099,533	0.432	2,202,998	25,631,289
13	12.5	11,333,159	4,192,151	2,461,029	7,141,008	4,679,979	1,352,046	754,875	-	5,034,087	0.402	2,023,703	27,654,992
14	13.5	11,333,159	4,275,994	2,486,788	7,057,165	4,570,377	1,320,382	760,535	-	4,976,248	0.373	1,856,141	29,511,133
15	14.5	12,013,149	4,361,513	2,512,970	7,651,636	5,138,666	1,484,561	766,240	(9,219)	5,410,054	0.347	1,877,289	31,388,422
16	15.5	12,013,149	4,448,744	2,539,579	7,564,405	5,024,826	1,451,672	771,988	-	5,340,745	0.323	1,725,061	33,113,483
17	16.5	12,013,149	4,537,720	2,566,617	7,475,429	4,908,812	1,418,156	777,777	-	5,279,496	0.300	1,583,849	34,697,332
18	17.5	12,733,938	4,628,474	2,594,092	8,105,464	5,511,372	1,592,235	783,611	(9,773)	5,739,391	0.279	1,601,290	36,298,622
19	18.5	12,733,938	4,721,044	2,622,008	8,012,894	5,390,886	1,557,427	789,487	-	5,665,980	0.259	1,467,489	37,766,111
20 and beyond	19.5	12,733,938	4,815,465	2,650,370	7,918,473	5,268,103	1,521,955	795,408	-	5,601,110	3.184	17,833,934	55,600,045
								15,540,755					
Age				19.5									
PW(Age) = 1/(1+Discount Rate)$^{(Age)}$				0.241				Net Plant		44,551,804			
PW to Perpetuity = 1/Capitalization Rate				13.210				ADIT		(6,443,119)			
$PW_{(20 and Beyond)}$ = PW to Perpetuity * $PW Factor_{(19.5)}$				3.184				Rate Base		38,108,685	0.241	9,184,193	46,950,304
								Annual Plant Construction Inflation Rate		0.0422 Input			
								Plant Inflation over 19.5 years		87,105,453	0.241	20,992,414	58,758,525
								PP	54,930,000				
								OCLD	33,403,972				
								PP/OCLD	1.644				
								RCNLD	58,078,339				
								RCNLD/PP		1.057315474			
										40,292,902.78	0.241	9,710,590	47,476,701
								Average					52,196,394

These results are detailed in Application **Exhibit R** (AUS Appraisal) under the Income Approach section.

Q. What number of Selling Utility customers or equivalent dwelling units did you use to value the Seller's system and how did you develop that number?

A. I used 3,918 customers based on a customer listing provided by East Whiteland Township in developing the forecasted revenues and expenses. I also used past and budgeted results from operations to establish forecasted operating results.

Q. Did you make any updates to your appraisal after it was submitted to the Seller, and if so, what was the update, when was it made, and why was it necessary?

A. No.

Q. Does this conclude your direct testimony?

A. It does. However, by filing this direct testimony I understand that I may have the opportunity to submit additional testimony responsive to challenges to my appraisal.

Curriculum Vitae (CV) of Jerome C. Weinert, P.E., CDP, ASA

Mr. Weinert is currently Principal and Director of AUS Consultants, Depreciation and Valuation. He has forty-nine (2021-1972) years' experience in valuation and depreciation consulting and management. AUS, with offices across the country, has provided consulting services to the regulated utility industry nationally for over thirty-nine years. A partial list of services provided includes valuations depreciation studies, rate of return studies, cost of service studies, and rate design.

Prior to joining AUS in 1987, Mr. Weinert was employed by American Appraisal Associates, Inc. (American) for sixteen years in their Regulated Industries Group. He held various positions at American, the last being supervising appraiser. Among his other valuation responsibilities, he directed the firm's utility industry capital recovery studies and AUS Consultant's valuation of communication company assets and businesses.

Mr. Weinert graduated from the Milwaukee School of Engineering with a Bachelor of Science degree in Mechanical Engineering and received a master's in business administration from Marquette University. He is a registered professional engineer (1976) (by examination) in the state of Wisconsin as well as a senior member (1982) of the American Society of Appraisers in the public utility valuation field. This latter designation is obtained by written examination primarily in the areas of utility valuation, depreciation, and the economics of regulated firms. He is also a Certified Depreciation Professional (1997) (CDP) and founding member of the Society of Depreciation Professionals and the Society's 1995 President and sponsor of the Society's Certification and re-certification program as such Mr. Weinert developed these programs and oversaw their initial introduction into the Society. He also worked in conjunction with Society members in the development of the Society's training programs which as of 2003 has become the only such formalized depreciation training program in the North America and is an instructor in several of its courses.

During his professional career related to valuations and depreciation matters Mr. Weinert has testified before various courts and public service commissions on these subjects. He has also assisted numerous utilities in preparing capital recovery plans which specifically address the issues of plant replacement. Mr. Weinert has also presented expert testimony on valuation matters. Mr. Weinert has testified before the Pennsylvania Public Utility Commission on regulatory matters associated with Pennsylvania Section 1329 matters. On matters related to eminent domain issues, Mr. Weinert has presented expert testimony in the Massachusetts Superior Court, the Court of Common Pleas, Fayette County, Ohio, the New Hampshire Public Utilities Commission, the Twentieth Judicial Court (deposition only) in Charlotte County, Florida, the Nineteenth Judicial Circuit Court in St. Lucie County, Florida (deposition only). In regard to ad valorem taxation, Mr. Weinert has presented study results to the New York State Board of Equalization and Assessment (now the New York Office of Real Property Services (NY ORPS)), pertaining to useful life and net salvage values for all types of utility property subject to the Board's mass appraisal model. Mr. Weinert has appeared before the Valuation Adjustment Board in Florida for Duval, Hillsborough, Okeechobee, and Palm Beach counties, the Twelfth Judicial Circuit Sarasota County, Florida, the California Board of Equalization and Assessment, the Arizona Board of Assessment, the Missouri Board of Taxation, the Colorado and Texas Departments of Review, the Massachusetts Tax Appeal Court, the Superior Court of the State of Arizona in the County of Maricopa, the State Tax Appeal Board of the State of Montana, the New York City Tax Commission and the Public Utility Commission of Pennsylvania Section 1329 hearings (8).

Mr. Weinert has appeared before regulatory bodies in Alaska, Arkansas, Illinois, Indiana, Iowa, Missouri, Nevada, Nebraska, North Carolina, Ohio, Oregon, Pennsylvania, and South Carolina in support of rate-base valuation determination and capital recovery. He has presented testimony on depreciation matters before the Canadian Radio-Television and Telecommunications Commission (CRTC) and the United

States Federal Energy Regulatory Commission (FERC). In terms of water and wastewater acquisitions and applications for regulatory approval of rate base Mr. Weinert has testified for two investor-owned acquisitions of municipal wastewater authorities one representing the municipality and secondly for the acquiring investor-owned utility. He has submitted study results to the State Commissions of Alabama, Alaska, Arkansas, Idaho, Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, North Carolina, Oregon, Pennsylvania, South Carolina, Washington, and Wisconsin, and the Federal Communications Commission.

Mr. Weinert has presented papers on valuation and depreciation topics to professional and utility industry trade organizations. He also directed AUS Consultants' semi-annual week-long depreciation training programs (1988-1997). These specialized training courses, offered at basic and advanced levels, teach depreciation study techniques to public utility and public service commission staff specialists. The training includes depreciation theory and concepts and hands-on experience with personal computer-based analytical depreciation programs.

Appraisal & Capital Recovery Activities Client List

Company	Property	Study Year	Year Performed	Activity
2021				
AT&T Communications	North America	2020	2021	Ad Valorem Tax Appraisal
AT&T Communications	California	2020	2021	Ad Valorem Tax Appraisal
AT&T Communications	Florida	2020	2021	Ad Valorem Tax Appraisal
Verizon Business (formerly MCI)	North America	2020	2021	Ad Valorem Tax Appraisal
AT&T - Indiana Bell Telephone Company	Indiana	2020	2021	Ad Valorem Tax Appraisal
Verizon New York, Inc.	New York	2020	2021	Ad Valorem Tax Appraisal
Lower Makefield	Lower Makefield Wastewater	2020	2021	Fair Market Value 1329
Pennsylvania American Water Company	Brentwood Borough Wastewater	2020	2021	Fair Market Value 1329
2020				
AT&T Communications	North America	2019	2020	Ad Valorem Tax Appraisal
AT&T Communications	California	2019	2020	Ad Valorem Tax Appraisal
AT&T Communications	Florida	2019	2020	Ad Valorem Tax Appraisal
AT&T - Indiana Bell Telephone Company	Indiana	2019	2020	Ad Valorem Tax Appraisal
Verizon New York, Inc.	New York	2019	2020	Ad Valorem Tax Appraisal
Verizon Business (formerly MCI)	North America	2019	2020	Ad Valorem Tax Appraisal
East Norriton Township, PA	East Norriton Wastewater	2019	2020	Fair Market Value 1329
Pennsylvania American Water Company	Kane Wastewater	2019	2020	Fair Market Value 1329
Pennsylvania American Water Company	Royersford Wastewater	2019	2020	Fair Market Value 1329
Pennsylvania American Water Company	Valley Wastewater	2019	2020	Fair Market Value 1329
Pennsylvania American Water Company	Valley Water	2019	2020	Fair Market Value 1329
Lehigh County Authority	Allentown Water & Sewer	2020	2020	Financing
Pennsylvania American Water Company	Upper Pottsgrove wastewater	2020	2020	Fair Market Value 1329
2019				
AT&T Communications	North America	2018	2019	Ad Valorem Tax Appraisal
AT&T Communications	California	2018	2019	Ad Valorem Tax Appraisal
AT&T Communications	Florida	2018	2019	Ad Valorem Tax Appraisal
AT&T - Indiana Bell Telephone Company	Indiana	2018	2019	Ad Valorem Tax Appraisal
Embarq Florida, Inc.	Florida	2018	2019	Ad Valorem Tax Appraisal
Verizon Business (formerly MCI)	North America	2018	2019	Ad Valorem Tax Appraisal
Cheltenham Township, PA	Cheltenham Wastewater	2018	2019	Fair Market Value 1329
Pennsylvania American Water Company	Steelton Water	2018	2019	Fair Market Value 1329
Pennsylvania American Water Company	Exeter Wastewater	2018	2019	Fair Market Value 1329
2018				
AT&T Communications	North America	2017	2018	Ad Valorem Tax Appraisal
AT&T Communications	California	2017	2018	Ad Valorem Tax Appraisal
AT&T Communications	Florida	2017	2018	Ad Valorem Tax Appraisal
AT&T - Indiana Bell Telephone Company	Indiana	2017	2018	Ad Valorem Tax Appraisal
Embarq Florida, Inc.	Florida	2017	2018	Ad Valorem Tax Appraisal
Verizon Business (formerly MCI)	North America	2017	2018	Ad Valorem Tax Appraisal
Level 3 Communications, LLC	North America	2017	2018	Ad Valorem Tax Appraisal
Level 3 Communications, LLC	California	2017	2018	Ad Valorem Tax Appraisal
CenturyLink Communications, LLC	North America	2017	2018	Ad Valorem Tax Appraisal
CenturyLink Communications, LLC	California	2017	2018	Ad Valorem Tax Appraisal
East Bradford Township, PA	East Bradford Wastewater	2018	2018	Fair Market Value 1329

Appraisal & Capital Recovery Activities Client List

Company	Property	Study Year	Year Performed	Activity
Pennsylvania American Water Company	Sadsbury Wastewater	2017	2018	Fair Market Value Appraisal
Pennsylvania American Water Company	Kane Wastewater	2017	2018	Fair Market Value Appraisal
2017				
AT&T Communications	North America	2016	2017	Ad Valorem Tax Appraisal
AT&T Communications	California	2016	2017	Ad Valorem Tax Appraisal
AT&T Communications	Florida	2016	2017	Ad Valorem Tax Appraisal
AT&T - Indiana Bell Telephone Company	Indiana	2016	2017	Ad Valorem Tax Appraisal
Embarq Florida, Inc.	Florida	2016	2017	Ad Valorem Tax Appraisal
Verizon Communications	Florida	2016	2017	Ad Valorem Tax Appraisal
Verizon Business (formerly MCI)	North America	2016	2017	Ad Valorem Tax Appraisal
Level 3 Communications	North America	2016	2017	Ad Valorem Tax Appraisal
Level 3 Communications	California	2016	2017	Ad Valorem Tax Appraisal
Whitpain Township, PA	Whitpain Wastewater	2016	2017	Appraisal for Planning
Plymouth Township, PA	Plymouth Wastewater	2016	2017	Appraisal for Planning
East Norriton Township, PA	East Norriton Wastewater	2016	2017	Appraisal for Planning
Pennsylvania American Water Company	Sadsbury Wastewater	2016	2017	Fair Market Value Appraisal
Pennsylvania American Water Company	McKeesport Wastewater	2016	2017	Fair Market Value Appraisal
Intermountain Gas Company	Idaho	2016	2017	Depreciation Study
2016				
AT&T Communications	North America	2015	2016	Ad Valorem Tax Appraisal
AT&T Communications	California	2015	2016	Ad Valorem Tax Appraisal
AT&T Communications	Florida	2015	2016	Ad Valorem Tax Appraisal
AT&T - Indiana Bell Telephone Company	Indiana	2015	2016	Ad Valorem Tax Appraisal
Embarq Florida, Inc.	Florida	2015	2016	Ad Valorem Tax Appraisal
Verizon Communications	Florida	2015	2016	Ad Valorem Tax Appraisal
Verizon Business (formerly MCI)	North America	2015	2016	Ad Valorem Tax Appraisal
Level 3 Communications	North America,	2015	2016	Ad Valorem Tax Appraisal
Level 3 Communications	California	2015	2016	Ad Valorem Tax Appraisal
New Garden Township, PA	New Garden Wastewater	2016	2016	Fair Market Value Appraisal
2015				
AT&T Communications	North America	2014	2015	Ad Valorem Tax Appraisal
AT&T Communications	California	2014	2015	Ad Valorem Tax Appraisal
AT&T Communications	Florida	2014	2015	Ad Valorem Tax Appraisal
AT&T - Indiana Bell Telephone Company	Indiana	2014	2015	Ad Valorem Tax Appraisal
Embarq Florida, Inc.	Florida	2014	2015	Ad Valorem Tax Appraisal
Verizon Communications	Florida	2014	2015	Ad Valorem Tax Appraisal
Verizon Business (formerly MCI)	North America	2014	2015	Ad Valorem Tax Appraisal
Level 3 Communications	North America,	2014	2015	Ad Valorem Tax Appraisal
Level 3 Communications	California	2014	2015	Ad Valorem Tax Appraisal
Verizon Wireless	Nationwide	2014	2015	Ad Valorem Tax Appraisal
2014				
AT&T Communications	North America	2013	2014	Ad Valorem Tax Appraisal
AT&T Communications	California	2013	2014	Ad Valorem Tax Appraisal
AT&T Communications	Florida	2013	2014	Ad Valorem Tax Appraisal

Appraisal & Capital Recovery Activities Client List

Company	Property	Study Year	Year Performed	Activity
AT&T - Indiana Bell Telephone Company	Indiana	2013	2014	Ad Valorem Tax Appraisal
Embarq Florida, Inc.	Florida	2013	2014	Ad Valorem Tax Appraisal
Verizon Communications	Florida	2013	2014	Ad Valorem Tax Appraisal
Verizon Business (formerly MCI)	North America	2013	2014	Ad Valorem Tax Appraisal
Level 3 Communications	North America,	2013	2014	Ad Valorem Tax Appraisal
Level 3 Communications	California	2013	2014	Ad Valorem Tax Appraisal
Cascade Natural Gas Corporation	Oregon & Washington	2013	2014	Depreciation Study
Intermountain Gas Company	Idaho	2013	2014	Depreciation Study
Virgin Islands Telephone Corporation	US Virgin Islands	2013	2014	Depreciation Study
Verizon Wireless	Nationwide	2013	2014	Ad Valorem Tax Appraisal

2013

Company	Property	Study Year	Year Performed	Activity
AT&T Communications	North America	2012	2013	Ad Valorem Tax Appraisal
AT&T Communications	California	2012	2013	Ad Valorem Tax Appraisal
AT&T Communications	Florida	2012	2013	Ad Valorem Tax Appraisal
AT&T - Indiana Bell Telephone Company	Indiana	2012	2013	Ad Valorem Tax Appraisal
AT&T - Michigan Bell Telephone Company	Michigan	2012	2013	Ad Valorem Tax Appraisal
Embarq Florida, Inc.	Florida	2012	2013	Ad Valorem Tax Appraisal
Verizon Communications	Florida	2012	2013	Ad Valorem Tax Appraisal
Verizon Communications	New England - Mass	2012	2013	Ad Valorem Tax Appraisal
Verizon Business (formerly MCI)	North America	2012	2013	Ad Valorem Tax Appraisal
Level 3 Communications	North America, California	2012	2013	Ad Valorem Tax Appraisal
Sprint Nextel Corporation	North America	2012	2013	Ad Valorem Tax Appraisal
Verizon Wireless	Palm Beach, Florida	2012	2013	Ad Valorem Tax Appraisal
Verizon Communications	New England Mass	2002-2007	2013	Ad Valorem Tax Appraisal

2012

Company	Property	Study Year	Year Performed	Activity
AT&T Communications	North America	2011	2012	Ad Valorem Tax Appraisal
AT&T Communications	California	2011	2012	Ad Valorem Tax Appraisal
AT&T Communications	Florida	2011	2012	Ad Valorem Tax Appraisal
AT&T - Indiana Bell Telephone Company	Indiana	2011	2012	Ad Valorem Tax Appraisal
AT&T - Michigan Bell Telephone Company	Michigan	2011	2012	Ad Valorem Tax Appraisal
Embarq Florida, Inc.	Florida	2011	2012	Ad Valorem Tax Appraisal
Verizon Communications	Florida	2011	2012	Ad Valorem Tax Appraisal
Verizon Communications	New England - Mass	2011	2012	Ad Valorem Tax Appraisal
Verizon Business (formerly MCI)	North America	2011	2012	Ad Valorem Tax Appraisal
Level 3 Communications	North America, California	2011	2012	Ad Valorem Tax Appraisal
Sprint Nextel Corporation	North America	2011	2012	Ad Valorem Tax Appraisal
Verizon Wireless	Palm Beach, Florida	2011	2012	Ad Valorem Tax Appraisal
MetroPCS	Palm Beach, Florida	2011	2012	Ad Valorem Tax Appraisal
Verizon Communications	Florida - revised	2008	2012	Ad Valorem Tax Appraisal
Verizon Wireless	Palm Beach, Florida	2012	2012	Ad Valorem Tax Appraisal

2011

Company	Property	Study Year	Year Performed	Activity
AT&T Communications	North America	2010	2011	Ad Valorem Tax Appraisal
AT&T Communications	California	2010	2011	Ad Valorem Tax Appraisal
AT&T Communications	Florida	2010	2011	Ad Valorem Tax Appraisal
AT&T - Indiana Bell Telephone Company	Indiana	2010	2011	Ad Valorem Tax Appraisal

Appraisal & Capital Recovery Activities Client List

Company	Property	Study Year	Year Performed	Activity
AT&T - Michigan Bell Telephone Company	Michigan	2010	2011	Ad Valorem Tax Appraisal
Embarq Florida, Inc.	Florida	2010	2011	Ad Valorem Tax Appraisal
Verizon Communications	Florida	2010	2011	Ad Valorem Tax Appraisal
Verizon Communications	New England - Mass	2010	2011	Ad Valorem Tax Appraisal
Verizon Business (formerly MCI)	North America	2010	2011	Ad Valorem Tax Appraisal
Level 3 Communications	North America, California	2010	2011	Ad Valorem Tax Appraisal
Global Crossing	North America	2010	2011	Ad Valorem Tax Appraisal
Intermountain Gas Company	Idaho	2010	2011	Depreciation Study
Sprint Nextel Corporation	North America	2010	2011	Ad Valorem Tax Appraisal
Verizon Wireless	Palm Beach, Florida	2010	2011	Ad Valorem Tax Appraisal
MetroPCS	Palm Beach, Florida	2010	2011	Ad Valorem Tax Appraisal
Verizon Communications	Florida - revised	2008	2011	Ad Valorem Tax Appraisal
Intermountain Gas Company	Idaho	2010	2011	Depreciation Study
Virgin Islands Telephone Corporation	US Virgin Islands	2010	2011	Technical Update of Depreciation Study

2010

Company	Property	Study Year	Year Performed	Activity
AT&T Communications	North America	2009	2010	Ad Valorem Tax Appraisal
AT&T Communications	California	2009	2010	Ad Valorem Tax Appraisal
AT&T Communications	Florida	2009	2010	Ad Valorem Tax Appraisal
AT&T - Indiana Bell Telephone Company	Indiana	2009	2010	Ad Valorem Tax Appraisal
AT&T - Michigan Bell Telephone Company	Michigan	2009	2010	Ad Valorem Tax Appraisal
AT&T - Southwestern Bell Telephone Company	Arkansas, Kansas, Missouri, Oklahoma, Texas	2009	2010	Ad Valorem Tax Appraisal
Embarq Florida, Inc.	Florida	2009	2010	Ad Valorem Tax Appraisal
Embarq Missouri, Inc.	Missouri	2009	2010	Ad Valorem Tax Appraisal
Verizon Communications	Florida	2009	2010	Ad Valorem Tax Appraisal
Verizon Communications	Northwest	2009	2010	Ad Valorem Tax Appraisal
Verizon Communications	New England - Mass	2009	2010	Ad Valorem Tax Appraisal
Verizon Business (formerly MCI)	North America	2009	2010	Ad Valorem Tax Appraisal
Level 3 Communications	North America, California	2009	2010	Ad Valorem Tax Appraisal
Global Crossing	North America	2009	2010	Ad Valorem Tax Appraisal
MetroPCS	Palm Beach, Florida	2009	2010	Ad Valorem Tax Appraisal

2009

Company	Property	Study Year	Year Performed	Activity
AT&T Communications	North America	2008	2009	Ad Valorem Tax Appraisal
AT&T Communications	California	2008	2009	Ad Valorem Tax Appraisal
AT&T Communications	Florida	2008	2009	Ad Valorem Tax Appraisal
AT&T - Indiana Bell Telephone Company	Indiana	2008	2009	Ad Valorem Tax Appraisal
AT&T - Michigan Bell Telephone Company	Michigan	2008	2009	Ad Valorem Tax Appraisal
AT&T - Wisconsin Bell Telephone Company	Wisconsin	2008	2009	Ad Valorem Tax Appraisal
AT&T - Southwestern Bell Telephone Company	Arkansas, Kansas, Missouri, Oklahoma, Texas	2008	2009	Ad Valorem Tax Appraisal
Embarq Florida, Inc.	Florida	2008	2009	Ad Valorem Tax Appraisal
Embarq Texas, Inc.	Texas	2008	2009	Ad Valorem Tax Appraisal
Embarq Missouri, Inc.	Missouri	2008	2009	Ad Valorem Tax Appraisal
Embarq Northwest	Washington	2008	2009	Ad Valorem Tax Appraisal

Appraisal & Capital Recovery Activities Client List

Company	Property	Study Year	Year Performed	Activity
Embarq Virginia	Virginia	2008	2009	Ad Valorem Tax Appraisal
Verizon Communications	Florida	2008	2009	Ad Valorem Tax Appraisal
Verizon Communications	Northwest	2008	2009	Ad Valorem Tax Appraisal
Verizon Communications	New England - Mass	2008	2009	Ad Valorem Tax Appraisal
Verizon Business (formerly MCI)	North America	2008	2009	Ad Valorem Tax Appraisal
Level 3 Communications	North America, California, Michigan & Arizona	2008	2009	Ad Valorem Tax Appraisal
Global Crossing	North America	2008	2009	Ad Valorem Tax Appraisal
AboveNet, Inc	North America/California	2003	2009	Ad Valorem Tax Appraisal
Verizon Wireless	Ohio Properties	2004-2005	2009	Ad Valorem Tax Appraisal
Virgin Islands Telephone Corporation	US Virgin Islands	2008	2009	Depreciation Study
Sprint Nextel Corporation	North America	2008	2009	Ad Valorem Tax Appraisal
2008				
AT&T Communications	North America	2007	2008	Ad Valorem Tax Appraisal
AT&T Communications	California	2007	2008	Ad Valorem Tax Appraisal
AT&T - Indiana Bell Telephone Company	Indiana	2007	2008	Ad Valorem Tax Appraisal
AT&T - Michigan Bell Telephone Company	Michigan	2007	2008	Ad Valorem Tax Appraisal
AT&T - Wisconsin Bell Telephone Company	Wisconsin	2007	2008	Ad Valorem Tax Appraisal
AT&T - Southwestern Bell Telephone Company	Arkansas, Kansas, Missouri, Oklahoma, Texas	2007	2008	Ad Valorem Tax Appraisal
Embarq Florida, Inc.	Florida	2007	2008	Ad Valorem Tax Appraisal
Embarq Texas, Inc.	Texas	2007	2008	Ad Valorem Tax Appraisal
Embarq Missouri, Inc.	Missouri	2007	2008	Ad Valorem Tax Appraisal
Embarq Northwest	Washington	2007	2008	Ad Valorem Tax Appraisal
Embarq Virginia	Virginia	2007	2008	Ad Valorem Tax Appraisal
Verizon Communications	Florida	2007	2008	Ad Valorem Tax Appraisal
Verizon Communications	California	2007	2008	Ad Valorem Tax Appraisal
Verizon Communications	Northwest	2007	2008	Ad Valorem Tax Appraisal
Verizon Communications	New England Mass	2002-2007	2008	Ad Valorem Tax Appraisal
Verizon Business (formerly MCI)	North America	2007	2008	Ad Valorem Tax Appraisal
Level 3 Communications	North America, California, Michigan & Arizona	2007	2008	Ad Valorem Tax Appraisal
Global Crossing	North America	2007	2007	Ad Valorem Tax Appraisal
Intermountain Gas Company	Idaho	2007	2008	Depreciation Study
2007				
AT&T Communications	North America	2006	2007	Ad Valorem Tax Appraisal
AT&T Communications	California	2006	2007	Ad Valorem Tax Appraisal
AT&T - Indiana Bell Telephone Company	Indiana	2006	2007	Ad Valorem Tax Appraisal
AT&T - Michigan Bell Telephone Company	Michigan	2006	2007	Ad Valorem Tax Appraisal
AT&T - Wisconsin Bell Telephone Company	Wisconsin	2006	2007	Ad Valorem Tax Appraisal
Embarq Florida, Inc.	Florida	2006	2007	Ad Valorem Tax Appraisal
Embarq Texas, Inc.	Texas,	2006	2007	Ad Valorem Tax Appraisal
Embarq Missouri, Inc.	Missouri	2006	2007	Ad Valorem Tax Appraisal
Embarq North Carolina	North Carolina	2006	2007	Ad Valorem Tax Appraisal
Embarq Virginia	Virginia	2006	2007	Ad Valorem Tax Appraisal
Verizon Communications	Florida	2006	2007	Ad Valorem Tax Appraisal
Verizon Communications	California	2006	2007	Ad Valorem Tax Appraisal
Verizon Communications	Northwest	2006	2007	Ad Valorem Tax Appraisal
Verizon Business (formerly MCI)	North America	2006	2007	Ad Valorem Tax Appraisal

Appraisal & Capital Recovery Activities Client List

Company	Property	Study Year	Year Performed	Activity
Qwest Communications Corporation	North America California	2006	2007	Ad Valorem Tax Appraisal
Level 3 Communications	North America, California, Michigan, & Arizona	2006	2007	Ad Valorem Tax Appraisal
Level 3 Communications	Arizona	2002 - 2006	2007	Ad Valorem Tax Appraisal
Global Crossing	North America	2006	2007	Ad Valorem Tax Appraisal
Alaska Communications System, Inc. (ACS)	ACS of Alaska ACS of Anchorage ACS of Fairbanks ACS of the Northland ACS Holdings	2006	2007	Depreciation Studies
Intermountain Gas Company	Idaho	2006	2007	Depreciation Study
2006				
AT&T Communications	Palm Beach Florida	2000 - 2003	2006	Ad Valorem Tax Appraisal
AT&T Communications	North America	2005	2006	Ad Valorem Tax Appraisal
AT&T Communications	California	2005	2006	Ad Valorem Tax Appraisal
Sprint Florida, Inc.	Florida	2005	2006	Ad Valorem Tax Appraisal
Sprint Texas, Inc.	Texas,	2005	2006	Ad Valorem Tax Appraisal
Sprint Missouri, Inc.	Missouri	2005	2006	Ad Valorem Tax Appraisal
Sprint North Carolina	North Carolina	2005	2006	Ad Valorem Tax Appraisal
Sprint Virginia	Virginia	2005	2006	Ad Valorem Tax Appraisal
Embarq Nevada	Nevada	2005	2006	Ad Valorem Tax Appraisal
Verizon Communications	Florida	2005	2006	Ad Valorem Tax Appraisal
Verizon Communications	California	2005	2006	Ad Valorem Tax Appraisal
Verizon Communications	Northwest	2005	2006	Ad Valorem Tax Appraisal
Verizon Business (formerly MCI)	Massachusetts	2002-2--5	2006	Ad Valorem Tax Appraisal
Level 3 Communications	North America	2005	2006	Ad Valorem Tax Appraisal
Level 3 Communications	Arizona	2002-2006	2006	Ad Valorem Tax Appraisal
Global Crossing	North America	2005	2006	Ad Valorem Tax Appraisal
Indianapolis Power & Light	IPL	2005	2006	Depreciation Study
2005				
AT&T Communications	North America	2004	2005	Ad Valorem Tax Appraisal
AT&T Communications	California	2004	2005	Ad Valorem Tax Appraisal
Sprint Florida, Inc.	Florida	2004	2005	Ad Valorem Tax Appraisal
Sprint PCS	North America	2004	2005	Ad Valorem Tax Appraisal
Verizon Communications	Florida	2004	2005	Ad Valorem Tax Appraisal
Verizon Communications	California	2004	2005	Ad Valorem Tax Appraisal
Verizon Communications	Northwest	2004	2005	Ad Valorem Tax Appraisal
Sprint Communications, LP	North America	2004	2005	Ad Valorem Tax Appraisal
Level 3 Communications	North America	2004	2005	Ad Valorem Tax Appraisal
Global Crossing	North America	2004	2005	Ad Valorem Tax Appraisal
Global Crossing	New York Special Franchise Property	2003 & 2004	2005	Ad Valorem Tax Appraisal
Indianapolis Power & Light	IPL	2004	2005	Depreciation Study
2004				
Sprint Florida, Inc.	Florida	2003	2004	Ad Valorem Tax Appraisal
Verizon Communications	California	2003	2004	Ad Valorem Tax Appraisal

Appraisal & Capital Recovery Activities Client List

Company	Property	Study Year	Year Performed	Activity
Verizon Communications	Northwest	2003	2004	Ad Valorem Tax Appraisal
Verizon Communications	New England	2003	2004	Ad Valorem Tax Appraisal
Sprint Communications, LP	North America	2003	2004	Ad Valorem Tax Appraisal
Level 3 Communications	North America	2003	2004	Ad Valorem Tax Appraisal
Global Crossing	North America	2003	2004	Ad Valorem Tax Appraisal
Sprint PCS	Cost Indexes	2003	2004	Ad Valorem Tax Appraisal
AT&T Communications	North America	2003	2004	Ad Valorem Tax Appraisal
AT&T Communications	California	2003	2004	Ad Valorem Tax Appraisal
Intermountain Gas Company	Idaho	2003	2004	Depreciation Study
2003				
Sprint Florida, Inc.	Florida	2002	2003	Ad Valorem Tax Appraisal
Verizon Communications	California	2002	2003	Ad Valorem Tax Appraisal
Verizon Communications	Northwest	2002	2003	Ad Valorem Tax Appraisal
Sprint Communications, LP	North America	2002	2003	Ad Valorem Tax Appraisal
Level 3 Communications	North America	2002	2003	Ad Valorem Tax Appraisal
Sprint PCS	Cost Indexes	2002	2003	Ad Valorem Tax Appraisal
AT&T Communications	North America	2002	2003	Ad Valorem Tax Appraisal
AT&T Communications	California	2002	2003	Ad Valorem Tax Appraisal
Global Crossing	North America	2002	2003	Ad Valorem Tax Appraisal
Verizon Wireless	Broward County, FL	1998 through 2002	2003	Ad Valorem Tax Appraisal
2002				
Sprint Florida, Inc.	Florida	2001	2002	Ad Valorem Tax Appraisal
Verizon Communications	California	2001	2002	Ad Valorem Tax Appraisal
Verizon Communications	Northwest	2001	2002	Ad Valorem Tax Appraisal
Sprint Communications, LP	North America	2001	2002	Ad Valorem Tax Appraisal
Level 3 Communications	North America	2001	2002	Ad Valorem Tax Appraisal
Global Crossing	North America	2001	2002	Ad Valorem Tax Appraisal
AT&T Wireless	Plymouth, MI	2001	2002	Ad Valorem Tax Appraisal
Sprint PCS	Cost Indexes	2001	2002	Ad Valorem Tax Appraisal
AT&T Communications	North America	2001	2002	Ad Valorem Tax Appraisal
Intermountain Gas Company	Idaho	2001	2002	Depreciation Study
AT&T Communications	California	2001	2002	Ad Valorem Tax Appraisal
2001				
Verizon	Verizon - New York	2001	2001-2	Functional Obsolescence & Useful Life studies for valuation
Sprint Florida, Inc.	Sprint Florida, Inc.	2000	2001	Ad Valorem Tax Appraisal
Verizon Communications	California	2000	2001	Ad Valorem Tax Appraisal
Sprint Communications, LP	North America	2000	2001	Ad Valorem Tax Appraisal
Global Crossing	North America	2000	2001	Ad Valorem Tax Appraisal
Sprint PCS	Cost Indexes	2000	2001	Ad Valorem Tax Appraisal
Sprint Corporation	Centel - Nevada	2000	2001-2	Depreciation Study
Alaska Communications System, Inc. (ACS)	ACS of Alaska ACS of Anchorage ACS of Fairbanks ACS of the Northland ACS Holdings	2000	2001	Depreciation Study

Appraisal & Capital Recovery Activities Client List

Company	Property	Study Year	Year Performed	Activity
2000				
Sprint PCS	BTS Equipment	2000	2000	Economic Life Study
Telus Communications	Telus - Alberta & British Columbia	2000	2000	Depreciation study Phase III Price Caps
Sprint Florida, Inc.	Florida	1999	2000	Ad Valorem Tax Appraisal
Verizon Communications	California	1999	2000	Ad Valorem Tax Appraisal
Sprint Communications, LP	North America	1999	2000	Ad Valorem Tax Appraisal
1999				
Sprint Corporation	Centel - Nevada	1998	1999	Depreciation Study
Intermountain Gas Company	Intermountain Gas Company	1998	1999	Depreciation Study
Sprint Florida, Inc.	Florida	1998	1999	Ad Valorem Tax Appraisal
Sprint Communications, LP	North America	1998	1999	Ad Valorem Tax Appraisal
1998				
Frontier Corporation	Frontier Telephone of Rochester	1998	1997	Valuation depreciation Lives and Net Salvage Parameters
Pacific Telecom, Inc.	Telephone Utilities of Washington	1997	1998	Depreciation Study
Sprint Florida, Inc.	Florida	1997	1998	Ad Valorem Tax Appraisal
Verizon Communications	Florida	1997	1998	Ad Valorem Tax Appraisal
Sprint Communications, LP	North America	1997	1998	Ad Valorem Tax Appraisal
Sprint Corporation	United Telephone Company of South Carolina	1998	1998	Depreciation Expense Universal Service Fund
Sprint Corporation	Carolina Telephone and Telegraph and Central Telephone of North Carolina	1998	1998	Depreciation Expense Universal Service Fund
Telus Communications	Telus - Edmonton (TCE)	1997	1998	Depreciation Study Phase II Price Caps
1997				
Sprint Corporation	Centel - Nevada	1997	1997	Unbundling/ Inter-connection Depreciation Study
Pacific Telecom, Inc.	Telephone Utilities of Oregon	1996	1997	Depreciation Study
Pacific Telecom, Inc.	Telephone Utilities of Alaska And the Northland	1996	1997	Depreciation Study
Telus Communications	Telus - TCI formerly AGT	1996	1997	Depreciation Study Phase II Price Caps
Indianapolis Power & Light	IPL	1996	1997	Depreciation Study
Sprint Florida, Inc.	Florida	1996	1997	Ad Valorem Tax Appraisal

Appraisal & Capital Recovery Activities Client List

Company	Property	Study Year	Year Performed	Activity
Verizon Communications	Florida	1996	1997	Ad Valorem Tax Appraisal
Pacific Telecom, Inc.	Eagle Telephone (Colorado)	1996	1997	Depreciation Study
1996				
Intermountain Gas Company	Intermountain Gas Company	1995	1996	Depreciation Study
Sprint Florida, Inc.	Florida	1995	1996	Ad Valorem Tax Appraisal
Century Telephone	Century Telephone of Ohio, Inc.	1995	1996	Depreciation Study
Telus Communications	AGT Limited (Alberta Government Telephones)	1995	1996	Depreciation Study
Johnson County Kansas Office of the Assessor	Useful Life of Computer Equipment	1995	1995	Useful/Market Life Analysis
Milwaukee Metropolitan Sewerage District	Milwaukee Metropolitan Sewerage District	1995	1996	Depreciation Study
Sprint Corporation	Long Distance Division	1995	1995	Depreciation/Recovery Status Study
Sprint Corporation	Cellular Division	1995	1995	Depreciation/Recovery Status Study
Pacific Telecom, Inc.	Alascom, Inc.	1994	1995	Depreciation Study
Pacific Telecom, Inc.	Telephone Utilities of the Northland	1993	1994	Depreciation Study
	Telephone Utilities of Alaska	1993	1994	Depreciation Study
Indiana Energy	Indiana Gas Company	1993	1994	Depreciation Study
Columbia Gas Transmission	Gas Pipeline Property in Sullivan County, NY	1993	1993	Useful Life Study
United Telephone - Midwest Group	United Telephone Company of Missouri	1993	1993	Modernization/ Depreciation Study
Intermountain Gas Co.	Intermountain Gas Co.	1992	1993	Depreciation Study
Pacific Telecom, Inc.	Alascom, Inc.	1992	1993	Depreciation Study
	Telephone Utilities of Oregon, Inc.	1991	1992	Depreciation Study
	Telephone Utilities of Washington, Inc.	1991	1992	Depreciation Study
Small Telephone Company Coalition	Oregon Small Telephone Companies	1991	1992	Depreciation Support

Appraisal & Capital Recovery Activities Client List

Company	Property	Study Year	Year Performed	Activity
United Telephone Systems	United Telephone Co. of Pennsylvania	1991	1992	Instructional Depreciation Study
New York State Division of Equalization and Assessment	Electric, Gas, Water, Telephone, Pipeline, Steam, CATV	1991	1992	Useful Lives and Net Salvage Values
Rochester Telephone Company	Enterprise Telephone	1991	1992	Study Review
Indiana Energy	Indiana Gas/Richmond Gas/ Terre Haute Gas	1990	1991	Depreciation Study
American Electric Power	Indiana/Michigan Power Co.	1990	1991	Depreciation Study
Rochester Telephone Company	Rochester Telephone Co.	1990	1991	Study Review
United Telephone Systems	United Telephone Co. of Florida	1990	1991	Instructional Depreciation Study
United Telephone Systems	United Telephone Co. of Oregon	1989	1990	Study Review
Telephone and Data Systems, Inc.	Quincy Telephone Company	1990	1991	Depreciation Study
Telephone and Data Systems, Inc.	Wolverine Telephone Company	1989	1990	Depreciation Study
Indiana Energy	Indiana Gas Company, Inc.	1989	1990	Depreciation Study
Intermountain Gas Co.	Intermountain Gas Co.	1989	1990	Remaining Life/Net Salvage Support
North-West Telephone Company	North-West Telephone Company	1989	1990	Study Review
United Telephone System	United of Texas	1989	1990	Instructional Depreciation Study
	United of Missouri	1989	1990	Instructional Depreciation Study
Milwaukee Water	Milwaukee Water	1989	1990	Depreciation Study
Indiana Natural Gas Corp.	Indiana Natural Gas Corp.	1989	1990	Depreciation Study
Pacific Telecom	Telephone Utilities of the Northland	1989	1990	Depreciation Study

Appraisal & Capital Recovery Activities Client List

Company	Property	Study Year	Year Performed	Activity
	Telephone Utilities of Alaska	1989	1990	Depreciation Study
	Alascom	1989	1990	Depreciation Study
	Telephone Utilities of Washington, Inc.	1988	1989	Depreciation Study
WICOR	Wisconsin Gas Company	1988	1989	Depreciation Study
ALLTEL	ALLTEL - Kentucky, Inc.	1987	1989	Depreciation Study
	ALLTEL - Ohio, Inc.	1988	1989	Depreciation Study
	Western Reserve Telephone Company	1988	1989	Depreciation Study
Milwaukee Metropolitan Sewer District	Milwaukee Metropolitan Sewer District	1988	1989	Depreciation Study
United Telephone	United of Ohio	1988	1989	ELG Support
		1988	1989	ELG Support
Telephone Company	Telephone Company			
United Telecom	U.S. Sprint	1988	1988	Useful Life Study
Pacific Telecom	Telephone Utilities of Oregon	1987	1988	Depreciation Study
	Telephone Utilities of Eastern Oregon	1987	1988	Depreciation Study
	Rose Valley Telephone Company	1987	1988	Depreciation Study
United Telephone	United of Minnesota	1987	1988	Capital Planning Support
Wisconsin Southern Gas	Wisconsin Southern Gas	1987	1988	Depreciation Study
Pacific Telecom	Glacier State Telephone Company	1986	1987	Depreciation Study
	Sitka Telephone Co.	1986	1987	Depreciation Study
	Juneau-Douglas Tel Company	1986	1987	Depreciation Study
Pacific Telecom	Telephone Utilities of Alaska	1986	1987	Depreciation Study
	Alascom	1986	1987	Depreciation Study

Appraisal & Capital Recovery Activities Client List

Company	Property	Year	Study Year Performed	Activity
Lincoln Telecommunications	Lincoln Telephone and Telegraph Company	1986	1987	Digital Switching Service Life
Northwest Natural Gas Corporation	Northwest Natural Gas Corporation	1985	1986	Depreciation Study
ALLTEL	Western Reserve Telephone Company	1984	1985	Depreciation Study
	ALLTEL - Ohio	1984	1985	Depreciation Study
	ALLTEL - Alabama	1984	1985	Depreciation Study
Gulf Telephone Co.	Gulf Telephone Company	1984	1985	Depreciation Study
United Telephone Systems, Inc.	United of Iowa	1984	1985	Depreciation Study
	United of Arkansas	1984	1985	Depreciation Study
Pacific Telecom	Telephone Utilities of Washington	1983	1984	Depreciation Study
	Telephone Utilities of Eastern Oregon	1983	1984	Depreciation Study
Pacific Telecom	Telephone Utilities of Oregon	1983	1984	Depreciation Study
	Northwestern Telephone Systems, Inc., Oregon	1983	1984	Depreciation Study
	Rose Valley Telephone Company	1983	1984	Depreciation Study
United Telecommunications	All United Telephone Companies	1983	1984	Capital Recovery Strategy
Lincoln Telecommunications	Lincoln Telephone & Telegraph Company	1983	1984	Depreciation Study
ALLTEL	ALLTEL - Mississippi	1982	1983	Depreciation Study
	ALLTEL - Michigan	1982	1983	Depreciation Study
North Carolina Natural Gas Corp.	North Carolina Natural Gas Corporation	1982	1983	Depreciation Study
Mid Continent Telephone (Currently ALLTEL)	Western Reserve Telephone	1982	1983	Depreciation Study
	Mid Ohio Telephone	1982	1982	Depreciation Study

Appraisal & Capital Recovery Activities Client List

Company	Property	Study Year	Year Performed	Activity
	Florence Telephone Company	1980	1981	Depreciation Study
	Leeds Telephone Co.	1980	1981	Depreciation Study
	Elmore Coosa Tel Company	1980	1981	Depreciation Study
	Brookville Telephone Company	1980	1981	Depreciation Study
	Mid-Pennsylvania Telegraph	1980	1981	Depreciation Study
Telephone Utilities (Currently Pacific Telecom)	Telephone Utilities of Oregon	1979	1980	Depreciation Study
	Telephone Utilities of Eastern Oregon	1979	1980	Depreciation Study
	Northwestern Telephone Systems, Inc.-Oregon	1979	1980	Depreciation Study
	Rose Valley Telephone Company	1979	1980	Depreciation Study
United Telephone Systems, Inc.	United of Ohio	1979	1980	Depreciation Study
Telephone Utilities	Telephone Utilities of Washington	1978	1979	Depreciation Study
United Telephone Systems, Inc.	United of Ohio	1978	1979	Depreciation Study
Rochester Telephone	Rochester Telephone (Indiana)	1977	1978	Depreciation Study
United Telephone Systems, Inc.	United of Ohio	1977	1978	Depreciation Study
Princeton Telephone	Princeton Telephone (Indiana)	1976	1977	Depreciation Study
Northwestern Telephone	Northwestern Telephone (Illinois)	1975	1976	Depreciation Study

Papers and Seminars

2011 Training Instructor Depreciation Basics Sessions A & B and Life and Salvage Analysis
Society of Depreciation Professionals 25th Annual Meeting
Atlanta, GA September 20-22, 2011

2010 Will the Real Cost Approach Please Stand Up?
National Association of Property Tax Representatives Transportation, Energy, & Communications (NAPTR·TEC)
Scottsdale, Arizona October 25-27, 2010

Issues Affecting Assessment of Regulated Industries
Institute for Professionals in Taxation (IPT) Property Tax Symposium
Austin, Texas October 31 – November 3, 2010

2009 (Valuing) Intangibles
Appraisal for Ad Valorem Taxation, Wichita State University
Wichita, Kansas July 28, 2009

Fair Value Accounting (Appraisal Panelist)
Appraisal for Ad Valorem Taxation, Wichita State University
Wichita, Kansas July 29, 2009

2008 Valuation Issues Valuation of Assets and the Impact of Depreciation
Society of Depreciation Professionals Annual Meeting
Greenville, SC September 21-26, 2008

Obsolescence in the Long-Distance and Local Transport Networks
Technology Futures Inc. Asset Valuation Conference
Austin Texas February 8, 2008

2007 Communications Industry Issues
National Association of Property Tax Representative – Transportation, Energy, & Communications
New Orleans, LA October 30, 2007

2006 Appraisal Procedures & Issues in a Changing communications Industry
Florida Chapter International Association of Assessing Officers' Tangible Personal Property Conference
Ocala, Florida January 12, 2006

Valuation of Intangibles
Appraisal for Ad Valorem Taxation, Wichita State University
Wichita, Kansas July 25, 2006

SDP 20 years of History and Beyond
Society of Depreciation Professionals 20th Annual Meeting
Long Beach, CA September 18, 2006

2005 Valuation in a World with Asset Impairments
Appraisal for Ad Valorem Taxation, Wichita State University
Wichita, Kansas August 1, 2005

<u>Papers and Seminars</u>

2004 <u>Depreciation in the Valuation of Assets</u>
Society of Depreciation Professionals' Eighteenth Annual Meeting
Washington, D.C., September 13, 2004

2003 <u>Cost Approach and the Use of Appraisal Guidelines</u>
Institute for Professionals in Taxation – Property Tax Symposium
Fort Lauderdale, FL, September 17, 2003

<u>Cost Approach – Obsolescence and Depreciation</u>
Appraisal for Ad Valorem Taxation, Wichita State University
Wichita, Kansas, July 28, 2003

2000 <u>Appraisal Issues Associated with Technological Change in the Wireline Telecommunications Industry</u>
Appraisal for Ad Valorem Taxation, Wichita State University
Wichita, Kansas, July 31, 2000

<u>The Impact of Advancing Technology and the Changing Regulatory Environment on Obsolescence Calculations for Ad Valorem Valuation Purposes</u>
Journal of Property Tax Management, Spring 2000

1996 <u>How to Develop a Reproduction/Replacement Cost New Less Depreciation Approach to Value</u>
Appraisal for Ad Valorem Taxation, Wichita State University
Wichita, Kansas, August 4, 1996

1995 <u>Valuation Method, Techniques and Strategies (How to Quantify Stranded Investment) (Market, Income, & Cost Approach</u>
AGA Depreciation Committee Meeting
Denver, Colorado, August 6-9, 1995, jointly presented with Earl Robinson of AUS Consultants

1994 <u>Integrating Future Expectations for the Telephone Industry into Historical Depreciation Analysis</u>
United States Telephone Association (USTA's 1994 Capital Recovery Seminar)
Scottsdale, Arizona, September 12-13, 1994

1994 <u>Capital Recovery: United States versus Canada</u>
Canadian Telephone Industry's Annual Capital Recovery Seminar
Edmonton, Alberta, Canada June 14-15, 1994

1990 <u>Capital Recovery: Methods, Terminology, Procedures, and Record Keeping</u>
United States Telephone Association (USTA)'s
1990 Non-FCC Subject and Small Company Capital Recovery Seminar
Minneapolis, Minnesota April 10_11, 1990

<u>Integration of Technology Forecasting Into Historical Life Studies</u>
29th Iowa State Regulatory Conference
Ames, Iowa May 15-17, 1990

<u>The 1990's and the Second Wave of Major Plant Retirements in the Communications Industry</u>
NARUC's Seventh Biennial Information Conference
Columbus, Ohio September 12-14, 1990

Papers and Seminars

How Do We Incorporate Change into the Study Filing Procedures?
USTA's 1990 Capital Recovery Seminar
Chicago, Illinois October 16_17, 1990

1989 Plant Modernization: Capital Planning and Capital Recovery
Midwest Utilities Conference
Chicago, Illinois September 11_14, 1989

Price Indexes Today: Procedures, Uses, and Misuses
Society of Depreciation Professionals' Third Annual Meeting
New Orleans, Louisiana December 6_7, 1989

1988 Plant Modernization: Capital Planning and Capital Recovery
National Association of Regulatory Utility Commissioners (NARUC)'s
Sixth Biennial Regulatory Information Conference
Columbus, Ohio September 14_16, 1988

Papers and Seminars

1997	Sprint Corporation - West Finance Center Overland Park, Kansas, August 1997
1997	Rochester Telephone Corporation Rochester, New York, April 1997
1996	Sprint-Florida-Vista United Telecommunications Altamonte Springs, Florida August 27-29, 1996
1994	Saskatchewan Telecommunications Regina, Saskatchewan, Canada, June 1994
1994	AUS Consultants/Leroy J. Murphy and Associates 1994 Capital Recovery Seminar May 1994
1993	Manitoba Telephone System, Winnipeg, Manitoba, December 1993
1993	Society of Depreciation Professionals Annual Meeting Charleston, South Carolina September 30, 1993
1993	SPRINT - Local Telephone Division Atlanta, Georgia August 11-12, 1993
1993	AUS Consultants/Leroy J. Murphy and Associates 1993 Capital Recovery Seminar Chicago, Illinois May 11 - 13, 1993
1993	Canadian Telephone Capital Recovery Seminar Halifax, Nova Scotia April 20 - 22, 1993
1993	United Telephone, Midwest Group Overland Park, Kansas January 20, 1993
1992	BellSouth Corporation Birmingham, Alabama November 23, 1992
1992	Sprint - Local Telephone Division Kansas City, Kansas November 18 - 20, 1992
1992	Society of Depreciation Professionals Annual Meeting San Antonio, Texas September 9 - 10, 1992
1992	AUS Consultants/Leroy J. Murphy and Associates 1992 Capital Recovery Seminar Chicago, Illinois October 6 - 8, 1992
1991	Society of Depreciation Professionals Annual Meeting Nashville, Tennessee November 20-22, 1991
1991	ALLTEL Corporation Microcomputer Depreciation Studies System Training Hudson, Ohio October 14-16, 1991

Capital Recovery Training

2016 Society of Depreciation Professionals
Annual Training
Charleston, South Carolina, September 18-23, 2016

2015 Society of Depreciation Professionals
Annual Training
Austin Texas September 2015

2014 Society of Depreciation Professionals
Annual Training
New Orleans, Louisiana September 2014

2013 Society of Depreciation Professionals
Annual Training
Salt Lake City, Utah September 2013

2012 Society of Depreciation Professionals
Annual Training
Minneapolis, Minnesota, September 16-18, 2012

1991 United Telecommunications, Inc., Capital Recovery/Microcomputer Depreciation
Studies System Training
Kansas City, Kansas September 23-25, 1991

1991 AUS Consultants/Leroy J. Murphy and Associates 1991 Capital Recovery Seminar
Lake Geneva, Wisconsin September 17-19, 1991

1991 Rochester Telephone Corporation, Capital Recovery/Microcomputer Depreciation Studies
System Training, Rochester, New York September 3-7, 1991

1991 Ameritech Services, Microcomputer Depreciation Studies System Training
Chicago, Illinois May 16-17, 1991

1991 AUS Consultants/Leroy J. Murphy and Associates 1991 Capital Recovery Seminar
Washington, D.C. April 9_11, 1991

1990 United Telecommunications, Inc., Capital Recovery Seminar
Overland Park, Kansas December 1990

1990 AUS Consultants/Leroy J. Murphy and Associates 1990 Capital Recovery Seminar
Chicago, Illinois September 24_27, 1990

1990 AUS Consultants/Leroy J. Murphy and Associates 1990 Capital Recovery Seminar
Chicago, Illinois January 29-February 1, 1990

1990 United Telecommunications, Inc., Capital Recovery/Microcomputer Depreciation Studies
System Training, Chicago, Illinois July 1990

1989 United Telecommunications, Inc., Capital Recovery/Microcomputer Depreciation Studies
System Training, Chicago, Illinois July 1989

Capital Recovery Training

1989 AUS Consultants/Leroy J. Murphy and Associates 1989 Capital Recovery Seminar
Chicago, Illinois March 6_9, 1989

1988 AUS Consultants/Leroy J. Murphy and Associates 1988 Capital Recovery Seminar
Chicago, Illinois July 25_28, 1988

1988 United Telecommunications, Inc., Microcomputer Depreciation Studies System Training
Kansas City, Kansas January 1988

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

AQUA PENNSYLVANIA WASTEWATER, INC.

DOCKET NO. A-2021- 3026132

AQUA STATEMENT NO. 5-R

REBUTTAL TESTIMONY OF
JEROME C. WEINERT, PE, ASA, CDP
UTILITY VALUATION EXPERT
SELECTED BY
EAST WHITELAND TOWNSHIP, PENNSYLVANIA

Date: March 18, 2022

REBUTTAL TESTIMONY OF JEROME C. WEINERT

Q. Please state your name, business address, and occupation.

A. My name is Jerome C. Weinert. My business address is 8555 West Forest Home Avenue, Suite 201, Greenfield, WI 53228. I am a Principal and Director of AUS Consultants, Inc. ("AUS Consultants"). This testimony was prepared by me.

Q. Have you presented testimony in this docket before?

A. Yes, I presented direct testimony in support of my Utility Valuation Expert ("UVE") appraisal which I prepared for my client the East Whiteland Township, PA ("EWT")

Q. What is the purpose of your testimony?

A. This rebuttal testimony will respond to OCA witness David J. Garrett's adjustments to AUS Consultants' UVE appraisal of EWT's wastewater system and its operations. Mr. Garrett made adjustments to each of AUS Consultants appraisal approaches as follows:

	AUS Consultants Appraisal				OCA Garrett Adjustment to AUS Appraisal		
Appraisal Approach	Value Indicator	Weight	Wtd Value Indicator	OCA Adjustment	Value Indicator	Weight	Wtd Value Indicator
Cost	59,847,171	50%	29,923,586	(6,722,100)	53,125,071	50%	26,562,536
Income	55,600,045	40%	22,240,018	(14,242,790)	41,357,255	40%	16,542,902
Market	56,178,539	10%	5,617,854	(15,232,008)	40,946,531	10%	4,094,653
Appraisal Conclusion			57,781,458				47,200,091

I will demonstrate why each of the OCA adjustments are unfounded.

Market Approach

Q. Please compare AUS Consultants market approach and the methods you use to determine the market approach results and those used by Mr. Garrett.

A. Both AUS Consultants and Mr. Garrett analyzed the comparable sales of water and wastewater properties in the Commonwealth of Pennsylvania subsequent to the passage of Section 1329. The statistic analyzed was the ratio of the purchase price to the property's cost of replacement cost less depreciation ("CORLD"). AUS Consultants additionally analyzed the transactions with alternative statistical comparisons namely purchase price to original cost less depreciation ("OCLD"), customers, and cash flows (EBITDA). AUS Consultants also determined EWT wastewater system's market value based on water/wastewater industry financial market value ratios of publicly traded water and wastewater companies as reported in the January 8, 2021, issue of Value Line Investment Survey.

Q. Please describe the adjustments the OCA made to your Market approach.

A. Mr. Garrett, in analyzing the various transactions, states that he made several adjustments to AUS Consultants Market Approach:

- First, he substituted the Commission determined rate base for the purchase price agreed to by the buyer and seller in the transactions he analyzed.
- Second, Mr. Garrett eliminated sales transactions of wastewater systems which included wastewater treatment facilities.
- Third, he did not utilize the size of the transactions in developing his Market conclusion.

However, he also utilized different cost of replacement new less depreciation ("CORLD") than those detailed in the AUS Consultants' appraisal for the PAWC / McKeesport (CORLD $156,524,909) and AQUA / Limerick (CORLD $73,068,377) transactions. Mr. Garrett also did not include one transaction which AUS Consultants included in our analysis, that of Delaware County Regional Water Quality Authority (purchase price $276.5 million with a CORLD of $399,664,111).

Q. What comparable transactions or comparable sales did you evaluate to develop your market approach?

A. I examined the following transactions to develop the result of my market approach:

	East Whiteland Township, Pennsylvania							
	East Whiteland Township's Wastewater Collection System and Purchased Treatment Capacity							
	Wastewater Collection System and Purchased Treatment Capacity							
	Investor-Owned Utility							
	As of January 8, 2021							
	Comparable Sales Approach							
	Market Sales Data							
RowID	Approximate Date	Buyer	Seller	County	Type of Facility	Initial Purchase Price	Final Purchase Price[1]	Number of Total Customers
1	9/1/2016	PA American Water	City of McKeesport	Allegheny	Wastewater Collection and Treatment	156,000,000	159,000,000	21,953
2	8/1/2016	Aqua PA	New Garden Twp. SA	Chester	Wastewater Collection and Paid for and Owned Treatment	29,500,000	29,500,000	2,106
3	11/16/2016	Aqua PA	Limerick Township	Montgomery	Wastewater Collection and Treatment System	75,100,000	64,373,378	5,434
4	12/10/2017	Aqua PA	East Bradford Township	Chester	Wastewater Collection and paid for treatment	5,000,000	5,000,000	1,248
5	4/20/2018	SUEZ	Mahoning	Carbon	Water Distribution System	4,734,800	4,734,800	1,186
6	4/20/2018	SUEZ	Mahoning	Carbon	Wastewater Collection	4,765,200	4,765,200	1,451
7	6/1/2018	Aqua PA	Cheltenham	Montgomery	Wastewater Collection	50,250,000	50,250,000	10,500
8	11/14/2018	PA American Water	Steelton	Dauphin	Water Distribution and Treatment	22,500,000	21,750,000	2,325
9	1/1/2017	PA American Water	Sadsbury	Chester	Wastewater Collection	9,250,000	8,600,000	998
10	5/28/2018	PA American Water	Exeter	Berks	Wastewater Collection and Treatment	96,000,000	93,500,000	9,000
11	10/29/2018	Aqua PA	East Norriton	Montgomery	Wastewater Collection	21,000,000	21,000,000	4,950
12	9/30/2018	PA American	Kane	McKean	Wastewater Collection and Treatment	17,560,000	17,560,000	2,006
13	12/10/2019	PA American	Royersford	Montgomery	Wastewater Collection and Treatment	13,000,000	13,000,000	1,596
14	12/17/2019	PA American	Valley	Chester	Water Treatment and Distribution System	7,325,000	7,325,000	1,459
15	12/17/2019	PA American	Valley	Chester	Wastewater Collection System	13,950,000	13,950,000	1,644
16	12/31/2019	Aqua PA	Delaware County Regional \	Delaware	Wastewater Collection and Treatment	276,500,000	276,500,000	16,473
17	4/28/2020	PA American Water	Upper Pottsgrove	Montgomery	Wastewater Collection	13,750,000	13,750,000	1,428
18	9/17/2020	Aqua PA	Lower Makefield	Bucks	Wastewater Collection and Purchased Treatment Capacity	53,000,000	53,000,000	11,151

Q. Do you agree with Mr. Garrett's substitution of the Commission determined rate base for the agreed upon purchase prices in his analysis of the transactions which he included in his market analysis?

A. No, the use of the rate base as opposed to the agreed upon purchase price is not an appraisal market comparable approach as it does not represent a market transaction as the following definition of Market Value requires:

> Market Value: The most probable price, as of a specific date, in cash, or in terms equivalent to cash, or in other precisely revealed term, for which the specified property rights should sell after reasonable exposure in a competitive market under all conditions requisite to a fair sale, with the buyer and seller each acting prudently, knowledgeably, and for self-interest, and assuming that neither is under undue duress. (The Appraisal of Real Estate 14th Edition, page 58)

The conditions under which the resultant rate bases were derived in the various Section 1329 applications do not meet the above definition in terms of an agreed upon price between a buyer and seller neither being under duress. Also, the conditions of Section 1329 introduce several additional parties in the determination of rate base which were not present when the buyers and sellers agreed to a purchase price and formalized that price and the conditions of the sale in their asset purchase agreement. It was the asset purchase agreements which AUS Consultants utilized in developing our market comparable analysis for the Market Approach in our appraisal.

Q. Do you agree with Mr. Garrett use of only wastewater collections systems as opposed to all of the Section 1329 transactions reviewed by this Commission?

A. No, for several reasons. First, Mr. Garrett's analysis, while eliminating wastewater transactions which include wastewater treatment facilities, includes three water distribution properties. If, according to Mr. Garrett, the wastewater properties that include treatment facilities should be eliminated on comparability issues, then so too should the water distribution properties be eliminated on similar comparability issues. When this is done, Mr. Garrett's Market Approach increases by $1,710,627 to $42,616,932, or approximately 4%.

Secondly, East Whiteland's wastewater system assets include purchased capacity as follows:

Descrition	Year	Original Cost	Replacement Cost	Replacement Cost less Depreciaiton
Capacity Rights outside of East Whiteland		2,168,888	2,446,506	2,291,383
Capacity RightsAT Valley Forge Tretment Plant		8,916,354	11,065,195	9,551,350
Total Capacity Rights		11,085,242	13,511,701	11,842,733
% of total		26%	16%	20%
Total East Whiteland Assets		43,447,209	85,223,123	58,078,339

If Mr. Garrett's analysis would have included Section 1329 transactions of wastewater properties with collection and treatment assets while excluding collection only systems, his Market Approach conclusion would have been $44,901,310 instead of $40,946,531.

Q. Do you agree with Mr. Garrett that AUS Consultants' use of transaction purchase price weighting is unreasonable because such weighting places undue weight on larger transactions?

A. No, the market comparable statistic being measured in the market analysis is the ratio of purchase price to the CORLD, not the size of the transaction. The use of a transaction size weighted average produces a weighted average with superior statistics as is demonstrated by the mean and its standard deviation shown below using Mr. Garrett's table on page 13 of his testimony:

Acquistion	Type	Fair Market Value	RCNLD	Ratio FMV/RCNLD	OCA Garrett	OCA Garrett without Water Distribution Sales	Market using only Integrate Wastewater Sales
Aqua/New Garden	Int	29,500,000	30,615,410	0.9636			0.9636
PAWC/McKeesport	Int	158,000,000	160,301,491	0.9856			0.9856
Aqua/Limerick	Int	64,373,378	86,086,756	0.7478			0.7478
SUEZ/Mahoning Water	WTR	4,734,800	8,899,336	0.532	0.53		
SUEZ/Mahoning Wastewater	C/D	4,765,200	7,991,234	0.5963	0.6	0.6	
Aqua/East Bradford	C/D	5,000,000	9,236,581	0.5413	0.54	0.54	
PAWC/Sadsbury	C/D	8,300,000	8,517,587	0.9745	0.97	0.97	
PAWC/Exeter	Int	92,000,000	99,589,819	0.9238			0.9238
PAWC/Steelton	WTR	20,500,000	23,921,473	0.857	0.86		
Aqua/Cheltenham	C/D	44,558,259	49,940,486	0.8922	0.89	0.89	
PAWC/Kane	Int	17,560,000	29,015,055	0.6052			0.6052
PAWC/Valley Water	WTR	7,325,000	11,664,026	0.628	0.63		
PAWC/Valley Wastewater	C/D	13,950,000	19,252,333	0.7246	0.72	0.72	
PAWC/Upper Pottsgrove	C/D	13,750,000	18,460,028	0.7449	0.74	0.74	
PAWC/Royersford	C/D	13,000,000	13,376,109	0.9719	0.97	0.97	
Aqua/Lower Makefield	C/D	53,000,000	51,414,555	1.0308	1.03	1.03	
Aqua/East Norriton	C/D	20,750,000	27,461,356	0.7556	0.76	0.76	
Total		571,066,637	655,743,635	0.8709			
Simple Average				0.7927	0.7700	0.8022	0.8452
Standard Deviation (Simple Average)				0.1648	0.1665	0.1626	0.1463
Median (simple average)				0.7556	0.7500	0.76	0.9238
Weighted Average				0.8709			
Standard Deviation (weighted Average)				0.0861			
Weighted Median				0.8947			
OCA Market PP/CORLD				0.78			
AUS Consultants Market PP/CORLD				0.8533			
East Whiteland RCNLD			53,125,071	59,847,171	53,125,071	53,125,071	53,125,071
East Whiteland Market			40,906,305	47,440,852	40,906,305	42,616,932	44,901,310
						1,710,627	2,284,378
						4%	5%

Using Mr. Garrett's data and using a weighted average of the purchase price to CORLD, the weighted mean is 0.8709 with a standard deviation of 0.0861 versus Mr. Garrett's use of a simple average of 0.77 with a standard deviation of 0.1665. The weighted average result produces a more reliable market indicator, as demonstrated by a standard deviation of 0.0861 (or nearly twice a closer fit to the data), thereby making the weighted average far superior to a simple mean.

Q. What is your recommendation in terms of Mr. Garrett's adjustment to AUS Consultants' Market Approach?

A. Mr. Garrett's use of the Commission determined rate bases as a substitute for market agreed purchase price invalidates the analysis as a market comparable approach. Further, his reliance on the simple average as opposed to the more accurate purchase price weighted average produces a less reliable market comparable indicator. As such, the Commission should not adopt Mr. Garrett's adjustment to the AUS Consultants' Market Approach.

Cost Approach

Q. Please explain the adjustments Mr. Garrett made to the AUS Consultants' Cost Approach.

A. The AUS Consultants' Cost Approach is based on the Cost of Replacement New less Depreciation ("CORLD"). Mr. Garrett accepted AUS Consultants' Cost of Replacement New but adjusted the appraisal depreciation by revising the estimated service lives for several plant categories as follows:

Account	Account Description	AUS Iowa-type Survivor Curve - Service Life	OCA Iowa-type Survivor Curve - Service Life
360.21	Collection Sewers - Force Mains	R3.0 -75 years	R3.0 -60 years
361.21	Collection Sewers -Gravity Mains	R2.5 -80 years	R2.5 -60 years
361.23	Collection Sewers -Gravity Manholes	R2.5 -80 years	R2.5 -60 years

Q. Did Mr. Garrett provide the basis for his recommendation of a 60-year service life for force and gravity mains?

A. Yes, Mr. Garrett states in his testimony at page 20 lines 7-8: "The 60-year average life is the same proposed by Gannett Fleming for these accounts from another wastewater case in which I also testified."[1] I have reviewed the testimony and exhibits filed in the referenced case by Gannett Fleming and have extracted Gannett Fleming's actuarial life analysis of the force and gravity mains in the wastewater depreciation study and include them as Exhibit JCW 5-R Exhibit 1 to this rebuttal testimony.

As these exhibits demonstrate, the actuarial life analysis of force mains indicates no retirements have occurred over the entire data analysis period (i.e., plant placed in service over the period 1950 through 2016) while only $30,000 of retirements occurred out of $27 million of plant available for retirement which occurred at 39.5 and 49.5 years of age. Mr. Garrett as a Certified Depreciation Professional (CDP) should be aware that the service life recommendations (i.e., Iowa-type Survivor Curves and associated service lives recommendations) made in the referenced case were based entirely on judgement and not the results of statistical actuarial life analysis. However, Mr. Garret's reference to the Gannett Fleming depreciation recommendation in the Indiana wastewater case suggests a level of statistical support that clearly does not exist. In Mr. Garrett's testimony at pages 14-15 he states:

> Q. Please generally describe how depreciation rates are typically estimated.
>
> A. Many utilities keep historical records of assets placement and retirements by vintage year. When such data is available, depreciation experts can use actuarial techniques to analyze the historical retirement patterns in each account. The most common of these techniques is called the retirement rate

[1] See OUCC Prefilled Testimony of David J Garrett – Public's Exhibit No. 1, file June 22, 2018, in Cause No. 45039 before the Indiana Utility Regulation Commission.

> method. Under this method, historical retirement patterns can be displayed graphically in the form of original survivor curves. Depreciation experts then use visual and mathematical curve fitting techniques, along with professional judgement, to select empirically derived Iowa curves that best fit the original survivor curve. The Iowa curve is ultimately used to calculate the average remaining life and depreciation rate for each account.

Mr. Garrett's testimony regarding the depreciation recommendations in the Indiana Regulatory Utility Commission (IRUC) does not provide support for his use of a 60-year service lives for force and gravity mains in this case.

Q. Does Mr. Garrett recognize the support which the UVE's provided in their testimony and appraisal?

A. No, while failing to recognize AUS Consultants' rationale for our service life selections, Mr. Garrett went out of his way in his testimony to fault the UVE appraisers in their purported lack of support for their service life selections. Mr. Garrett states on page 15-16 of his testimony:

> Q. Despite the lack of retirement data required to conduct conventional Iowa curve fitting analysis, did the UVEs in this case nonetheless choose Iowa curves to estimate the remaining life and accumulated depreciation for the Township's accounts?
>
> A. Yes. When aged data are available for conventional actuarial analysis, depreciation analysts can rely on more objective, empirical analysis when selecting the most appropriate Iowa curve and remaining life. In this case, however, the lack of data required for such objective analysis led the UVEs to rely on more subjective elements when choosing their selected Iowa curves. For example, according to Mr. Weinert, the Iowa curves selected for the AUS Consultants' appraisal were based on AUS Consultants' "experience in preparing depreciation studies for the water and wastewater industry . . . ." Mr. Walker's justification for his selected Iowa curves was similar: "We believe our average service lives of depreciable assets are appropriate based on our experience . . . ." Thus, both UVEs are relying upon entirely subjective factors, such as "experience", in support of their proposed service lives, without any objective, empirical support."

And here is the entire paragraph from AUS Consultants' direct testimony on pages 8-9 with the portion Mr. Garrett referenced in his testimony:

> Q. How did you determine the depreciation parameters of survival/retirement characteristics and service lives for the utility property under the cost approach?
>
> A. I determined those parameters based on our review of the depreciation studies filed by Pennsylvania-American Water Company ("PAWC") and Aqua Pennsylvania Wastewater, Inc. ("Aqua") in support of their depreciation parameters (Iowa-type Survival Characteristics and Service Lives) and the resultant depreciation expense and rate base (net book) in their recent General Rate Cases (R-2017-2595853, R-2020-3019371 and R-2018-3003561) and AUS Consultants' experience in preparing depreciation studies for the water and wastewater industry and our experience appraising water and wastewater properties. The following table summarizes those studies and AUS Consultants' review of the depreciation parameters:

Summary of PAWC & Aqua Depreciation Studies Prepared for Rate Case

Account	Account Description	Iowa Curves			Service Life		
		PAWC	PAWC	Aqua	PAWC	PAWC	Aqua
		12/31/2016	12/31/2019	3/31/2018	12/31/2016	12/31/2019	3/31/2018
					years	years	
354.20	STRUCTURES AND IMPROVEMENTS - COLLECTION	R3	R3	S0.5	45	45	55
354.30	STRUCTURES AND IMPROVEMENTS - SPP	R2.5	S0	S1.0	50	55	60
354.40	STRUCTURES AND IMPROVEMENTS - TDP	R2	S0	R2.0	65	55	50
354.70	STRUCTURES AND IMPROVEMENTS - GENERAL	S1	S1	R3.0	35	35	50
355.00	POWER GENERATION EQUIPMENT	R2.5	S0.5		35	35	
360.10	COLLECTION SEWERS - FORCE MAINS	S2	R3	R2.5	70	75	75
361.10	COLLECTION SEWERS - GRAVITY MAINS	R2.5	R2.5	R2.5	70	80	75
361.20	MANHOLES	S1.5	S2.5		50	50	
363.00	SERVICES	R3	R3	R4.0	38	47	70
364.00	FLOW MEASURING DEVICES	L3	L2.5		20	15	
365.00	FLOW MEASURING INSTALLATIONS	S1.5	S2		30	25	
370.00	RECEIVING WELLS	R3	R3		50	50	
371.00	PUMPING EQUIPMENT	SO	S0.5	L0.5	40	30	25
380.00	TREATMENT EQUIPMENT	5-R2	S1.5	S0.0	45	35	40
381.00	PLANT SEWERS	R3	R3	R1.5	50	50	40
382.00	OUTFALL SEWER LINES	R3	R3	R2.5	50	50	40
389.10	OTHER PLANT AND MISCELLANEOUS EQUIPMENT - INTANGIBLES	52.5	S2.5		20	20	
389.60	OTHER PLANT AND MISCELLANEOUS EQUIPMENT - CPS	SQ	SQ	L3.0	20	5	20
390.00	OFFICE FURNITURE AND EQUIPMENT	L4	SQ	SQ	15	20	20
391.00	TRANSPORTATION EQUIPMENT	SQ	L4		25	14	
392.00	STORES EQUIPMENT	SQ	SQ		20	25	
393.00	TOOLS, SHOP AND GARAGE EQUIPMENT	SQ	SQ	SQ	15	20	20
394.00	LABORATORY EQUIPMENT	L2.5	SQ	SQ	16	15	25
395.00	POWER OPERATED EQUIPMENT	SQ	R2		15	22	
396.00	COMMUNICATION EQUIPMENT	SQ	SQ		15	15	
397.00	MISCELLANEOUS EQUIPMENT		SQ			15	
398.00	OTHER TANGIBLE PLANT		SQ			25	
	TOTAL DEPRECIABLE PLANT						

AUS Consultants' support for its Iowa curve and service life selection was supported by our review of depreciation studies filed with this Commission in four General Rate Cases. In each of those cases, the depreciation parameters proposed were based on the analysis of aged survival and retirement data using the actuarial life analysis method of retirement rate analysis as describe in Mr. Garrett's testimony.

Q. Were the results of the aforementioned depreciation studies presented in AUS Consultants' appraisal report and related direct testimony?

A. Yes, the depreciation studies and AUS Consultants' reliance on them were described in the narrative and Depreciation and Obsolescence sections of our appraisal report and in my direct testimony at pages 8 through 10.

Q. Please explain the reason AUS Consultants used the service lives it did for the EWT wastewater facilities.

A. In arriving at the service lives, which were used in developing the depreciation associated with EWT's wastewater facilities in preparing our appraisal, AUS Consultants reviewed the depreciation studies filed by Aqua and PAWC in their most recent General Rate Cases.[2] The following table represents the depreciation parameter data extracted from those General Rate Cases:

[2] *Pa. Pub. Util. Comm'n v. Aqua Pa.,* Docket Nos. R-2018-3003561, R-2018-3003558 *et al*. (water and wastewater); *Pa. Pub. Util. Comm'n v. Aqua Pa.,* Docket Nos. R-2021-3027385 and R-2021-3027386 (water and wastewater); *Pa. Pub. Util. Comm'n v. PAWC,* R-2017-2595853 (water and wastewater); and *Pa. Pub. Util. Comm'n v. PAWC,* Docket Nos. R-2020-3019369 and R-2020-3019371 (water and wastewater).

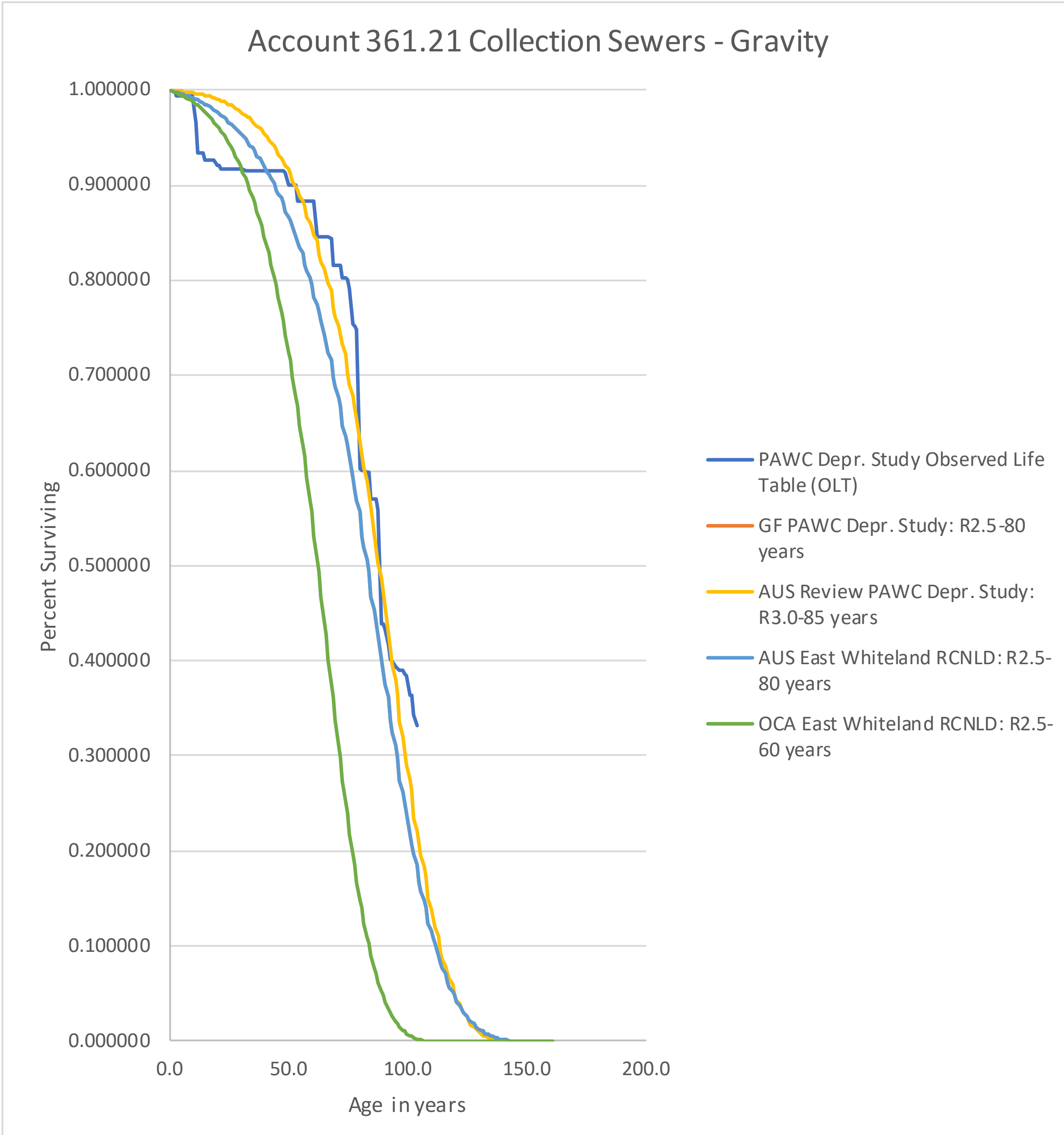
Summary of Aqua & PAWC Depreciation Studies Prepared for Rate Case

Account	Account Description	Iowa Curves			Service Life		
		Aqua	PAWC	PAWC	Aqua	PAWC	PAWC
		3/31/2019	12/31/2016	12/31/2019	3/31/2019	12/31/2016	12/31/2019
						years	years
354.20	STRUCTURES AND IMPROVEMENTS - COLLECTION	S0.5	R3	R3	55	45	45
354.30	STRUCTURES AND IMPROVEMENTS - SPP	S1.0	R2.5	S0	60	50	55
354.40	STRUCTURES AND IMPROVEMENTS - TDP	R2.0	R2	S0	50	65	55
354.70	STRUCTURES AND IMPROVEMENTS - GENERAL	E3.0	S1	S1	50	35	35
355.00	POWER GENERATION EQUIPMENT		R2.5	S0.5		35	35
360.10	COLLECTION SEWERS - FORCE MAINS	R2.5	S2	R3	75	70	75
361.10	COLLECTION SEWERS - GRAVITY MAINS	R2.5	R2.5	R2.5	75	70	80
361.20	MANHOLES		S1.5	S2.5		50	50
363.00	SERVICES	R4.0	R3	R3	70	38	47
364.00	FLOW MEASURING DEVICES		L3	L2.5		20	15
365.00	FLOW MEASURING INSTALLATIONS		S1.5	S2		30	25
370.00	RECEIVING WELLS		R3	R3		50	50
371.00	PUMPING EQUIPMENT	L0.5	SO	S0.5	25	40	30
380.00	TREATMENT EQUIPMENT	S0.0	5-R2	S1.5	40	45	35
381.00	PLANT SEWERS	R1.5	R3	R3	40	50	50
382.00	OUTFALL SEWER LINES	R2.5	R3	R3	40	50	50
389.10	OTHER PLANT AND MISCELLANEOUS EQUIPMENT - INTANGIBLES		52.5	S2.5		20	20
389.60	OTHER PLANT AND MISCELLANEOUS EQUIPMENT - CPS	L3.0	SQ	SQ	20	20	5
390.00	OFFICE FURNITURE AND EQUIPMENT	SQ.0	L4	SQ	20	15	20
391.00	TRANSPORTATION EQUIPMENT		SQ	L4		25	14
392.00	STORES EQUIPMENT		SQ	SQ		20	25
393.00	TOOLS, SHOP AND GARAGE EQUIPMENT		SQ	SQ		15	20
394.00	LABORATORY EQUIPMENT	SQ.0	L2.5	SQ	25	16	15
395.00	POWER OPERATED EQUIPMENT		SQ	R2		15	22
396.00	COMMUNICATION EQUIPMENT		SQ	SQ		15	15
397.00	MISCELLANEOUS EQUIPMENT			SQ			15
398.00	OTHER TANGIBLE PLANT			SQ			25
	TOTAL DEPRECIABLE PLANT						

As the above table demonstrates, a service life in the range of 75 to 80 years is supported by the companies' depreciation studies, which were filed in support of the requested depreciation expense in the aforementioned General Rate Cases. It should be noted that the depreciation parameters determined in the companies' depreciation studies were the result of analysis of the companies' historical survival and retirement experience over a wide span of years, thus representing actual service life experience of wastewater plant as demonstrated in the following table:

Account	Account Description	Depreciation Parameters Recommendation			Life	Age=Life-RL	Remaining Life (RL)	Placement Band		Experience Band	
			Year Ending	Investment				Year Period	Exposures	Year Period	Retirements
PAWC Rate Case R-2017-2595853		Full Depreciation Study i.e., Life Analysis and Depreciation Life Calculations									
361.1	Collection Mains - Gravity	R2.5 - 70 years	2016	74,842,231	70.0	13.1	56.9	1915-2016	411,819,765	2001-2016	773,032
PAWC Rate Case R-2020-3019371		Full Depreciation Study i.e., Life Analysis and Depreciation Life Calculations									
361.1	Collection Mains - Gravity	R2.5 - 80 years	2020	106,666,375	80.0	40.6	39.4	1915-2019	1,679,425,134	2001-2019	3,846,092
AQUA Rate Case R-2018--3003561		Full Depreciation Study i.e., Life Analysis and Depreciation Life Calculations									
360.1 / 361.1 / 361.2	Collection Mains - Force, Gravity, & Manholes	R2.5 - 75 years	2017	55,735,077	75.0	25.9	49.1	1943-2017	235,963,466	2010-2017	744,790
AQUA Rate Case R-2021-3027386		Used results of 2018 Depreciation Study to perform the Depreciation Life Calculations									
360.1 / 361.1 / 361.2	Collection Mains - Force, Gravity, & Manholes	R2.5 - 75 years	2020		75.0	26.4	48.6	1943-2017	235,963,466	2010-2017	744,790

The above table details the accounting experience analyzed in the companies' depreciation studies. In the case of PAWC's 2020 depreciation study (its most recent), the life analysis of the gravity mains entailed plant placed in service over the period 1915 through 2019 and included $1,679,425,134 of plant exposures to survival and potential retirement. It also included plant retirements over the period 2001 through 2019 wherein $3,846,092 of plant retirements were experienced. When studying the plant accounting experience, the following survival and retirement pattern was experienced:



As the above graph shows, the PAWC Depreciation Study fitted R2.5 Iowa-type survivor curve with an 80-year service life is the basis for AUS Consultants' survivor curve and service life utilized in our Cost Approach. The Aqua and PAWC depreciation studies show gravity service lives in a range of 75-80 years, and this demonstrates the 80-year service life chosen in the AUS Consultants appraisal is reasonable. Attached to my rebuttal testimony as JCW 5-R Exhibit 2, Account 361.21 Collection Mains – Gravity Life Analysis presents the historical accounting data and the actuarial life analysis which supports the above chart.

OCA witness Garrett, in his testimony and associated adjustment to the AUS Consultants' Cost Approach, recommended a R2.5 Iowa-type Survivor curve with a 60-year service life. As the above graph demonstrates, the R2.5 60-year depreciation life clearly understates the actual experience of Aqua for gravity mains constructed and serving Pennsylvania customers.

Q. Mr. Weinert is there an additional reason why your 80-year service life is more likely to occur than Garrett's 60-year service life?

A. Yes. The majority of EWT facilities is in mains and the majority of those mains are plastic as is shown in the following table which was extracted from the Engineering Assessment of the EWT facilities:

Total Force Mains	26,300	2,304,355	5,971,267
Gravity Mains			
ACP	140,592	2,609,631	14,136,182
PVC	157,290	8,039,079	15,980,180
DIP	1,229	16,928	88,183
CIP	123	2,080	11,500
CSP	3,539	100,020	366,116
Total Gravity Mains	302,773	10,767,738	30,582,161
Service Laterals			
ACP	24,976	401,445	2,734,294
PVC	94,264	6,138,531	9,525,539
Total Service Laterals	119,240	6,539,976	12,259,833
Plastic	264,554	15,560,916	28,278,049
% Plastic	59.0%	79.3%	57.9%
Other	183,759	4,051,153	20,535,212
Total	448,313	19,612,069	48,813,261
ACP	Asbestos Cement Pipe		
PVC	Plastic		
DIP	Ductile Iron Pipe		
CIP	Cast Iron Pipe		
CSP	Corrugated Steel Pipe		

In a 2014 study conducted by the Utah State University Buried Structures Laboratory entitled PVC Longevity Report – Affordability & The 100+ Year Benchmark Standard (JCW 5-R Exhibit 3) states in its Executive Summary:

> Life cycle cost analysis is presented as a financial decision tool for pipe replacement selection by applying the findings of reliability and longevity

> research and testing. This combination of pipe examination and testing data in conjunction with previous pipe break studies supports PVC as a sustainable pipe material, confirming a 100+ year benchmark as an industry standard.

Considering this study's findings, Mr. Garrett's use of a shortened service life compared to AUS Consultants' recommended 80-year service life for mains is unwarranted.

Q. Please explain why your use of a 80 year service life for the Asbestos Cement Pipe (ACP) in the gravity mains account is also reasonable.

A. It is true that the ACP also constitutes a large portion of EWT's gravity mains account. The ACP mains have attained an average age of 45.65 years as of the appraisal date. The ACP mains are good candidates for Cured in Place Plastic lining ("CIPP"). The CIPP suppliers and installation firms generally warranty the CIPP rehabilitation of existing mains for 50 years (see JCW 5-R Exhibit 4); therefore, the service life potential of the ACP mains once rehabilitated would be approximately 95 years which is consistent with AUS Consultants' 80-year service life recommendation.

Q. Mr. Weinert how does Mr. Garrett's use of a 60-year service life affect the appraisal results?

A. The use of a shortened service life results in excess depreciation in both the original cost less depreciation (OCLD) and the cost of replacement new less depreciation (CORLD), which understates the value determination of the Cost Approach. Also, since the Market Approach statistics consider the OCLD and the CORLD, the use of a shortened service life also reduces the Market Approach's value conclusion. Finally, since the depreciation lives and the age at the appraisal date are used to determine the depreciation expenses and capital expenditures for plant renewal, the shortened service life increases expenses and capital expenditures, thus reducing the Income Approach's value determination.

Q. What is your recommendation concerning Mr. Garrett's adjustment to the cost approach related to the gravity mains' service life?

A. As demonstrated above, the Gravity Mains service life of 80 years in my appraisal is reasonable and well supported by both Aqua's and PAWC's depreciation analyses. In my opinion, the AUS Consultants' service lives should be retained, and Mr. Garrett's proposed service lives should be rejected.

Q. Do you have any further comments regarding the AUS Consultants' cost approach?

A. Yes. As noted in in AUS Consultants' response to I&E interrogatory I&E -I-5 certain items were updated in the Engineer's Assessment as a result of the PUC's review of Aqua's application subsequent to preparing our final report. I have quantified the impact in the below table as a reduction to the cost approach:

Account	Description	Original Cost	Cost of Replacement less Depreciation
390.7	Durbook Laptop and software	21,550.00	3,763
354.3	Sewer Jet - Trailer Mounted	53,907.50	56,163
391.7	2001 Ford E350 Truck	39,952.00	6,982
391.7	2003 GMC Truck	25,808.00	4,669
391.7	2010 Ford E550 Truck	62,722.85	10,839
391.7	2019 Ford F150 Truck	33,000.00	28,350
353.2	Old Vlley Road	1.00	1,036
	Total	236,941.35	111,802

Income Approach

Q. Would you explain Mr. Garrett's adjustments to AUS Consultants' Income Approach?

A. Mr. Garrett substituted his own Income approach for both UVEs appraisals. The income approach he utilized is based on the average of EWT's 2016 through 2018 financials included with his testimony as OCA Exhibit DJG-15:

Annual Freee Cash Flow Calculation				OCA Exhibit DJG-15	
	Year 0		2018	2019	2020
Operating Revenues	4,734,652		5,372,388	4,444,567	4,387,000
EBIT	1,116,178		2,246,182	596,544	505,808
Tax (28.89%)	322,464		648,922	172,342	146,128
EBIT (1-t)	793,714		1,597,260	424,202	359,680
Depreciation	756,089		718,700	774,783	774,783
Capital Expenditures	1,290,442		393,256	740,070	2,738,000
Free Cash Flow from Operations	259,361	[1]	1,922,704	458,915	(1,603,537)
See Exhibit Q Gannett Flemiing FMV Appraisal, Exhibit 13 for 2018-2019 figures					
Year 0 figures are averages of 2018-2020 figures					

Based on the above financial information, Mr. Garrett performed a direct capitalization of similar cashflows from operations to perpetuity in OCA Exhibit DJG-14 as follows:

Income Approach Adjustment Summary	OCA Exhibit DJG-14	
Cash Flow	259,361	[1]
Cash Flow		
Constant Growth Rate	0.038	[2]
Discount Rate	0.045	[3]
Multiplier	159.4585	[4]
Value	41,357,255	[5]
[1] From OCA Exhibit DJG-15		
[2] From OCA Exhibit DJG-17		
[3] From OCA Exhibit DJG-16		
[4] Multiplier = (1+[2])/([3]-[2])		
[5] Value = [1] * Multiplier		

Q. Do you agree with Mr. Garrett's formulation of the income from operations and the resultant value?

A. No. It assumes that revenues and expenses as reported in EWT's financials will be the operating results of the buyer which is an erroneous assumption. First, as the ownership and operation migrate to the buyer, Aqua in this case, a number of changes will occur; namely there will be a new rate base determined by the Commission based on their findings in this Application and the buyer (Aqua) will be allowed to earn a Commission authorized return on rate base. Operating expense, including taxes, will be incorporated along with the allowed return on rate base in determining the ongoing EWT revenue requirement. Mr. Garrett's input in the above-described model does not factor these changes to EWT's operation as a rate regulated wastewater utility. Further, Mr. Garrett's estimated cost of equity at 6.0% is far below the Commission's stated cost of equity of 9.85% based on the Bureau of Technical Utility Services Report on Quarterly Earnings of Jurisdictional Utilities for the Year Ending December 31, 2020, which is the cost of equity used in the AUS Consultants' appraisal.

Q. Mr. Weinert did you attempt to rectify Mr. Garrett's income model for the aforementioned adjustment?

A. Yes, I assumed a rate regulated wastewater entity with an authorized return on rate base of 7.21% developed as follows:

Water and Wastewater Cost of Capital							
First Quarter 2021 (0-01-2021)							
As an Investor-Owned Utility							
Weighted Cost of Capital (Rate of Return on Rate Base)							
(1)	(2)	(2a)	(3)	(3a)	(4)	(4a)	(5)
	Portion of Capital	Type of Data	Capital Cost	Type of Data	Tax Rate	Tax affect on cost of capital	Required Return on Rate Base
	AUS Input		AUS Input				(2)*(3)
Debt	44%	Embedded	3.84%	Embedded	Not Applicable	Not Applicable	1.69%
Equity	56%	Embedded	9.85%	Market	Not Applicable	Not Applicable	5.52%
Total Capital r	**100.0%**						**7.21%**
Growth (g)						Not Applicable	**0.00%**
Rate without Growth: [(1+r)/(1+g)]-1							**7.21%**

With a rate making rate base of $54.930 million (i.e., the lower of the purchase price and the average of the UVEs appraisals) and an estimated 7.21% return on rate base, the allowed return on rate base was estimated to be $3,960,453, to which I included the operating expenses of $4,564,296 in order to estimate the cashflows from operations. I then adjusted the cash flows from operations for capital expenditures based on the new rate base. Finally, I discounted those cashflows with a discount rate of 7.21% which resulted in an income indicator of value of $61.2 million as follows:

Rate Base	54,930,000
Authorized Return on Rate Base	7.21%
Return on Rate Base	3,960,453
Operating Expenses	3,305,486
Depreciation	1,258,810
Total Operating Expenses	4,564,296
Revenue Requirement(including taxes)	10,132,835
Operating expenses	4,564,296
Income before taxes	5,568,539
Taxes @ 28.89%	1,608,751
Income after taxes	3,959,788
Depreciation	1,258,810
Cap X	806,090
Cash flows from Operations	4,412,508
Discount rate	7.21%
Indicated Value	61,199,836

Q. Regarding your application of the income approach, what method did you use to determine the income approach result?

A. I used the discounted cash flow method.

Q. What assumptions did you employ to develop your income approach result?

A. Under the income approach, it is my opinion that the results of the future operations of the EWT system must be considered. I believe that an accurate result depends on adjusting recent results of the system's operation to better reflect how those results will migrate over future periods as a rate regulated wastewater system under the PUC.

Q. What discount rate did you use to calculate your income approach?

A. I used a discount rate of 7.57% and 5.65% capitalization rate.

Q. What is your Income Approach conclusion?

A. AUS Consultants' income approach conclusion was determined to be $55,600,045 detailed as follows:

East Whiteland Township, Pennsylvania
East Whiteland Township's Wastewater Collection System and Purchased Treatment Capacity
Wastewater Collection System and Purchased Treatment Capacity
Potential Purchaser: Investor-Owned Utility
As of January 8, 2021
Discounted Cash Flow Analysis

Discount Rate:			7.57%										
Capitalization Rate:			5.65%										
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Period	Age	Revenues	O&M Expenses	Tax Depreciation	Cash Flow from Operations	Taxable Income before State & Federal Taxes	State and Federal Taxes @ 28.89%	Capital Expenditures	Change in Working Capital	Net Cash Flows	Period Present Worth Factor (PW)	PW of Cashflow	Accumulated PW of Cashflows
					(3)-(4)	(6)-(5)	(7) *28.89%			(3)-(4)-(8)-(9)-(10)		(11)*(12)	Sum (13)
1	0.5	5,759,816	3,305,486	2,193,634	2,454,330	260,696	75,315	806,090	(78,093)	1,651,018	0.964	1,591,581	1,591,581
2	1.5	5,759,816	3,371,594	2,218,239	2,388,222	169,983	49,108	812,135	-	1,526,979	0.896	1,368,173	2,959,754
3	2.5	5,759,816	3,439,026	2,243,274	2,320,790	77,516	22,394	818,227	-	1,480,169	0.833	1,232,981	4,192,735
4	3.5	7,775,752	3,507,806	2,268,741	4,267,946	1,999,205	577,570	824,363	(27,334)	2,893,347	0.775	2,242,344	6,435,079
5	4.5	7,775,752	3,577,962	2,294,647	4,197,790	1,903,143	549,818	830,547	-	2,817,425	0.720	2,028,546	8,463,625
6	5.5	9,719,690	3,649,522	2,320,996	6,070,168	3,749,172	1,083,136	836,776	(26,356)	4,176,612	0.669	2,794,153	11,257,778
7	6.5	9,719,690	3,722,512	2,315,050	5,997,178	3,682,128	1,063,767	721,779	-	4,211,632	0.622	2,619,635	13,877,413
8	7.5	9,719,690	3,796,962	2,338,381	5,922,728	3,584,347	1,035,518	727,193	-	4,160,017	0.579	2,408,650	16,286,063
9	8.5	10,691,659	3,872,902	2,362,106	6,818,757	4,456,651	1,287,526	732,647	(13,178)	4,811,762	0.538	2,588,728	18,874,791
10	9.5	10,691,659	3,950,359	2,386,228	6,741,300	4,355,072	1,258,180	738,141	-	4,744,979	0.500	2,372,490	21,247,281
11	10.5	10,691,659	4,029,366	2,410,754	6,662,293	4,251,539	1,228,270	743,679	-	4,690,344	0.465	2,181,010	23,428,291
12	11.5	11,333,159	4,109,952	2,435,686	7,223,207	4,787,521	1,383,115	749,257	(8,698)	5,099,533	0.432	2,202,998	25,631,289
13	12.5	11,333,159	4,192,151	2,461,029	7,141,008	4,679,979	1,352,046	754,875	-	5,034,087	0.402	2,023,703	27,654,992
14	13.5	11,333,159	4,275,994	2,486,788	7,057,165	4,570,377	1,320,382	760,535	-	4,976,248	0.373	1,856,141	29,511,133
15	14.5	12,013,149	4,361,513	2,512,970	7,651,636	5,138,666	1,484,561	766,240	(9,219)	5,410,054	0.347	1,877,289	31,388,422
16	15.5	12,013,149	4,448,744	2,539,579	7,564,405	5,024,826	1,451,672	771,988	-	5,340,745	0.323	1,725,061	33,113,483
17	16.5	12,013,149	4,537,720	2,566,617	7,475,429	4,908,812	1,418,156	777,777	-	5,279,496	0.300	1,583,849	34,697,332
18	17.5	12,733,938	4,628,474	2,594,092	8,105,464	5,511,372	1,592,235	783,611	(9,773)	5,739,391	0.279	1,601,290	36,298,622
19	18.5	12,733,938	4,721,044	2,622,008	8,012,894	5,390,886	1,557,427	789,487	-	5,665,980	0.259	1,467,489	37,766,111
20 and beyond	19.5	12,733,938	4,815,465	2,650,370	7,918,473	5,268,103	1,521,955	795,408	-	5,601,110	3.184	17,833,934	55,600,045
								15,540,755					
Age				19.5				777,038					
PW(Age) = 1/(1+Discount Rate)$^{(Age)}$				0.241				Net Plant		44,551,804			
PW to Perpetuity = 1/Capitalization Rate				13.210				ADIT		(6,443,119)			
$PW_{(20 and Beyond)}$ = PW to Perpetuity * PW $Factor_{(19.5)}$				3.184				Rate Base		38,108,685	0.241	9,184,193	46,950,304
								Annual Plant Construction Inflation Rate		0.0422	Input		
								Plant Inflation over 19.5 years		87,105,453	0.241	20,992,414	58,758,525
								PP	54,930,000				
								OCLD	33,403,972				
								PP/OCLD	1.644				
								RCNLD	58,078,339				
								RCNLD/PP		1.057315474			
										40,292,902.78	0.241	9,710,590	47,476,701
								Average					52,196,394

These results are detailed in Application Exhibit R (AUS Appraisal) under the Income Approach section.

Q. How does your OCA adjusted model compare to the AUS Consultants' Income approach in your appraisal?

A. My income approach conclusion was $55,600,045, while my adjustment to the OCA model resulted in an income approach indicator of $62,117,860, which suggest AUS Consultants initial conclusions are conservative.

Q. Do you have a recommendation as to Mr. Garrett's income approach which he is substituting for AUS Consultants' Income Approach?

A. Yes, when adjusted for the transition of EWT wastewater operation to a rate regulated utility, the OCA model produces an income indicator of $62,117,860 in excess of AUS Consultants' income indicator in our appraisal. As such, the Commission should reject Mr. Garrett's income indicator and adopt AUS Consultants' Income Approach

Q. Does this conclude your rebuttal testimony?

A. It does. However, I reserve the right to supplement my rebuttal testimony as needed during this proceeding.

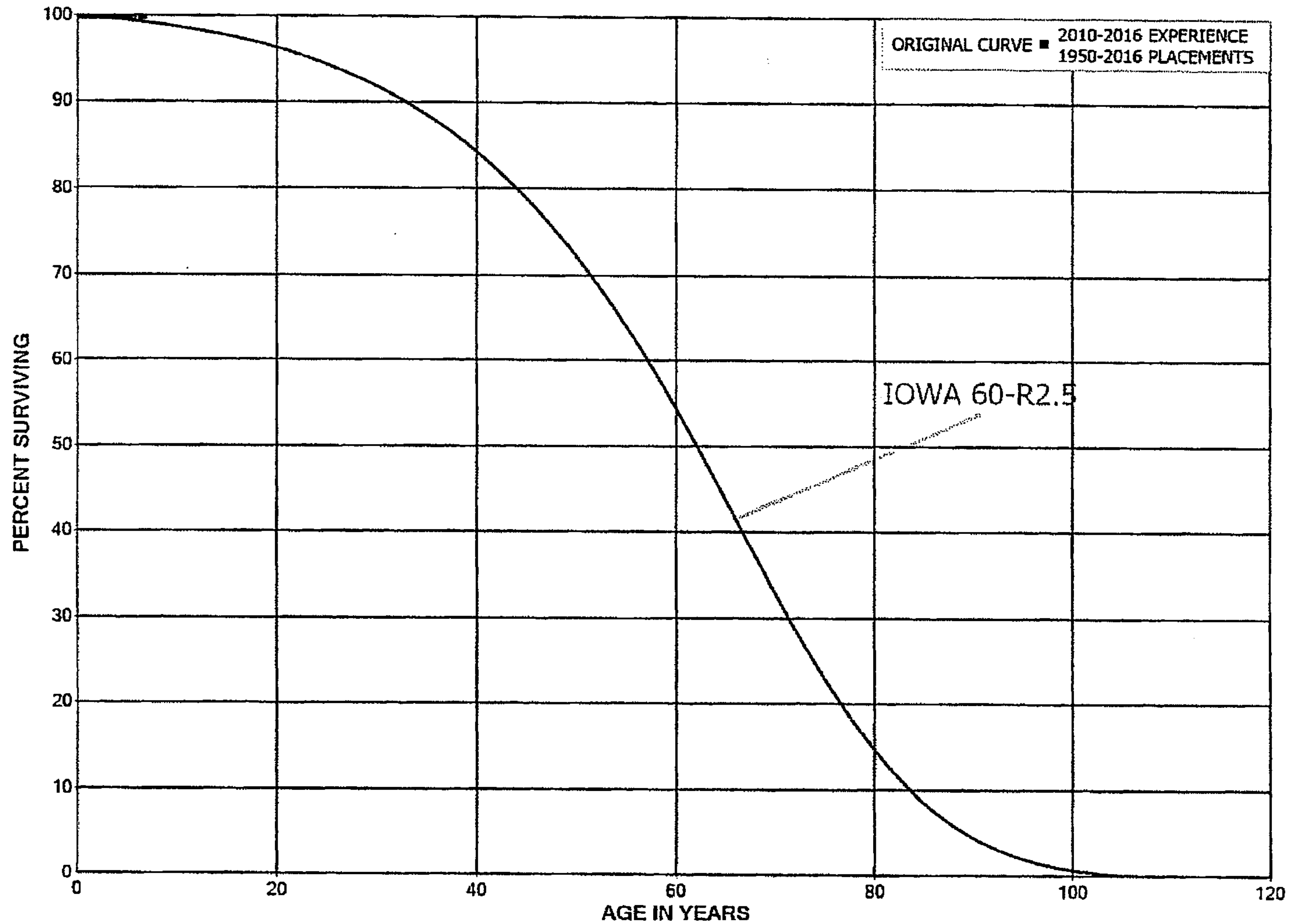
Indiana Regulation Utility Commission Docket 45039

Citizens Wastewater

Account 360.2 Collection Sewers – Force

Account 361.2 Collection Sewers - Gravity

CITIZENS ENERGY GROUP
CITIZENS WASTEWATER
ACCOUNT 360.2 COLLECTION SEWERS - FORCE
ORIGINAL AND SMOOTH SURVIVOR CURVES



CITIZENS ENERGY GROUP
CITIZENS WASTEWATER

ACCOUNT 360.2 COLLECTION SEWERS - FORCE

ORIGINAL LIFE TABLE

PLACEMENT BAND 1950-2016 EXPERIENCE BAND 2010-2016

AGE AT BEGIN OF INTERVAL	EXPOSURES AT BEGINNING OF AGE INTERVAL	RETIREMENTS DURING AGE INTERVAL	RETMT RATIO	SURV RATIO	PCT SURV BEGIN OF INTERVAL
0.0	11,141,165		0.0000	1.0000	100.00
0.5	11,902,755		0.0000	1.0000	100.00
1.5	11,695,096		0.0000	1.0000	100.00
2.5	8,691,601		0.0000	1.0000	100.00
3.5	8,127,753		0.0000	1.0000	100.00
4.5	6,319,209		0.0000	1.0000	100.00
5.5	822,987		0.0000	1.0000	100.00
6.5					100.00
7.5					
8.5					
9.5					
10.5					
11.5					
12.5					
13.5					
14.5					
15.5					
16.5					
17.5					
18.5					
19.5					
20.5					
21.5					
22.5					
23.5					
24.5					
25.5					
26.5					
27.5					
28.5					
29.5					
30.5	193,462		0.0000		
31.5	193,462		0.0000		
32.5	193,462		0.0000		
33.5	193,462		0.0000		
34.5	193,462		0.0000		
35.5	193,462		0.0000		
36.5					
37.5					
38.5					

CITIZENS ENERGY GROUP
CITIZENS WASTEWATER

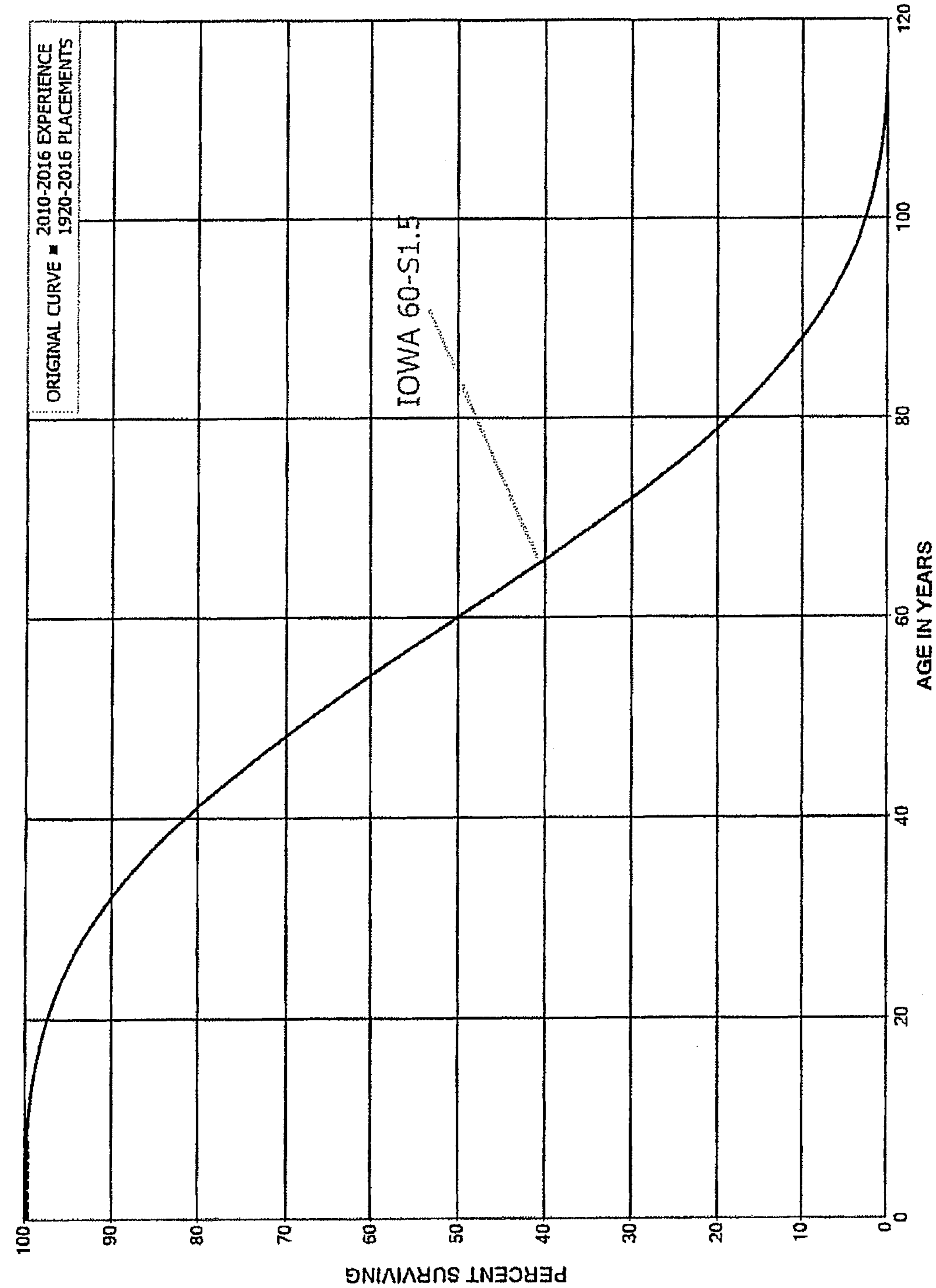
ACCOUNT 360.2 COLLECTION SEWERS - FORCE

ORIGINAL LIFE TABLE, CONT.

PLACEMENT BAND 1950-2016 EXPERIENCE BAND 2010-2016

AGE AT BEGIN OF INTERVAL	EXPOSURES AT BEGINNING OF AGE INTERVAL	RETIREMENTS DURING AGE INTERVAL	RETMT RATIO	SURV RATIO	PCT SURV BEGIN OF INTERVAL
39.5					
40.5	2,269,298		0.0000		
41.5	2,269,298		0.0000		
42.5	2,269,298		0.0000		
43.5	2,269,298		0.0000		
44.5	2,269,298		0.0000		
45.5	2,269,298		0.0000		
46.5					
47.5					
48.5					
49.5					
50.5					
51.5					
52.5					
53.5					
54.5					
55.5					
56.5					
57.5					
58.5					
59.5					
60.5	74,827		0.0000		
61.5	74,827		0.0000		
62.5	74,827		0.0000		
63.5	74,827		0.0000		
64.5	74,827		0.0000		
65.5	74,827		0.0000		
66.5					

CITIZENS ENERGY GROUP
CITIZENS WASTEWATER
ACCOUNT 361.2 COLLECTION SEWERS - GRAVITTIY
ORIGINAL AND SMOOTH SURVIVOR CURVES



CITIZENS ENERGY GROUP
CITIZENS WASTEWATER

ACCOUNT 361.2 COLLECTION SEWERS - GRAVITIY

ORIGINAL LIFE TABLE

PLACEMENT BAND 1920-2016 EXPERIENCE BAND 2010-2016

AGE AT BEGIN OF INTERVAL	EXPOSURES AT BEGINNING OF AGE INTERVAL	RETIREMENTS DURING AGE INTERVAL	RETMT RATIO	SURV RATIO	PCT SURV BEGIN OF INTERVAL
0.0	246,280,340		0.0000	1.0000	100.00
0.5	280,182,832		0.0000	1.0000	100.00
1.5	305,552,710		0.0000	1.0000	100.00
2.5	269,486,657		0.0000	1.0000	100.00
3.5	215,293,345		0.0000	1.0000	100.00
4.5	133,961,206		0.0000	1.0000	100.00
5.5	73,196,456		0.0000	1.0000	100.00
6.5	36,459,515		0.0000	1.0000	100.00
7.5					100.00
8.5					
9.5					
10.5					
11.5					
12.5					
13.5					
14.5					
15.5					
16.5					
17.5					
18.5					
19.5					
20.5	32,412,071		0.0000		
21.5	32,412,071		0.0000		
22.5	32,412,071		0.0000		
23.5	32,412,071		0.0000		
24.5	32,412,071		0.0000		
25.5	32,412,071		0.0000		
26.5					
27.5					
28.5					
29.5					
30.5	19,761,095		0.0000		
31.5	19,761,095		0.0000		
32.5	19,761,095		0.0000		
33.5	19,761,095		0.0000		
34.5	19,761,095		0.0000		
35.5	46,922,546		0.0000		
36.5	27,161,451		0.0000		
37.5	27,161,451		0.0000		
38.5	27,161,451		0.0000		

CITIZENS ENERGY GROUP
CITIZENS WASTEWATER

ACCOUNT 361.2 COLLECTION SEWERS - GRAVITIY

ORIGINAL LIFE TABLE, CONT.

PLACEMENT BAND 1920-2016 EXPERIENCE BAND 2010-2016

AGE AT BEGIN OF INTERVAL	EXPOSURES AT BEGINNING OF AGE INTERVAL	RETIREMENTS DURING AGE INTERVAL	RETMT RATIO	SURV RATIO	PCT SURV BEGIN OF INTERVAL
39.5	27,161,451	10,000	0.0004		
40.5	124,835,819		0.0000		
41.5	679,692,571		0.0000		
42.5	679,692,571		0.0000		
43.5	679,692,571		0.0000		
44.5	679,692,571		0.0000		
45.5	707,314,466		0.0000		
46.5	609,630,098		0.0000		
47.5	27,621,895		0.0000		
48.5	27,621,895		0.0000		
49.5	27,621,895	20,000	0.0007		
50.5	28,916,434		0.0000		
51.5	1,314,539		0.0000		
52.5	1,314,539		0.0000		
53.5	1,314,539		0.0000		
54.5	1,314,539		0.0000		
55.5	1,314,539		0.0000		
56.5					
57.5					
58.5					
59.5					
60.5	2,130,987		0.0000		
61.5	2,130,987		0.0000		
62.5	2,130,987		0.0000		
63.5	2,130,987		0.0000		
64.5	2,130,987		0.0000		
65.5	2,130,987		0.0000		
66.5					
67.5					
68.5					
69.5					
70.5					
71.5					
72.5					
73.5					
74.5					
75.5	296,249		0.0000		
76.5	296,249		0.0000		
77.5	296,249		0.0000		
78.5	296,249		0.0000		

CITIZENS ENERGY GROUP
CITIZENS WASTEWATER

ACCOUNT 361.2 COLLECTION SEWERS - GRAVITIY

ORIGINAL LIFE TABLE, CONT.

PLACEMENT BAND 1920-2016 EXPERIENCE BAND 2010-2016

AGE AT BEGIN OF INTERVAL	EXPOSURES AT BEGINNING OF AGE INTERVAL	RETIREMENTS DURING AGE INTERVAL	RETMT RATIO	SURV RATIO	PCT SURV BEGIN OF INTERVAL
79.5	296,249		0.0000		
80.5	332,012		0.0000		
81.5	35,763		0.0000		
82.5	35,763		0.0000		
83.5	35,763		0.0000		
84.5	35,763		0.0000		
85.5	8,710,988		0.0000		
86.5	8,675,225		0.0000		
87.5	8,675,225		0.0000		
88.5	8,675,225		0.0000		
89.5	8,675,225		0.0000		
90.5	11,412,729		0.0000		
91.5	2,737,504		0.0000		
92.5	2,737,504		0.0000		
93.5	2,737,504		0.0000		
94.5	2,737,504		0.0000		
95.5	2,737,504		0.0000		
96.5					

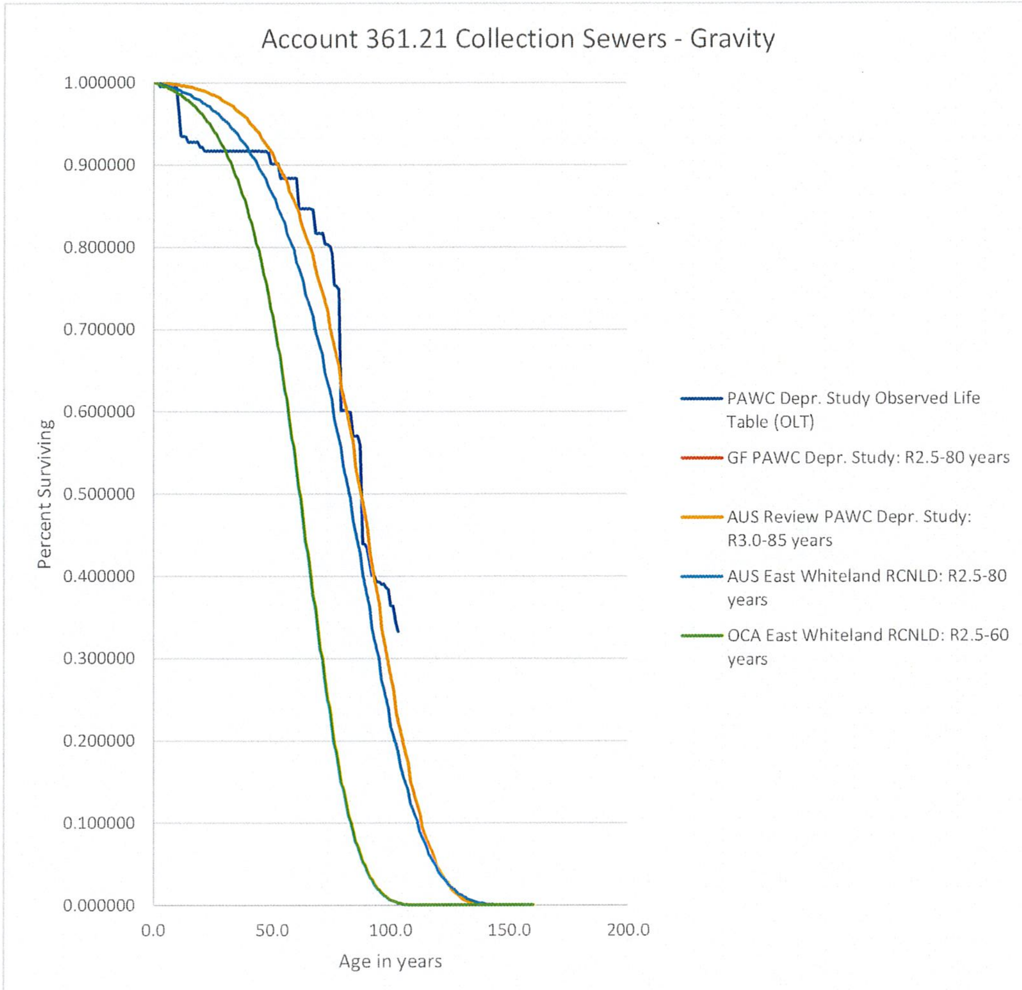
JCW Exhibit 2

Pennsylvania Public Utility Commission

Docket R-2020-3019371

PAWC Wastewater

Account 361.2 Collection Sewers – Gravity Life Analysis


Account 361.21 Collection Sewers - Gravity
1.000000
0.900000
0.800000
0.700000
0.600000
0.500000
0.400000
0.300000
0.200000
0.100000
0.000000
Percent Surviving
0.0
50.0
100.0
150.0
200.0
Age in years
PAWC Depr. Study Observed Life Table (OLT)
GF PAWC Depr. Study: R2.5-80 years
AUS Review PAWC Depr. Study: R3.0-85 years
AUS East Whiteland RCNLD: R2.5-80 years
OCA East Whiteland RCNLD: R2.5-60 years

Account:	361.210000	361.210000
Account Description:	Gravity Collection Mains	Gravity Collection Mains

Service Life Curve Fitting: 361.21-Gravity Collection Mains

Age	PAWC Depreciation Study Observed Life Table (OLT)	Gannett Fleming PAWC Wastewater Depreciation Study (GF PAWC Depr. Study)	AUS Consultant Review PAWC Wastewater Depreciation Study (AUS Review PAWC Depr. Study)	AUS Consultants East Whitelan RCNLD Study (AUS York RCNLD)	OCA RCNLD Study (OCA East Whiteland RCNLD)
Iowa Curve		R2.5	R3.0	R2.5	R2.5
Life		80	85	80	60

Age	PAWC Depr. Study Observed Life Table (OLT)	GF PAWC Depr. Study: R2.5-80 years	AUS Review PAWC Depr. Study: R3.0-85 years	AUS East Whiteland RCNLD: R2.5-80 years	OCA East Whiteland RCNLD: R2.5-60 years
0.0	1.000000	1	1	1	1
0.5	0.999988	0.999448471	0.9998452	0.999448471	0.999448471
1.5	0.999966	0.998873749	0.999676819	0.998873749	0.998274994
2.5	0.995070	0.998274994	0.999493866	0.998274994	0.997651138
3.5	0.995070	0.997651138	0.999295349	0.997651138	0.996324539
4.5	0.995070	0.996324539	0.9990802	0.996324539	0.994885635
5.5	0.994473	0.995619659	0.998847427	0.995619659	0.994121399
6.5	0.994155	0.994885635	0.998324051	0.994885635	0.992497406
7.5	0.993866	0.994121399	0.998031082	0.994121399	0.99073822
8.5	0.993866	0.992497406	0.997715454	0.992497406	0.989804764
9.5	0.993567	0.991635361	0.99737587	0.991635361	0.987823334
10.5	0.966029	0.99073822	0.997010956	0.99073822	0.985680008
11.5	0.934602	0.989804764	0.996198959	0.989804764	0.984543991
12.5	0.934193	0.987823334	0.995748825	0.987823334	0.98213562
13.5	0.933402	0.986772614	0.995267029	0.986772614	0.979534836
14.5	0.927565	0.985680008	0.994751968	0.985680008	0.978158188
15.5	0.927548	0.984543991	0.994201889	0.984543991	0.975243912
16.5	0.927506	0.98213562	0.993614883	0.98213562	0.972102966
17.5	0.927390	0.980860062	0.992322693	0.980860062	0.970442963
18.5	0.927390	0.979534836	0.991613617	0.979534836	0.966934204
19.5	0.921404	0.978158188	0.990859833	0.978158188	0.963160858
20.5	0.921404	0.975243912	0.990059204	0.975243912	0.961169891
21.5	0.916419	0.973702698	0.989209595	0.973702698	0.956968994
22.5	0.916419	0.972102966	0.988308792	0.972102966	0.952461929
23.5	0.916419	0.970442963	0.986344528	0.970442963	0.950088043
24.5	0.916419	0.966934204	0.985276337	0.966934204	0.945088348
25.5	0.916419	0.965081635	0.984147568	0.965081635	0.939737396
26.5	0.916419	0.963160858	0.982955627	0.963160858	0.936924286
27.5	0.916419	0.961169891	0.981698151	0.961169891	0.931010666
28.5	0.916419	0.956968994	0.978975983	0.956968994	0.924697266
29.5	0.916419	0.954754791	0.977505951	0.954754791	0.921384354
30.5	0.916419	0.952461929	0.975959625	0.952461929	0.914432831
31.5	0.916324	0.950088043	0.974334259	0.950088043	0.907029343
32.5	0.916322	0.945088348	0.972627106	0.945088348	0.903151245
33.5	0.916322	0.942457962	0.970835114	0.942457962	0.895028305
34.5	0.916322	0.939737396	0.966985245	0.939737396	0.88639679
35.5	0.916322	0.936924286	0.964921341	0.936924286	0.881882858
36.5	0.916322	0.931010666	0.962760773	0.931010666	0.872443237
37.5	0.916322	0.927905197	0.960500336	0.927905197	0.862433395
38.5	0.916322	0.924697266	0.958136902	0.924697266	0.857206497
39.5	0.916322	0.921384354	0.955667343	0.921384354	0.846291656
40.5	0.916322	0.914432831	0.950396347	0.914432831	0.834739227
41.5	0.916202	0.910788956	0.947588348	0.910788956	0.828715057

Account:	361.210000	361.210000
Account Description:	Gravity Collection Mains	Gravity Collection Mains

Service Life Curve Fitting: 361.21-Gravity Collection Mains

Age	PAWC Depreciation Study Observed Life Table (OLT)	Gannett Fleming PAWC Wastewater Depreciation Study (GF PAWC Depr. Study)	AUS Consultant Review PAWC Wastewater Depreciation Study (AUS Review PAWC Depr. Study)	AUS Consultants East Whitelan RCNLD Study (AUS York RCNLD)	OCA RCNLD Study (OCA East Whiteland RCNLD)
Iowa Curve		R2.5	R3.0	R2.5	R2.5
Life		80	85	80	60

Age	PAWC Depr. Study Observed Life Table (OLT)	GF PAWC Depr. Study: R2.5-80 years	AUS Review PAWC Depr. Study: R3.0-85 years	AUS East Whiteland RCNLD: R2.5-80 years	OCA East Whiteland RCNLD: R2.5-60 years
42.5	0.916200	0.907029343	0.944660721	0.907029343	0.816152802
43.5	0.916200	0.903151245	0.941609955	0.903151245	0.802881012
44.5	0.916200	0.895028305	0.938432465	0.895028305	0.795969925
45.5	0.915958	0.890777588	0.931682739	0.890777588	0.781579285
46.5	0.915958	0.88639679	0.928102951	0.88639679	0.766407242
47.5	0.915870	0.881882858	0.924381332	0.881882858	0.758519821
48.5	0.914106	0.872443237	0.92051384	0.872443237	0.742126617
49.5	0.901059	0.867511215	0.916496429	0.867511215	0.724890442
50.5	0.900889	0.862433395	0.912324905	0.862433395	0.715950317
51.5	0.900889	0.857206497	0.903501816	0.857206497	0.697417297
52.5	0.900889	0.846291656	0.898841171	0.846291656	0.67800705
53.5	0.883194	0.840596924	0.894008331	0.840596924	0.66797226
54.5	0.883194	0.834739227	0.888998337	0.834739227	0.647247162
55.5	0.883194	0.828715057	0.883806152	0.828715057	0.625660896
56.5	0.883194	0.816152802	0.878426666	0.816152802	0.614552612
57.5	0.883194	0.809607391	0.867084656	0.809607391	0.591728439
58.5	0.883194	0.802881012	0.861111069	0.802881012	0.568135223
59.5	0.883186	0.795969925	0.854928284	0.795969925	0.55606926
60.5	0.883175	0.781579285	0.848530426	0.781579285	0.531445503
61.5	0.846166	0.774092636	0.841911621	0.774092636	0.506240311
62.5	0.846166	0.766407242	0.827987213	0.766407242	0.493451385
63.5	0.846163	0.758519821	0.820669327	0.758519821	0.467572784
64.5	0.846152	0.742126617	0.813106308	0.742126617	0.441399498
65.5	0.846152	0.733615112	0.805291901	0.733615112	0.428245277
66.5	0.846152	0.724890442	0.79722023	0.724890442	0.401893387
67.5	0.844868	0.715950317	0.788885269	0.715950317	0.375611725
68.5	0.816358	0.697417297	0.771403046	0.697417297	0.362546539
69.5	0.816358	0.687822113	0.762244949	0.687822113	0.336666946
70.5	0.816358	0.67800705	0.752802353	0.67800705	0.311253185
71.5	0.816216	0.66797226	0.743070679	0.66797226	0.298769035
72.5	0.803298	0.647247162	0.733046112	0.647247162	0.274337311
73.5	0.802532	0.636560326	0.72272522	0.636560326	0.250733204
74.5	0.800791	0.625660896	0.701184464	0.625660896	0.239280224
75.5	0.791990	0.614552612	0.689961777	0.614552612	0.217139492
76.5	0.753582	0.591728439	0.678437042	0.591728439	0.196094093
77.5	0.752047	0.580024414	0.666611252	0.580024414	0.186005306
78.5	0.748110	0.568135223	0.654486389	0.568135223	0.166730156

Account:	361.210000	361.210000
Account Description:	Gravity Collection Mains	Gravity Collection Mains

Service Life Curve Fitting: 361.21-Gravity Collection Mains

Age	PAWC Depreciation Study Observed Life Table (OLT)	Gannett Fleming PAWC Wastewater Depreciation Study (GF PAWC Depr. Study)	AUS Consultant Review PAWC Wastewater Depreciation Study (AUS Review PAWC Depr. Study)	AUS Consultants East Whitelan RCNLD Study (AUS York RCNLD)	OCA RCNLD Study (OCA East Whiteland RCNLD)
Iowa Curve		R2.5	R3.0	R2.5	R2.5
Life		80	85	80	60

Age	PAWC Depr. Study Observed Life Table (OLT)	GF PAWC Depr. Study: R2.5-80 years	AUS Review PAWC Depr. Study: R3.0-85 years	AUS East Whiteland RCNLD: R2.5-80 years	OCA East Whiteland RCNLD: R2.5-60 years
79.5	0.601185	0.55606926	0.629354553	0.55606926	0.148688679
80.5	0.601042	0.531445503	0.616358185	0.531445503	0.140137281
81.5	0.601042	0.518909492	0.603084412	0.518909492	0.123976231
82.5	0.598853	0.506240311	0.589542313	0.506240311	0.109063148
83.5	0.598853	0.493451385	0.575742493	0.493451385	0.102068386
84.5	0.570010	0.467572784	0.56169735	0.467572784	0.088983831
85.5	0.570000	0.45451458	0.532928581	0.45451458	0.077074528
86.5	0.570000	0.441399498	0.518237991	0.441399498	0.071547322
87.5	0.559366	0.428245277	0.503368111	0.428245277	0.061318512
88.5	0.438702	0.401893387	0.488339539	0.401893387	0.05214901
89.5	0.438494	0.388733978	0.473174591	0.388733978	0.047945251
90.5	0.432694	0.375611725	0.457896957	0.375611725	0.04026597
91.5	0.416758	0.362546539	0.42710537	0.362546539	0.033510611
92.5	0.401026	0.336666946	0.411645317	0.336666946	0.03046103
93.5	0.399227	0.323892136	0.396180115	0.323892136	0.02497931
94.5	0.393057	0.311253185	0.380739021	0.311253185	0.020266249
95.5	0.392744	0.298769035	0.365351944	0.298769035	0.01817651
96.5	0.389965	0.274337311	0.334860992	0.274337311	0.014485561
97.5	0.389905	0.262423935	0.319817886	0.262423935	0.01138387
98.5	0.385508	0.250733204	0.30494978	0.250733204	0.0100304
99.5	0.383962	0.239280224	0.290286102	0.239280224	0.00767163
100.5	0.363604	0.217139492	0.275855522	0.217139492	0.00571864
101.5	0.362966	0.206474915	0.2616856	0.206474915	0.0048749
102.5	0.343512	0.196094093	0.23423151	0.196094093	0.00342593
103.5	0.332341	0.186005306	0.220995102	0.186005306	0.00227604
104.5		0.166730156	0.208114719	0.166730156	0.00180615
105.5		0.157553549	0.195609436	0.157553549	0.00105991
106.5		0.148688679	0.183496208	0.148688679	0.00054588
107.5		0.140137281	0.171789665	0.140137281	0.00036472
108.5		0.123976231	0.149643297	0.123976231	0.00012981
109.5		0.116364727	0.139220829	0.116364727	2.542E-05
110.5		0.109063148	0.129239712	0.109063148	6.41E-06
111.5		0.102068386	0.119702721	0.102068386	0
112.5		0.088983831	0.11061039	0.088983831	0
113.5		0.082884846	0.093751583	0.082884846	0
114.5		0.077074528	0.085976267	0.077074528	0
115.5		0.071547322	0.078628387	0.071547322	0

Account:	361.210000	361.210000	
Account Description:	Gravity Collection Mains	Gravity Collection Mains	

Service Life Curve Fitting: 361.21-Gravity Collection Mains

Age	PAWC Depreciation Study Observed Life Table (OLT)	Gannett Fleming PAWC Wastewater Depreciation Study (GF PAWC Depr. Study)	AUS Consultant Review PAWC Wastewater Depreciation Study (AUS Review PAWC Depr. Study)	AUS Consultants East Whitelan RCNLD Study (AUS York RCNLD)	OCA RCNLD Study (OCA East Whiteland RCNLD)
Iowa Curve		R2.5	R3.0	R2.5	R2.5
Life		80	85	80	60

Age	PAWC Depr. Study Observed Life Table (OLT)	GF PAWC Depr. Study: R2.5-80 years	AUS Review PAWC Depr. Study: R3.0-85 years	AUS East Whiteland RCNLD: R2.5-80 years	OCA East Whiteland RCNLD: R2.5-60 years
116.5		0.061318512	0.071699691	0.061318512	0
117.5		0.056604538	0.065180721	0.056604538	0
118.5		0.05214901	0.059061069	0.05214901	0
119.5		0.047945251	0.047974458	0.047945251	0
120.5		0.04026597	0.04298358	0.04026597	0
121.5		0.036776421	0.03834455	0.036776421	0
122.5		0.033510611	0.034044859	0.033510611	0
123.5		0.03046103	0.03007201	0.03046103	0
124.5		0.02497931	0.02641356	0.02497931	0
125.5		0.02253093	0.01999079	0.02253093	0
126.5		0.020266249	0.01720217	0.020266249	0
127.5		0.01817651	0.0146794	0.01817651	0
128.5		0.014485561	0.01241055	0.014485561	0
129.5		0.01286577	0.01038362	0.01286577	0
130.5		0.01138387	0.00700692	0.01138387	0
131.5		0.0100304	0.00563223	0.0100304	0
132.5		0.00767163	0.00444948	0.00767163	0
133.5		0.00664853	0.00344531	0.00664853	0
134.5		0.00571864	0.00260589	0.00571864	0
135.5		0.0048749	0.00191696	0.0048749	0
136.5		0.00342593	0.000931315	0.00342593	0
137.5		0.00281496	0.000604152	0.00281496	0
138.5		0.00227604	0.000366793	0.00227604	0
139.5		0.00180615	0.00020376	0.00180615	0
140.5		0.00105991	9.98467E-05	0.00105991	0
141.5		0.00077598	4.04126E-05	0.00077598	0
142.5		0.00054588	1.66246E-06	0.00054588	0
143.5		0.00036472	0	0.00036472	0
144.5		0.00012981	0	0.00012981	0
145.5		6.435E-05	0	6.435E-05	0
146.5		2.542E-05	0	2.542E-05	0
147.5		6.41E-06	0	6.41E-06	0
148.5		0	0	0	0
149.5		0	0	0	0
150.5		0	0	0	0

PENNSYLVANIA-AMERICAN WATER COMPANY

WASTEWATER OPERATIONS (EXCLUDING SCRANTON WASTEWATER)

PENNSYLVANIA-AMERICAN WATER COMPANY

WASTEWATER OPERATIONS (EXCLUDING SCRANTON WASTEWATER)

ACCOUNT 361.10 COLLECTION SEWERS - GRAVITY MAINS

ORIGINAL LIFE TABLE

	PLACEMENT BAND 1965-2019	EXPERIENCE BAND 2001-2019			
AGE AT BEGIN OF BEGINNING OF AGE INTERVAL	EXPOSURES AT BEGIN OF BEGINNING OF INTERVAL AGE INTERVAL	Experience BandRETIREMENTS DURING AGE INTERVAL	RETIREMENT Rate	SURVIVL RATE	PCT SURV BEGIN OF INTERVAL
0.0	123,698,865	1,489	0.0000	1.0000	100.00
0.5	80,968,134	1,744	0.0000	1.0000	100.00
1.5	71,427,735	349,743	0.0049	0.9951	100.00
2.5	61,491,291		0.0000	1.0000	99.51
3.5	47,985,505		0.0000	1.0000	99.51
4.5	43,496,282	26,093	0.0006	0.9994	99.51
5.5	34,622,702	11.064	0.0003	0.9997	99.45
6.5	36,236,717	10.556	0.0003	0.9997	99.42
7.5	44,473,440	-	0.0000	1.0000	99.39
8.5	44,403,805	13,334	0.0003	0.9997	99.39
9.5	42,579,956	1,180,167	0.0277	0.9723	99.36
10.5	27,257,562	886,763	0.0325	0.9675	96.61
11.5	23,041,413	10,064	0.0004	0.9996	93.47
12.5	15,696,984	13,300	0.0008	0.9992	93.43
13.5	13,197,516	82,522	0.0063	0.9937	93.36
14.5	9,898,866	187	0.0000	1.0000	92.77
15.5	8,175,329	367	0.0000	1.0000	92.77
16.5	11,005,722	1,374	0.0001	0.9999	92.77
17.5	22,668,123		0.0000	1.0000	92.76
18.5	22,367,436	144,378	0.0065	0.9935	92.76
19.5	21,841,271		0.0000	1.0000	92.16
20.5	10,429,000	56.430	0.0054	0.9946	92.16
21.5	13,494,984		0.0000	1.0000	91.66
22.5	12,095,717		0.0000	1.0000	91.66
23.5	13,846,891		0.0000	1.0000	91.66
24.5	14,182,481		0.0000	1.0000	91.66
25.5	19,071,002		0.0000	1.0000	91.66
26.5	16,170,692		0.0000	1.0000	91.66
27.5	36,060,280		0.0000	1.0000	91.66
28.5	35,923,542		0.0000	1.0000	91.66
29.5	33,683,971		0.0000	1.0000	91.66
30.5	8,391,683	866	0.0001	0.9999	91.66
31.5	8,167,272	21	0.0000	1.0000	91.65
32.5	8,027,418		0.0000	1.0000	91.65
33.5	7,266,714		0.0000	1.0000	91.65
34.5	5,540,059		0.0000	1.0000	91.65
35.5	3,406,034		0.0000	1.0000	91.65
36.5	3,951,146		0.0000	1.0000	91.65
37.5	4,287,296		0.0000	1.0000	91.65
38.5	4,273,219		0.0000	1.0000	91.65
39.5	4,243,666		0.0000	1.0000	91.65
40.5	41,503,891	5,447	0.0001	0.9999	91.65
41.5	41,043,016	49	0.0000	1.0000	91.64
42.5	41,341,828		0.0000	1.0000	91.64
43.5	20,516,395		0.0000	1.0000	91.64

PENNSYLVANIA-AMERICAN WATER COMPANY
WASTEWATER OPERATIONS (EXCLUDING SCRANTON WASTEWATER)

PENNSYLVANIA-AMERICAN WATER COMPANY
WASTEWATER OPERATIONS (EXCLUDING SCRANTON WASTEWATER)

ACCOUNT 361.10 COLLECTION SEWERS - GRAVITY MAINS

ORIGINAL LIFE TABLE

	PLACEMENT BAND 1965-2019	EXPERIENCE BAND 2001-2019			
AGE AT BEGIN OF BEGINNING OF AGE INTERVAL	EXPOSURES AT BEGIN OF BEGINNING OF INTERVAL AGE INTERVAL	Experience BandRETIREMENTS DURING AGE INTERVAL	RETIREMENT Rate	SURVIVL RATE	PCT SURV BEGIN OF INTERVAL
44.5	17,262,745	4,573	0.0003	0.9997	91.64
45.5	17,447,879		0.0000	1.0000	91.61
46.5	16,922,111	1,617	0.0001	0.9999	91.61
47.5	1,493,981	2,878	0.0019	0.9981	91.60
48.5	1,491,103	21,283	0.0143	0.9857	91.43
49.5	995,707	187	0.0002	0.9998	90.12
50.5	1,249,631		0.0000	1.0000	90.10
51.5	1,214,773		0.0000	1.0000	90.10
52.5	1,253,366	24,618	0.0196	0.9804	90.10
53.5	28,374,663		0.0000	1.0000	88.34
54.5	38,998,170		0.0000	1.0000	88.34
55.5	39,986,553		0.0000	1.0000	88.34
56.5	13,005,874		0.0000	1.0000	88.34
57.5	59,432,346		0.0000	1.0000	88.34
58.5	60,820,282	557	0.0000	1.0000	88.34
59.5	59,761,303	747	0.0000	1.0000	88.34
60.5	2,094,297	87,761	0.0419	0.9581	88.34
61.5	22,663,762	8	0.0000	1.0000	84.64
62.5	21,213,491	61	0.0000	1.0000	84.64
63.5	21,215,934	289	0.0000	1.0000	84.64
64.5	46,353		0.0000	1.0000	84.64
65.5	1,102,303		0.0000	1.0000	84.64
66.5	1,102,303	1,673	0.0015	0.9985	84.64
67.5	1,100,630	37,140	0.0337	0.9663	84.51
68.5	1,259,440		0.0000	1.0000	81.66
69.5	290,689		0.0000	1.0000	81.66
70.5	962,463	168	0.0002	0.9998	81.66
71.5	962,295	15,230	0.0158	0.9842	81.65
72.5	1,042,298	993	0.0010	0.9990	80.36
73.5	946,072	2,053	0.0022	0.9978	80.28
74.5	683,176	7,508	0.0110	0.9890	80.10
75.5	675,668	32,767	0.0485	0.9515	79.22
76.5	642,901	1,310	0.0020	0.9980	75.38
77.5	1,531,686	8,017	0.0052	0.9948	75.22
78.5	1,523,669	299,242	0.1964	0.8036	74.83
79.5	1,224,427	291	0.0002	0.9998	60.14
80.5	1,522,508		0.0000	1.0000	60.12
81.5	632,413	2,303	0.0036	0.9964	60.12
82.5	648,868		0.0000	1.0000	59.91

PENNSYLVANIA-AMERICAN WATER COMPANY
WASTEWATER OPERATIONS (EXCLUDING SCRANTON WASTEWATER)

PENNSYLVANIA-AMERICAN WATER COMPANY
WASTEWATER OPERATIONS (EXCLUDING SCRANTON WASTEWATER)

ACCOUNT 361.10 COLLECTION SEWERS - GRAVITY MAINS

ORIGINAL LIFE TABLE

	PLACEMENT BAND 1965-2019	EXPERIENCE BAND 2001-2019			
AGE AT BEGIN OF BEGINNING OF AGE INTERVAL	EXPOSURES AT BEGIN OF BEGINNING OF INTERVAL AGE INTERVAL	Experience BandRETIREMENTS DURING AGE INTERVAL	RETIREMENT Rate	SURVIVL RATE	PCT SURV BEGIN OF INTERVAL
83.5	648,868	31,252	0.0482	0.9518	59.91
84.5	601,981	10	0.0000	1.0000	57.02
85.5	722,814		0.0000	1.0000	57.02
86.5	722,814	13,485	0.0187	0.9813	57.02
87.5	709,329	153,014	0.2157	0.7843	55.95
88.5	556,315	264	0.0005	0.9995	43.88
89.5	329,027	4,352	0.0132	0.9868	43.86
90.5	306,175	11,276	0.0368	0.9632	43.28
91.5	294,898	11,132	0.0377	0.9623	41.69
92.5	283,767	1,273	0.0045	0.9955	40.12
93.5	282,484	4,366	0.0155	0.9845	39.94
94.5	278,128	221	0.0008	0.9992	39.32
95.5	277,906	1,967	0.0071	0.9929	39.29
96.5	275,939	42	0.0002	0.9998	39.01
97.5	3,804,626	42,906	0.0113	0.9887	39.00
98.5	3,761,720	15,091	0.0040	0.9960	38.56
99.5	3,616,599	191,754	0.0530	0.9470	38.41
100.5	3,424,846	6,012	0.0018	0.9982	36.37
101.5	96,405	5,167	0.0536	0.9464	36.31
102.5	91,238	2,967	0.0325	0.9675	34.36
103.5	88,271	309	0.0035	0.9965	33.24
104.5			0.0000	1.0000	33.13
105.5			0.0000	1.0000	33.13
106.5			0.0000	1.0000	33.13
107.5			0.0000	1.0000	33.13
108.5			0.0000	1.0000	33.13
109.5			0.0000	1.0000	33.13
110.5			0.0000	1.0000	33.13
111.5			0.0000	1.0000	33.13
112.5			0.0000	1.0000	33.13
113.5			0.0000	1.0000	33.13
114.5			0.0000	1.0000	33.13
115.5			0.0000	1.0000	33.13
116.5			0.0000	1.0000	33.13
117.5			0.0000	1.0000	33.13
118.5			0.0000	1.0000	33.13
119.5			0.0000	1.0000	33.13
120.5			0.0000	1.0000	33.13
121.5			0.0000	1.0000	33.13

PENNSYLVANIA-AMERICAN WATER COMPANY
WASTEWATER OPERATIONS (EXCLUDING SCRANTON WASTEWATER)

PENNSYLVANIA-AMERICAN WATER COMPANY
WASTEWATER OPERATIONS (EXCLUDING SCRANTON WASTEWATER)

ACCOUNT 361.10 COLLECTION SEWERS - GRAVITY MAINS

ORIGINAL LIFE TABLE

	PLACEMENT BAND 1965-2019	EXPERIENCE BAND 2001-2019			
AGE AT BEGIN OF BEGINNING OF AGE INTERVAL	EXPOSURES AT BEGIN OF BEGINNING OF INTERVAL AGE INTERVAL	Experience BandRETIREMENTS DURING AGE INTERVAL	RETIREMENT Rate	SURVIVL RATE	PCT SURV BEGIN OF INTERVAL
122.5			0.0000	1.0000	33.13
123.5			0.0000	1.0000	33.13
124.5			0.0000	1.0000	33.13
125.5			0.0000	1.0000	33.13
126.5			0.0000	1.0000	33.13
127.5			0.0000	1.0000	33.13
128.5			0.0000	1.0000	33.13
129.5			0.0000	1.0000	33.13
130.5			0.0000	1.0000	33.13
131.5			0.0000	1.0000	33.13
132.5			0.0000	1.0000	33.13
133.5			0.0000	1.0000	33.13
134.5			0.0000	1.0000	33.13
135.5			0.0000	1.0000	33.13
136.5			0.0000	1.0000	33.13
137.5			0.0000	1.0000	33.13
138.5			0.0000	1.0000	33.13
139.5			0.0000	1.0000	33.13
140.5			0.0000	1.0000	33.13
141.5			0.0000	1.0000	33.13
142.5			0.0000	1.0000	33.13
143.5			0.0000	1.0000	33.13
144.5			0.0000	1.0000	33.13
145.5			0.0000	1.0000	33.13
146.5			0.0000	1.0000	33.13
147.5			0.0000	1.0000	33.13
148.5			0.0000	1.0000	33.13
149.5			0.0000	1.0000	33.13
150.5			0.0000	1.0000	33.13
151.5			0.0000	1.0000	33.13
152.5			0.0000	1.0000	33.13
153.5			0.0000	1.0000	33.13
154.5			0.0000	1.0000	33.13
155.5			0.0000	1.0000	33.13
156.5			0.0000	1.0000	33.13
157.5			0.0000	1.0000	33.13
158.5			0.0000	1.0000	33.13
159.5			0.0000	1.0000	33.13
160.5			0.0000	1.0000	33.13

PENNSYLVANIA-AMERICAN WATER COMPANY
WASTEWATER OPERATIONS (EXCLUDING SCRANTON WASTEWATER)

PENNSYLVANIA-AMERICAN WATER COMPANY
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ACCOUNT 361.10 COLLECTION SEWERS - GRAVITY MAINS

ORIGINAL LIFE TABLE

	PLACEMENT BAND 1965-2019	EXPERIENCE BAND 2001-2019			
AGE AT BEGIN OF BEGINNING OF AGE INTERVAL	EXPOSURES AT BEGIN OF BEGINNING OF INTERVAL AGE INTERVAL	Experience BandRETIREMENTS DURING AGE INTERVAL	RETIREMENT Rate	SURVIVL RATE	PCT SURV BEGIN OF INTERVAL
Total	1,679,425,134	3,846,092			

PVC PIPE LONGEVITY REPORT

Affordability & The 100+ Year Benchmark Standard

A Comprehensive Study on PVC Pipe Excavations, Testing, & Life Cycle Analysis

UTAH STATE UNIVERSITY
BURIED STRUCTURES LABORATORY
STEVEN FOLKMAN, Ph.D., P.E.
UtahStateUniversity

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INTRODUCTION

In the United States and Canada, underground water infrastructure was installed during three main time periods because of population growth in the 1800s, 1900–1945, and post 1945. Pipes made of iron constructed in each of these three eras will all start to fail at nearly the same time over the next couple of decades due to the corrosion of the iron pipes. Additionally, the life span of the materials used since the 1960's has changed. Grey cast iron pipes are no longer manufactured and the new ductile iron material has been made thinner to reduce costs, but as a result, the pipe life expectancy has become shorter with each new investment cycle (1). In 2013, the American Society of Civil Engineers issued a USA Infrastructure Report Card and gave an overall "D" grade to drinking water and wastewater infrastructure which included the piping infrastructure.

In an update to the "Dawn of the Replacement Era," (2) AWWA has published "Buried No Longer" which states "More than a million miles of pipes are nearing the end of its useful life and approaching the age at which it needs to be replaced." (3) These water pipe replacement costs combined with projected expansion costs will cost over $1 trillion over the next couple of decades. The cost of underground pipe infrastructure is 60% of the US water industry's total funding requirement. In addition, sewer and storm drain funding needs also drive up the cost burden on rate payers. Municipalities continue to struggle with balancing water service affordability against the rise in service interruptions from water main breaks. With the introduction of piping materials such as PVC, utilities were able to address the issue of iron pipe degradation due to corrosion. To gain the full benefits of reliability and longevity, asset management financial practices need to be applied.

Infrastructure asset management is an approach which can help utilities bring together the concepts, tools, and techniques to manage assets at an acceptable service level at the lowest life-cycle cost. Asset management practices applied to underground infrastructure help utilities understand the timing and costs associated with replacement activities. The knowledge gained from these efforts also helps in the development of effective pipe material selection through comparative financial analysis called "life cycle costing" as part of the replacement strategies and funding plans. Understanding the longevity of a pipe improves the ability for management to make better infrastructure investment decisions with improved affordability results for customers.

The water industry has seen many types of academic surveys and studies on water main replacement programs and the benefits of asset management and prioritization. However, many utilities have not historically tracked all of the elements of pipe failure. As this trend changes, more data and analysis will be available to the industry to improve water distribution system repair and replacement decision making. This comprehensive study provides the next body of evidence supporting the ability of utilities to address the failing infrastructure and the affordability dilemma.

THE PRIMARY RESEARCHER

DR. STEVEN FOLKMAN

Dr. Steven Folkman is a registered Professional Engineer, a member of American Society for Testing and Materials (ASTM) F17 Plastic Piping Systems, a member of AWWA and a member of the Transportation Research Board Committee on Culverts and Hydraulic Structures, and has oversight of the prestigious Utah State University's (USU) Buried Structures Laboratory. The Buried Structures Laboratory at USU has been involved in analysis and testing of all kinds of pipe and associated structures for over 50 years. Previous directors include Dr. Reynold Watkins and Dr. Al Moser who are internationally recognized experts. Dr. Moser and Dr. Folkman are coauthors of the widely used text *Buried Pipe Design* (McGraw Hill, 3rd Edition). Dr. Folkman's expertise includes structural dynamics, linear and nonlinear finite element analysis utilizing soil/structure interaction, and testing. The USU buried structures laboratory is recognized as one of the laboratories in the United States capable of performing large scale tests on buried pipes. It is from this expertise and background that the excavation reports were reviewed and additional quality control testing was conducted in 2012 and 2013 to complete this comprehensive study.

EXECUTIVE SUMMARY

In 2012, The Utah State University's Buried Structures Laboratory published a comprehensive study based on statistical results of water main breaks in the US and Canada. The findings of the research demonstrated that PVC pipe has the lowest rate of main breaks of pipe materials considered in the study, which included ductile iron, cast iron, steel, concrete, and asbestos cement.

This study continues to explore the elements of PVC reliability and longevity through the comprehensive research on PVC pipe testing results. Pipe experts from around the world have contributed to the documented evidence of PVC pipe longevity through excavations and testing. These dig-up or pipe excavation reports are from "in service" pipes with operational conditions. Non-operational pipe dig-up testing offers very limited performance data.

This comprehensive study reviews past PVC dig-up reports and presents new quality control testing results that continue to validate the performance and longevity of PVC pipe used in water networks. A second component to this research addresses the fundamental challenge of affordability for utilities facing the difficult process of replacing the buried infrastructure which is at the end of its service life.

Life cycle cost analysis is presented as a financial decision tool for pipe replacement selection by applying the findings of reliability and longevity research and testing. This combination of pipe examination and testing data in conjunction with previous pipe break studies supports PVC as a sustainable pipe material, confirming a 100+ year benchmark as an industry standard.

OBJECTIVES & GOALS OF THE STUDY

- Reviewing the results of excavated PVC testing globally.
- Itemizing the types of PVC pipe testing.
- Determining if testing results support the 2012 survey findings of the water main break study.
- Providing a validation tool for comparative analysis for pipe affordability.
- Providing a basis for design engineers to develop new pipe specifications with expected design life standards.
- Providing a basis for new procurement practices to evaluate affordable solutions without compromising on long-term financial benefits.
- Creating an improved integration of pipe infrastructure design and asset management practices.
- Supporting the water industry efforts in developing academic research in support of solutions to address the national concerns over water service sustainability and affordability.

MAJOR FINDINGS

The comprehensive nature of this study has provided several national recommendations and rules of thumb which utilities can use for benchmarking and procurement purposes.

1. Dig-up test results in the U.S. and around the world indicate that PVC pipe can be expected to provide reliable service in excess of 100 years.
2. The average water main is failing at 47 years. Corrosion is the major cause.
3. Utilities using non-corrodible pipe materials are able to reduce the number of water main breaks.
4. Many utilities still have the ability to reduce water main breaks and to reduce O&M costs by utilizing non-corrodible pipes in their replacement and procurement strategies.
5. Internationally, PVC dig-up reports support the previous findings of PVC having the lowest water main break-rate.
6. Improved installation and inspection practices have been shown to contribute to lower failure rates and increased pipe longevity and affordability.
7. Dig-up studies on PVC pipe materials around the world report no degradation after decades of operational service.
8. Recently excavated PVC pipes, some nearly 50 years old, were tested by Utah State University and met all applicable standards. They are expected to easily exceed 100 years of service life.
9. PVC pipes offer a high degree of resilience in freezing conditions and after 25 years meet virtually all new pipe requirements.
10. PVC pressure pipes exhumed after being in operation for almost 30 years have not suffered any loss of strength. All tested pipes would be expected to exceed a 100 year life under normal operating conditions.
11. After over 35 years of operation, PVC pipes have virtually no change in mechanical properties due to ageing. Both ductility and resistance to internal pressure are still on the same level as new pipes.
12. Based on stress regression, slow crack growth and fatigue testing, the service life of PVC pressure pipe should exceed 100 years.
13. The Water Research Foundation reported that 100 years is a conservative estimate for a properly designed and installed PVC pipe.
14. Life cycle costing provides a basis to financially evaluate pipe selection over a 100 year period.
15. Including the realistic costs of corrosion control mitigation* for ductile iron pipes over the 100 year period for all pipe sizes is critical in developing a comparable evaluation of PVC pipe costs and ductile iron pipe costs.

** Corrosion mitigation methods approved by the National Association of Corrosion Engineers*

THE AFFORDABILITY ISSUE

Traditionally, there has been a lack of analysis that combines both underground pipe performance and affordability. Existing practices tended to ignore the effect of environmental conditions on different pipe materials. Engineers understand how the complexity of underground infrastructure has increased along with the array of pipe material and installation choices. The ability to change old habits and consider new materials requires additional analysis, and improved design and installation practices requires more work. This additional "reevaluation work" is required in this new generation of sustainability and striving to make critical decisions in the core infrastructure enabling a healthy and productive life for communities. This enhanced work analysis of pipe design, selection and installation sets forth the longevity and life-cycle costs critically influencing water service affordability for the next 100-200 years.

There have been many studies on water main failure rates in the US, Canada, Australia, and Europe over the last three decades. These studies mainly compared the number of pipe breaks by general pipe type and by length. While these studies have been very helpful to the water industry, the new driver has been concern with the ability to make underground pipe decisions to improve the repair and replacement costs in an effort to address the affordability of water services to customers. This new level of fiscal accountability and demand for transparent utility management back to their owners and stakeholders has increased the need for additional evidence to demonstrate the improved decision making. Dig-up reports and pipe performance and longevity studies form the next body of evidence needed to collaborate water main break surveys and studies.

The simple formula in a life cycle cost framework is essentially that "a pipe which has a long life at a low cost is the most affordable." Engineers are to make available every alternative which would answer the simple question of longevity and cost at each relevant point within the underground network providing service.

The analysis of pipe breakage is incomplete without the assessment of why the pipe failed. This knowledge is then applied to the cost analysis of repairing and replacing the pipe. Once again, analysis would dictate that if a pipe is failing in less than 100 years then one or more of the following factors should be considered; a) the pipe has an identified manufacturing defect, b) the recommended installation procedures were not followed, c) the design process did not correctly address the actual operating conditions, d) the system was not properly maintained, e) the pipe material originally selected needs to be changed, and/or f) efforts need to be made to increase the pipe's longevity and performance as compared to an alternative option based on cost. The 2013 United States Conference of Mayor's report on *Municipal Procurement* (4) highlighted the importance of such procurement policies and also in the appendix demonstrated a simple cost comparison methodology for affordable pipe options for utilities.

WATER MAIN BREAK STUDIES

Water main break studies over the last 30 years demonstrate the changing trends based on the use of various pipe types.

1981

Kirby (5) published an early study of water main failure rates in England. Kirby noticed that first PVC installations in 1965 suffered from higher failure rates than cast iron pipes. Most of these failures were related to improper installation procedures. By 1979, the failure rates of PVC had dropped to well below that of cast iron due to improved pipe installation procedures.

Bjorklund (6) looked at water main failure rates in Sweden. He noted the improved performance of PVC pipes.

2005

Burn, et. al. (7) conducted a small survey of water utilities in Australia, Canada, and US. Important observations include the low overall failure rate of PVC relative to other pipe materials. Variability in survey data indicated that early failures were very likely attributed to installation practices.

2012

US Water Main Breaks Study by Folkman, et. al. (8) reported results of a survey of 188 utilities across the US and Canada. That survey demonstrated that PVC pipe has the lowest overall failure rate when compared to cast iron, ductile iron, concrete, steel and asbestos cement pipes. Corrosion was indicated as the primary cause of failure. PVC currently represents 23%-27% of the total length of pipe installed in US water systems. PVC dominates the rural water systems and the sewer underground infrastructure. The report also found that 8.4% of water mains are described as beyond their useful life.

2013

In 2013, EPCOR's Seargeant (9) reported on water main breaks in the system in Edmonton, Canada. The highly corrosive soil in Edmonton necessitated a transition from cast iron to asbestos cement pipes in 1966 and then to PVC starting in 1977. The transition to PVC has produced a dramatic reduction in water main break rates for the city. EPCOR also demonstrated that a PVC water main could be frozen in winter and not burst. This evidence is critically important for geographic areas facing climate change with severe winter conditions and freezing storms and flooding. Three PVC pipes were excavated and tested. One pipe had been in service for 17 years and the other two had been in service for 25 years. Quality control tests including quick burst, impact resistance, flattening, and acetone immersion were completed and the tests demonstrated the pipe met all new pipe requirements.

THE DIG-UP REPORTS

EVIDENCE OF PERFORMANCE & LONGEVITY

Dig-up reports have occurred globally, but mainly in Australia, Europe, Canada and the United States. In these studies, the pipes were subjected to a range of mechanical tests in order to assess whether there had been any deterioration during their service. PVC pressure pipes have been used in Australia for over thirty years. A presentation in 2001 by Stahmer (10) on the long-term performance of these pipes explained that quantifying how long a pipe will remain serviceable is sometimes complicated by misunderstandings surrounding the characteristics of PVC pipes. An excerpt includes:

> *PVC exhibits time dependent properties under stress. Unfortunately this time dependency is sometimes interpreted as age dependency. For example, the downward slope of the traditional pipe hoop-stress regression curve is often interpreted as a loss of strength with age. In fact the downward slope simply reflects the ability of the viscoelastic material to support lower stresses for longer periods than it can support higher stresses. Hucks demonstrated the burst strength of PVC pipes was not diminished by long term exposure to lower stresses. The burst strength was shown to be higher for pipe aged in the laboratory for 10 years than it was for the same pipe at the time of manufacture.*

AUSTRALIAN TESTING DEMONSTRATES **NO PIPE DEGRADATION** AFTER 30 YEARS

The testing methodology used by Stahmer (10) takes into consideration the field performance of the PVC pressure pipes as well as the actual testing based on the Australian Standards. The pipes which were exhumed in 1996 after 25 years of operation were subjected to the following tests:

1. Resistance to flattening was carried out by placing short sections of pipe between parallel plates and deflecting to 40% of the original diameter. The sections were then inspected for any damage or fracture. Test Method: Australian Standard AS 1462.2
2. Resistance to impact was performed using a weight falling 2 m. A failure is recoded if there was any fracture evident in the specimen at the conclusion of the test. The size of the weight varies with the size of the pipe in the manner described in the product standard. Test Method: Australian Standard AS 1462.3
3. The dispersion of the resin in the pipes was assessed on samples approximately 0.02 mm thick under low power magnification.
4. Tensile properties of the PVC were determined on four pipe samples, using the average of five determinations for each. Test Method: ASTM D638M.
5. The fracture toughness of the pipes was determined using the notched C-ring method. For each of the pipes tested, a series of C-rings was prepared and tested under a range of applied stresses. The stress and time-to-failure were recorded for each and the fracture toughness versus the time-to-failure was plotted. Test Method: Australian Standard Draft No. 2570.

It was reported that these PVC pressure pipes were installed in a variety of terrains including sandy soil and solid limestone. The performance was reported to have been satisfactory in all situations. In addition, the pipes in the system traverse both roads and rail lines. In neither instance was the pressure class of the pipe upgraded to accommodate the dynamic loads imposed by passing road traffic or trains. Nevertheless, no failures have been reported as a consequence of dynamic loading.

The long-term performance of the system has been clearly dependent upon the initial pipe quality, handling and installation. *Degradation of the PVC material has not occurred.* For the four pipes tested, both the tensile strength at yield and elongation-at-break were essentially the same. Moreover, the results are the same as expected for contemporary pipes tested at the time of manufacture. Thus it can be concluded there has been *no degradation in the strength or elongation characteristics of the PVC during the service life of the pipes. The exhumed pipes have not suffered any loss of strength as a consequence of operating under pressure for almost 30 years.*

These results showed there was no deterioration in the fracture toughness during a service life approaching 30 years. A number of studies have been made of exhumed PVC pipes in order to test the premise that material degradation is neither occurring nor adversely affecting potential service life. The findings of the Australian pipe testing support the earlier works by Lancashire (11), Bauer (12) and Alferink et al (13).

Numerous studies on the fatigue failure characteristics of PVC pipe have been conducted. In 2005 Whittle and Teo (14) summarized previous research and conducted rotating beam experiments with notched PVC specimens and were able to match fatigue failure test results from pressure cycling PVC pipes. Their results show that an endurance limit exists in PVC-U pipes such that stress amplitudes less than 2.5 MPa (362 psi) would have negligible effect on the life of a pipe. This stress range is well below that expected in a typical municipal water system.

The Water Research Foundation funded a study published in 2005 titled "Long-Term Performance Predictions for PVC Pipes," Burn, et. al. (7). This report has a comprehensive review of methods to analyze the expected life of PVC pipe. *They report that 100 years is a conservative estimate for a "properly designed and installed pipe."* A detailed survey was sent out to 44 water utilities in Australia, Canada, and the USA. Of the 44 participants, 17 water utilities provided detailed data. This provided a benchmark for failure models developed. Fracture mechanics-based models were produced to predict the conditions under which pipe failure will occur in service. These models were calibrated against failure rates recorded in a number of North American and Australian utilities.

UNITED KINGDOM & EUROPEAN STUDIES RESULT IN PIPE LIFE IN EXCESS OF 100 YEARS

In 1985, Lancashire (11) investigated whether the performance of PVC-U pipe is affected by time in service. Lancashire studied PVC water pipes exhumed after 4 to 16 years' service and concluded that ageing was not a significant factor influencing the performance of the pipes. Material quality, particularly good gelation and small size of inclusions, was found to have the overwhelming influence on performance. The pipes were 4 inch, Class C (operating pressure 9 bar) from a single manufacturer. They performed stress regression testing and concluded that initial pipe quality is the overriding influence in determining pipe performance. *All of the pipes tested would be expected to exceed a 100 year life under normal operating conditions.*

In 1996, Alferink et al (13) tested exhumed PVC pressure pipes ranging up to 37 years of age. It was concluded there was virtually no change in the mechanical properties of the pipes due to ageing. The report summarized results of testing a total of 19 pipe samples. The tensile tests showed that the material modulus does not decrease with pipe age. There did not appear to be any changes in tensile strength and impact strength with pipe age. Stress regression testing showed that PVC pipes after 35 years of service still were meeting CEN stress regression requirements. They concluded that "old PVC water pressure pipes still fulfill the most important functional requirements. *Ductility and resistance to internal pressure have been virtually unaffected by ageing, and are still on the same level as for new pipes."*

Hülsmann (15) in 2004 reported tests on some of the first PVC pipes installed in Germany. One set of tests examined 15 pipe specimens exhumed after being in use for 23 years. They ranged in diameter from 20-48 mm (0.787-1.890 in) and were subjected to long term hydrostatic pressure testing. The testing was completed at 60°C and then the Arrhenius equation was used to scale the results back to 20°C. The extrapolation of the stress regression data was taken out to 10^6 hours (114 years). Hülsmann concluded that under realistic conditions in the Bitterfeld location and at 4-5 bar (58-83 psi) water pressure, it may be assumed that another 100 years of safe operation could be expected. An additional nine pipe specimens, 4 coming from a 32.5 mm (1.28 in) pipe and 5 coming from a 25.2 mm (1.0 in) pipe, were in operation as potable water pipes for 53 years at 4-5 bar (58-83 psi) operation pressure.

The 9 samples were subjected to long term hydrostatic pressure tests at 60°C. An extrapolation of the stress regression data was to 10^6 hours (114 years). They concluded these pipes would last another 100 years of operation even at 7 bar (102 psi) and 60°C (140°F) operating conditions.

If the temperature is between 20-40°C (68-104°F) and the operating pressure is doubled to 8-10 bar (116-145 psi), *the pipe would easily operate for 100 years as a potable water pipe with a safety factor of 1.5.*

The following year in 2005, Boersma and Breen (16) examined chemical and physical ageing of PVC pressure pipe. They defined chemical ageing by a change in the chemical structure of a polymer and physical ageing as a change in the physical structure. He notes that "Chemical ageing at 15°C seems not to have a significant influence on the quality of PVC water distribution pipes." Physical ageing was investigated by examining the free volume relaxation by measuring yield stress. Accelerated aging of PVC pipe at 60°C leads to an increase in yield stress and thus yield stress is an indication of the pipe age. However, measured yield strength of pipes in service up to 30 years does not show any trends indicating changes in yield strength with pipe age. They concluded that "Physical ageing at 15°C seems not to have a significant influence on the quality of water distribution pipes." They also tested PVC pipes for stress regression, slow crack growth, and fatigue and concluded *that the service life of high quality PVC should exceed 100 years.*

In 2006, Breen (17) studied five excavated pressure pipe specimens produced between 1959 and 1997 with pipe diameters between 160 and 400 mm (6.3 and 15.7 inch). He performed chemical and physical ageing tests on the PVC along with tensile, burst test, slow crack growth, impact test, and fatigue measurements. He concluded that the "existing PVC tap water pipe systems in the Netherlands will operate for at least 100 years provided that the internal and external loads do not result in hoop stresses which will exceed 12.5 MPa and that no micro-crack and mechanical damages are present in the PVC pipes."

NORTH AMERICAN STUDIES STATE THAT **100 YEARS IS A CONSERVATIVE ESTIMATE**

Moser and Kellogg in 1994 (18) published an AWWARF funded survey of water utilities and performed impact and acetone immersion tests on 59 PVC pipe samples from 16 different utilities that were being installed in 1992. The samples provided came from ten different PVC pipe manufacturers. All of the samples passed the acetone immersion test and only four samples failed the impact tests. The survey results found some evidence of early PVC pipe failure but these problems usually occurred in the first year of operation and were usually attributed to improper pipe installation.

Moser and Folkman (19) reviewed previous studies of fatigue failure in PVC pipe and guidelines to prevent failures. They also conducted numerous pressure cycling tests of 6-inch PVC pipe and combined their results with previously reported data. Their results are currently the design guidelines presented in the AWWA C900 standard in Appendix B.

In 2013, Folkman and Barfuss (20) reported on quality control tests on PVC pipe that had been in use for a number of years. The pipes tested are summarized in Table 1 and had been in continuous use for between 20 and 49 years. Note that sample #1 was manufactured under an early commercial standard CS 256. In 1964, the CS 256 standard became ASTM D2241. The tests included pipe dimensions, acetone immersion, and pressure tests. The burst pressure test was used for samples #1 and #2 that were manufactured to CS 256 and ASTM D2241 standards and the hydrostatic integrity test was applied to sample #3 which was made to the AWWA C905 standard. Table 2 lists the specifications used for these quality control tests. All three samples passed all of the quality control tests. Figure 1 is a photograph of Sample #3 prior to the hydrostatic integrity test.

FIGURE 1 : PHOTO OF SAMPLE #3 PRIOR TO STRUCTURAL INTEGRITY TESTING

TABLE 1 : Description of PVC Pipe Tested at USU

	SAMPLE #1	SAMPLE #2	SAMPLE #3
SIZE, DR	4 INCH, SDR21	4 INCH, SDR21	24 INCH, DR18
USAGE	WATER MAIN	WATER MAIN	SEWER FORCEMAIN
MANUFACTURING STANDARD	CS 256	ASTM D2241	AWWA C905
YEAR INSTALLED AGE	1964	1987	EARLY 1990'S
YEAR EXCAVATED	2012	2012	2012
YEARS IN SERVICE	49 YEARS	26 YEARS	~20 YEARS

TABLE 2 : Quality Control Test Specifications

TEST	TEST CONDITIONS	APPLICABLE STANDARDS
PIPE DIMENSIONS	6 SPECIMENS @ 8 POINTS	AWWA C905 & ASTM D2122
ACETONE IMMERSION	8 SAMPLES	ASTM D2152
BURST PRESSURE	1 SPECIMEN, 630 PSI IN 60 SEC	ASTM D2241 & D1599
HYDROSTATIC INTEGRITY	1 SPECIMEN, 470 PSI IN 60 SEC	AWWA C905 & ASTM D1599

DIG-UP TEST RESULTS SUMMARY

Accelerated ageing studies all indicate that PVC pressure pipe can be expected to provide reliable service in excess of 100 years. Accelerated ageing tests provide the best estimates a laboratory can provide for longevity. Validation of PVC expected long-term performance with exhumed samples provides confidence to the end user. With many installations of PVC pipe reaching 50 years with no indication of loss of capacity, this provides further validation of PVC pipe's long life.

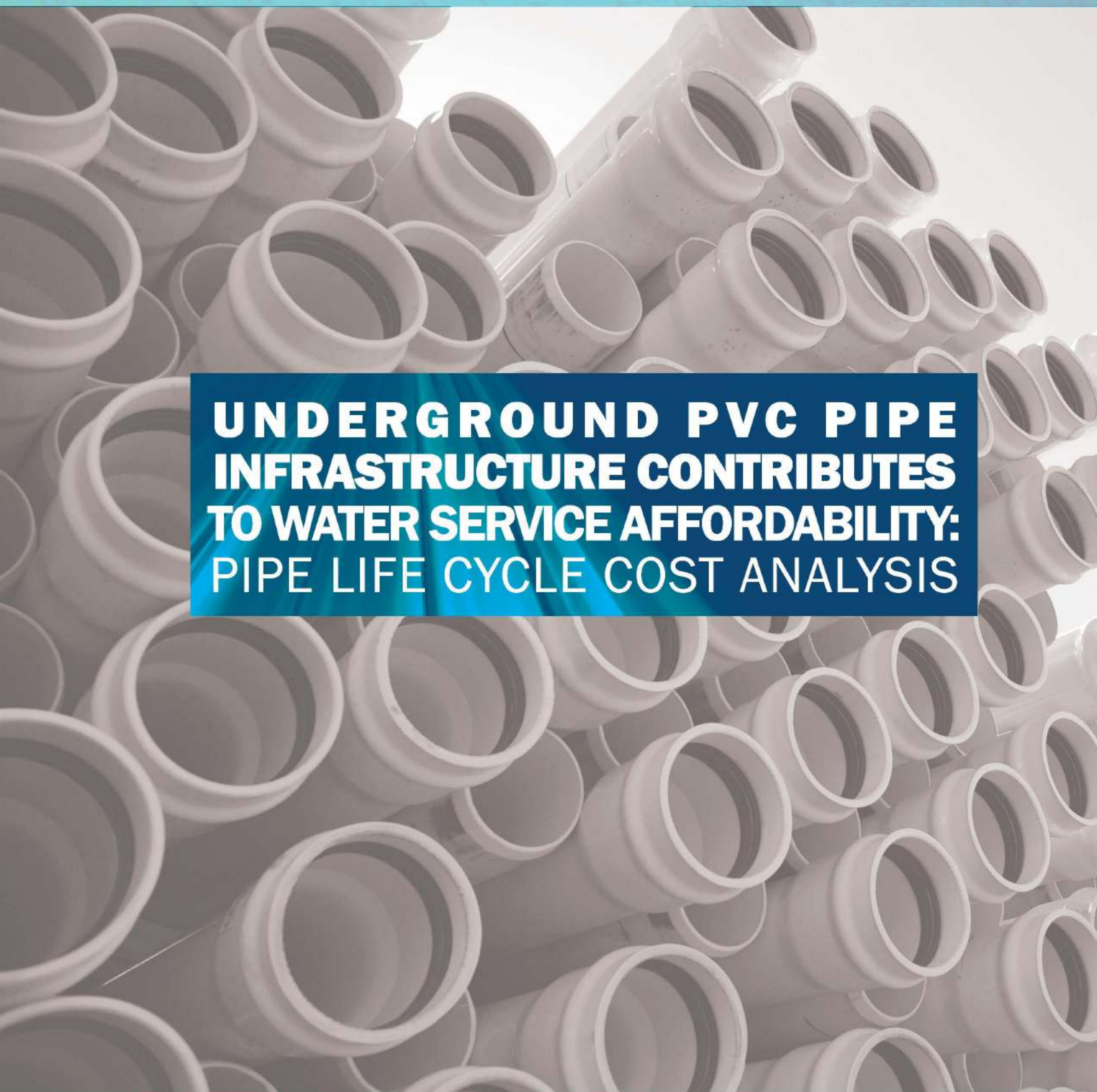
Examples can be found of PVC pipe failures with very short life spans. When an early PVC failure occurs, it has been the experience of the author that there will be two possible causes. The failure could be due to a defective pipe usually caused by incomplete gelation of the PVC. Quality control tests by manufacturers on each lot of pipe should prevent this occurrence. The primary cause of early PVC pipe failure is improper installation procedures. Regardless of the pipe material chosen, a quality installation procedure will provide enhanced pipe life.

SEWER PIPE STUDIES

Bauer (22) tested PVC sewer pipe exhumed after 15 years of service and in 1990 reported on tests that no measurable degradation of the material occurred in this period. In particular it was reported that there was *no embrittlement and no decrease in modulus or pipe stiffness.*

Meerman (23) in 2008 conducted inspections of sewer pipe up to 25 years old. A number of pipes were recovered from their service sites and subjected to a range of visual, microscopic and other test to assess their condition. The tests included: visual and microscopic inspections, geometrical analysis and deformations, and surface roughness and degradation. He concluded that the existing PVC sewer pipe systems will operate for at least 100 years.

UNDERGROUND PVC PIPE INFRASTRUCTURE CONTRIBUTES TO WATER SERVICE AFFORDABILITY: PIPE LIFE CYCLE COST ANALYSIS



LIFE CYCLE COST ANALYSIS

Life cycle cost analysis (LCCA) is an evaluation technique applicable for the consideration of certain water and wastewater infrastructure investment decisions. Specifically, when it has been decided that a project will be implemented, LCCA will assist in determining the best—the lowest-cost—way to accomplish the project. The LCCA approach (24) enables the total cost comparison of competing design (or preservation) alternatives, each of which is appropriate for implementation of underground pipe projects. All of the relevant costs that occur throughout the life of an alternative, not simply the original expenditures, are included. Also, the effects of the utility's construction and maintenance activities and the direct costs to the utility are included.

LCCA is reasonably straightforward to understand and perform. It incorporates both the utility's institutional knowledge and the application of sound economic analysis techniques. In brief, the LCCA process begins with the development of alternatives to accomplish the structural and performance objectives for a project. The analyst then defines the schedule of initial and future activities involved in implementing each project design alternative. Next, the costs of these activities are estimated. Best-practice LCCA calls for including not only direct agency expenditures (for example, construction or maintenance activities) but other related costs. Using an economic technique known as "discounting," these costs are converted into present dollars and summed for each alternative. The analyst can then determine which alternative is the most cost-effective. It is important to note that the lowest LCCA option may not necessarily be implemented when other considerations such as risk, available budgets, and political and environmental concerns are taken into account. LCCA provides critical information to the overall decision-making process, but not the final answer.

1. ESTABLISH DESIGN ALTERNATIVES
2. DETERMINE ACTIVITY TIMING
3. ESTIMATE COSTS
4. COMPUTE LIFE-CYCLE COSTS
5. ANALYZE THE RESULTS

The EPA's 10 step process (25) for asset management programs supports the activity of life cycle costing.

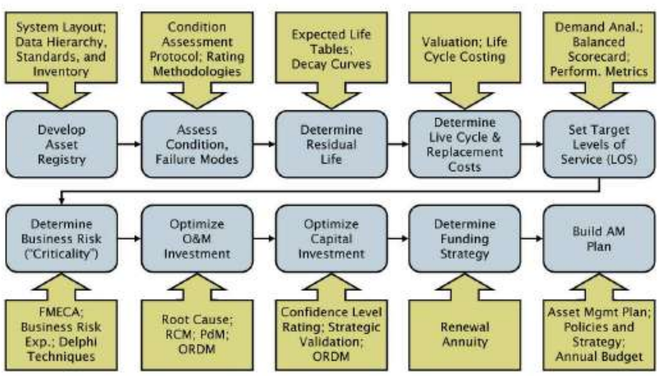


FIGURE 2 : EPA's Life Cycle Steps

In summary, LCCA (24) is a cost-centric business approach used to select the most cost-effective alternative that accomplishes a preselected project at a specific level of benefits that is assumed to be equal among project alternatives being considered. Underground pipe infrastructure is a perfect application of life cycle cost analysis.

LIFE CYCLE COST ANALYSIS
CONTINUED

The life cycle costs according to the EPA include the total cost of an item throughout its life, including costs of planning, design, acquisition, operations, maintenance, and disposal, less any residual value, or the total cost of providing, owning and maintaining an asset over a predetermined evaluation period. The EPA asset management training charts (25) below in Figures 3 and 4 illustrate this concept.

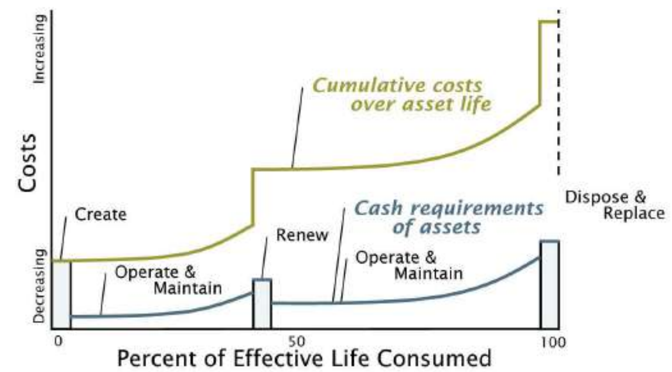


FIGURE 3 : . EPA Costs Over Lifetime

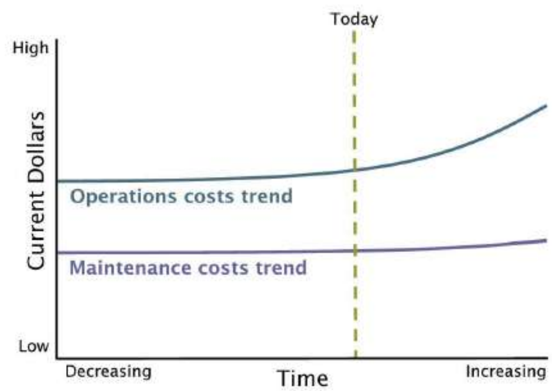


FIGURE 4 : . EPA Replacement Timing

The timing of rehabilitation activities as shown in Figure 4 should be based on existing performance records such as those available from a utilities work order management system or CMMS (computerized maintenance management system). This information may be supplemented with findings from outside research such as national water main break studies, national database repositories of pipe condition assessment data like WaterID (waterid.org) and dig-up studies. When actual data are unavailable or not applicable, the judgment of experienced engineers may be particularly useful for both planned activities and costs to monitor, rehab or replace underground infrastructure.

The national database of WaterID offers various cost synthesis data (26) on water and sewer pipe costs including estimated and reported costs for various types of condition assessment and rehabilitation.

In 2014, a North Carolina city published (27) in a local newspaper article "Saluda estimates costs of repairing infrastructure" the initial price comparisons for replacing two current lines with PVC pipe versus iron pipe.

Costs for Replacing Waterlines A:
Eight-inch PVC Pipe
1,600 feet – $29,587.72

Eight-inch Ductile Iron Pipe
1,600 feet – $42,352.32

Costs for Replacing Waterlines B:
Six-inch PVC Pipe
1,500 feet – $20,125.20

Six-inch Ductile Iron Pipe
1,500 feet – $40,110.30

The focus of this study is not to produce a price list of pipes, condition assessment and corrosion control activities but to recommend that these types of costs be included in a life cycle costing analysis. Life cycle costing as a pipe selection evaluation tool becomes very valuable in comparing underground pipe replacement cost for pipe projects. These tools and recommendations should become standards in the procurement process of utilities in order to support sustainability and affordability goals and polices. This same methodology can be applied to other infrastructure categories such as valves and manholes.

Underground infrastructure projects have a number of different types of costs beyond the initial pipe price as demonstrated in Figure 5 from a Water ID synthesis report (26) on pipe costs and considerations.

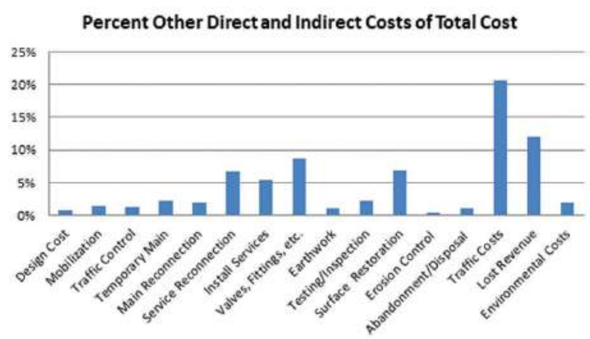


FIGURE 5 : WaterID Synthesis Report Example of Costs

CONCLUSIONS AND RECOMMENDATONS

Our water and sewer underground infrastructure is now in decline after decades of service. The signs of distress surface daily as water mains break, creating floods and sink holes. The loss of service is more than an inconvenience, causing significant social and economic disruptions at ever increasing costs. The downturn of the economy has also given rise to new issues on the affordability of water services when the total price tag of regulatory issues and replacement costs are considered. These issues create a more complex environment for utility management, including an increased amount of public awareness and a greater demand for transparency and accountability. In an effort to provide solutions to these new utility business requirements, additional processes and tools are needed as part of the underground pipe infrastructure evaluation and selection process. This effort requires the attention of elected officials, the support of utility management and the involvement of engineering, financial and procurement resources to develop a new program for sustainability and affordability.

The first phase of gathering evidence of new solutions involved a study of pipes to quantify the occurrences of failing underground pipe networks namely water main break rates. Water main break rates are calculated for all pipe materials used in the transport of water to create a measurement to judge pipe performance and durability. Water main break rates can vary year to year and by utility. However, in aggregate, break rates produce a compelling story which can aid our prudent decision making as it relates to repairing and replacing our underground pipes.

The second phase to further support the water main break evidence involves reports and studies on "in service," excavated pipe testing. These results further the development of a case for performance and longevity review as well as contributing to financial costs analysis tools. Within the framework of this collective data including life cycle costs and asset management practices, many new standards of pipe evaluation selection can be performed. This methodology provides for greater understanding and acceptance of alternative materials to be used in the underground networks necessary to withstand corrosion and other environmental challenges facing every utility to some degree. Many utilities have fallen short in producing appropriate cost and life cycle comparison of pipe performance. This has occurred when insignificant statistical sampling is used, poor installation practices are assumed as local standards, modeling activities do not take into consideration the difference in material mechanics, and cost analysis omits the operational and maintenance cost of corrosion control programs both internal and external to the pipe.

As these recommendations continue to become accepted best practices for effectively managed utilities in both private and public operations, the nation as a whole can rebuild its basic water and sewer infrastructure and stand as a national treasure of innovation and industry with performance and longevity to extend beyond the next 100 years. This process can be achieved by applying correct tools and methodologies which can quantify the costs and demonstrate efforts towards achieving more affordable infrastructure choices without sacrificing quality or performance. The combination of research, testing, and analysis results in confirming a 100+ year benchmark standard for PVC pipes.

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JCW Exhibit 3 PVC Life

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Water Environment Federation
the water quality people®

FACT SHEET

Sanitary Sewer Rehabilitation

Sanitary sewer rehabilitation through repair and renewal is a common practice to reduce extraneous flow, and address structural defects. This fact sheet serves as a basic resource for practitioners providing rehabilitation information, methods and key industry references.

Introduction

Sewers are a series of connected pipes or pipelines that convey either wastewater or storm water to a designated downstream location for treatment and/or disposal. There are three different types of sewers: sanitary, storm and combined. Sanitary sewers and combined sewers convey wastewater from homes, institutions and businesses to a centralized treatment plant. Sanitary sewers carry only wastewater whereas combined sewers carry both wastewater and storm water. Wastewater conveyance and treatment are important because they help prevent waterborne illnesses and promote general sanitation before safely discharging to receiving waters. Many older sewer systems consist primarily of combined sewers in the central or older part of the city but are surrounded by sanitary sewers built in newer growth areas. Storm sewers convey snowmelt and rainwater from yards, sidewalks and roadways and route it to receiving waters directly or through best management practices and facilities to remove certain pollutants.

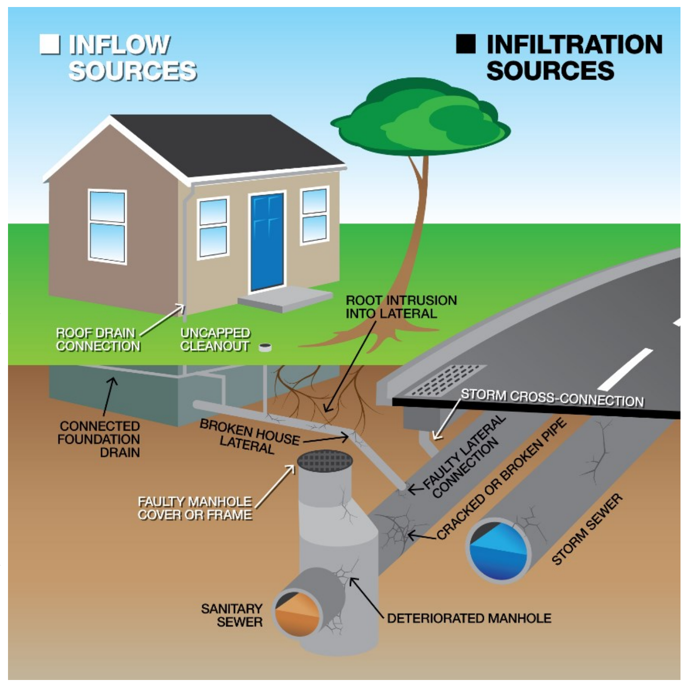

Figure 1: Typical Sources of I/I in Sanitary Sewer Systems (Image from WEF, 2017)

Sanitary and combined sewer systems usually contain private sewer laterals that connect individual buildings to main sewer pipelines. However, sanitary and combined sewers include more than just pipes. The pipes are part of an entire conveyance system that includes pump stations, force mains, manholes, storage facilities and other components. Similarly, storm sewer conveyance systems can also include pump stations, force mains, manholes and storage facilities. WEF's Sanitary Sewers fact sheet provides an overview of sanitary sewer basics, design, operation and maintenance, as well as repair / rehabilitation/ replacement issues. This fact sheet provides sanitary sewer rehabilitation information, methods and references.

The primary focus of this fact sheet is rehabilitation of the sanitary sewer mainline located in the public right-of-way or dedicated easement. In addition, it provides basic information on rehabilitation of private sewer laterals that connect homes/buildings to the sewer mains in the public right-of-way.

Sanitary Sewer Defects and Extraneous Flow

Sewers are designed to collect wastewater from intended sources and convey it downstream. However, some extraneous water may enter the pipes from unintended sources, either from surface water, groundwater through defects or direct illicit connection. Sewer defects are pipe system deficiencies resulting from system aging, structural failure, lack

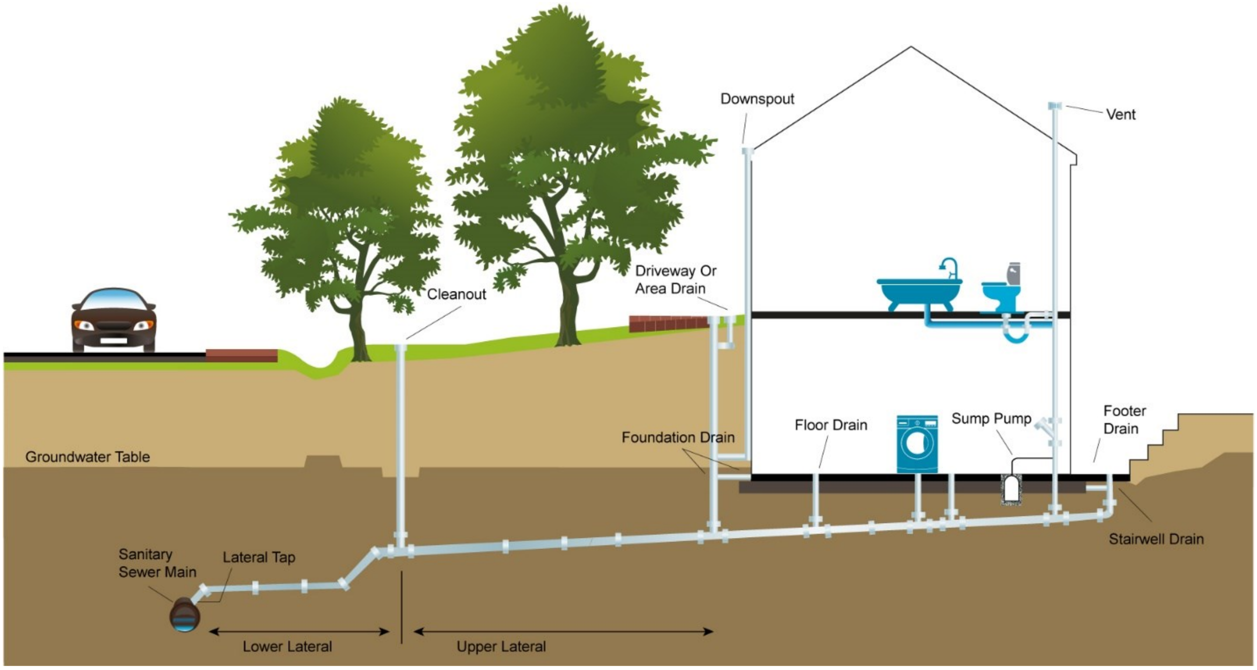

Figure 2: Example Sewer Lateral Configuration (Image from WEF, 2016)

of proper maintenance, and/or poor construction and design practices. They can include conditions such as broken pipe; leaking joints; manhole lids with holes and/or poor sealing; and root infested sewer laterals (See Figure 1). In sanitary sewers, this can lead to excessive infiltration and inflow (I/I), which can be more noticeable after precipitation conditions.

Extraneous water entering any collection system can consume some or all the available capacity as originally designed. These additional flows have a significant impact in relatively small sanitary sewers since they are sized to collect wastewater flow, not storm water. When the available capacity is reduced, or consumed, water levels rise and surcharging can occur. Surcharging, when the water level exceeds the height of the pipe, can accelerate pipe deterioration by forcing water to leave the pipe through defects into surrounding soil, and bringing in surrounding soil when the surcharge is alleviated, causing voids to form outside the pipe. Surcharging can lead to sanitary sewer overflows (SSOs) either in the street or into buildings, and surface flooding. I/I entering sanitary sewers is the highest level of concern.

Sewer laterals, which connect buildings on private properties to sewer mains, are often a significant source of I/I (See Figure 2). A comprehensive I/I reduction program requires effectively addressing private property I/I (PPII) sources. Private property laterals can account for half of the I/I entry to sanitary sewers. WEF's *Private Property Infiltration and Inflow* fact sheet outlines key considerations for municipal utilities establishing a framework for PPII mitigation activities such as program approaches, policy and legal issues, funding, public outreach, and implementation.

Sewer rehabilitation, or restoring to an improved condition, is a means to reducing the extraneous flow entering the system, which in turn lowers the potential for causing SSOs and flooding by correcting defects. Sewer defects can also be structural in nature and rehabilitation can be necessary to prevent structural failure. Increasing extraneous flow is one symptom of the poor structural condition of aging sewers in many cases. Hence, the sewer rehabilitation provides a solution to extend the useful life of the asset. Consequently, rehabilitation can result in reduction of extraneous flow which in turn reduces sewer surcharges and unintended poor system performance.

The state-of-the-art industry experiences indicate that before investing in sanitary sewer capacity improvements to handle excessive I/I, it is prudent to improve sewer system structural conditions to realize practical levels of I/I reduction first and then consider supplementing with right-sized conveyance/storage and downstream treatment systems. It has also been proven that asset management approaches to sewer system rehabilitation are effective and adding extraneous (I/I) flow reduction criteria will bring overall comprehension to prioritize public investments. Reducing I/I is a foundational step before adding additional sewer assets. Moreover, reducing PPII is critical for overall success of I/I reduction efforts. Rehabilitating the sewer system should be undertaken first to determine the magnitude of I/I reduction possible. It may be that partial or comprehensive rehabilitation of the system restores adequate levels of the conveyance capacity. Additional conveyance/storage/treatment capacity should be supplemented as needed.

Sanitary Sewer Rehabilitation

Sewer rehabilitation can be considered both repair and renewal, to reduce extraneous flow, and address structural defects. Rehabilitation is different from system replacement in that repairs selectively target I/I sources and structural defects rather than complete replacement of pipes and/or manholes. Not all sewer defects cause capacity restrictions or are considered I/I sources.

Repairs are generally made to allow the pipe to function to the end of its useful life. They can involve location specific repairs that seal the sewer pipeline and may restore the structural integrity of the pipe at that location, but does not restore the structural integrity of the entire pipe. It can include repair methods that seal the entire pipe segment but do not restore structural integrity. There are several methods of sewer rehabilitation, including internal and external point repairs, sealing joints or cracks, spray lining or applying a coating, and partial replacement.

Renewal is more comprehensive than repair, and extends the useful life of the pipe. Renewal includes techniques that renew the structural integrity of the entire sewer pipeline segment between manholes. Pipeline renewal techniques include a variety of liners, coatings, panel systems and replacing segments of pipe. Like all rehabilitation methods, eventually renewal technologies will generally decrease in effectiveness until replacement becomes the most cost-effective alternative.

Sewer rehabilitation projects can include a mixture of repairs and renewal – with a focus on both restoring structural integrity and practical reduction of I/I. Each system component is analyzed to determine where defective areas allow I/I to enter the system, and the most cost-effective repair or renewal method is applied to eliminate that source of I/I while ensuring that the extraneous water does not migrate to enter the system through a different defect. For sewer mains, a rehabilitation project may include a combination of selective sealing, point repairs, partial replacement, and lining. It is through a comprehensive analysis that the most cost-effective combination of repair, renewal, and replacement techniques are employed to meet objectives for structural condition improvements, I/I control, or both. Depending upon the size of the pipe, some methods can only be used on larger diameter pipe, while others are more universal.

Sanitary sewer conditions affecting rehabilitation

With a multitude of options available to rehabilitate sewers, the different conditions affecting the sewer should be considered before deciding on a rehabilitation method. Factors to consider when selecting a rehabilitation method include, but are not limited to the following:

- Pipe characteristics: age; diameter; shape; material; length; joint type and frequency; slope; depth; and number of service laterals connected
- Soil and groundwater conditions that effect the structural conditions and active infiltration and/or high groundwater
- Sewer location, i.e., public right-of-way or an easement or private property
- Service area characteristics: number of connections and/or tributary area; previous evaluation data such as televised inspection, smoke testing, dye water testing; maintenance history on how frequently does this sewer require cleaning or root cutting; and flow monitoring data that indicates dry weather conditions and/or wet weather response
- Installation conditions, access restrictions, and other factors to be considered during construction

Methodologies for sewer pipe rehabilitation

Sewer pipe failure is most often a result of lack of maintenance. There are 3 stages of decay that warrant definition and are a direct result of I/I (See Figure 3).

- **Stage 1**: Initial Defect allows the deterioration process to begin. Pipe remains supported by the surrounding soil.
- **Stage 2**: Structural defects continue deterioration to a point where soil around the pipe egresses into the pipe through infiltration at defects, causing a loss of supporting soils and voids to develop outside the pipe, accelerating deterioration.
- **Stage 3**: Loss of support from surrounding soil allows deformation or joint defects to degrade, leading to structural failure.

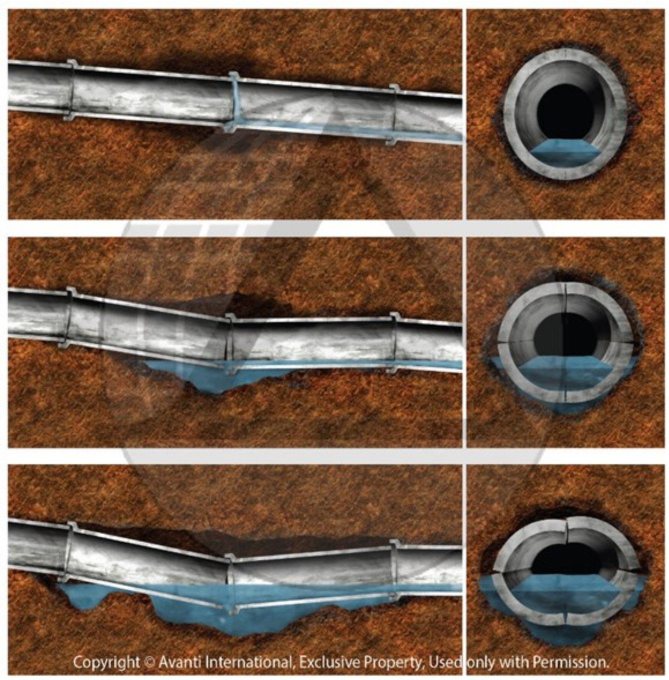

Figure 3: Process of Sewer Failure (Image from Avanti International)

Based on a thorough condition assessment, both structural and non-structural trenchless rehabilitation methodologies are proven to remediate and restore useful life of sewer pipe. The advantages of trenchless are numerous including time-to-benefit, minimal disruption to the community, and lower project costs. As opposed to defaulting to open-cut replacement methods, trenchless alternatives provide several options.

Trenchless Methodologies: Non-structural Rehabilitation

- **Injection Grouting**— Utilizing the *Test, Seal, and Validate process with Remote Packer Method*, injection grouting is a remediation method for controlling infiltration and should be performed prior to pipe degradation requiring structural repair. With the aid of closed circuit televising (CCTV), the remote packer aligns squarely with the joint, expands bladders on both sides, and performs an air test. If it does not leak air, it will not leak water. If it fails the air test, a low viscosity acrylic grout is pressure injected through the defect into the surrounding soil, and provides stabilization. A second air-test is then performed to validate the seal. Gel-times can be customized from 5 seconds to over 12 hours based on the degree of permeation required into the soil. The gel-soil matrix forms an impermeable barrier to eliminate groundwater intrusion and according to the US Department of Energy, has a 362-year half-life in the soil. It is noted there are multiple types and variations of grouts available for use, depending on the application and desired results.

Trenchless Methodologies: Structural Remediation

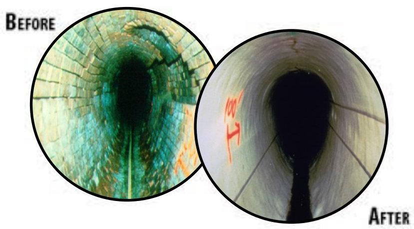

Figure 4: Sewer pipe condition, before and after CIPP (images are used courtesy of Aegion Corporation)

Pipe linings are tight fitting and installed continuously from one access point to the next. Linings provide structural renewal of the pipe barrel, improve the performance of the existing sewer, and are appropriate for various pipe sizes and shapes.

- **Cured in Place Pipe (CIPP)**— Used primarily for structural rehabilitation of sewer lines, CIPP consists of a tubular composite product composed of a reinforced mesh or felt material saturated with a thermosetting resin that cures through ambient temperatures, hot water, steam, or ultraviolet (UV) light. Before and after images of CIPP rehabilitation are shown in Figure 4. The resins are typically selected based on the CIPP performance requirements (gravity or pressure) and the nature of the wastewater (domestic or industrial).
- **Sliplining**— Used to rehabilitate deteriorating sewer pipes by inserting a smaller pipe inside the host pipe. High density polyethylene (HDPE) is a widely-used pipe material for sliplining; however, other materials such as polyvinyl chloride (PVC), fiber reinforced polymer (FRP) pipe, polymer concrete pipe and other pipe materials have been used successfully. The slipliner pipe is inserted into the existing pipe at an excavated access pit location. For small diameter pipe, a continuous pipe, often butt-fused HDPE, is typically pulled through the existing pipe by a cable from the termination location. Large diameter pipes more often are pushed, jacked or winched into place, piece-by-piece. Depending on the design conditions and pipe size, the annular space is grouted.
- **Spiral Wound Pipe**— This renewal technique is based on creating a pipe in situ by using HDPE or PVC-ribbed profiles with interlocking edges. The ribs, which may be reinforced with steel, enhance the hoop strength of the pipe. After the strips are installed, the annular space is grouted in entry size pipe. Small diameter pipe (12-inches or less) is typically not grouted except at the terminations and any side connections. Spiral wound pipe can be fitted to circular or odd-shaped pipes such as horseshoe or egg-shaped sewers.
- **Fold-and Form Pipe**— This sewer rehabilitation method inserts a folded thermoplastic pipe into the existing pipe which is expanded or re-rounded back to a circular shape through pressure, heat, or mechanical means. Fold-and-Form pipes consist of PVC or HDPE thermoplastic material folded into a cross-sectional shape that is significantly smaller than that of the pipe to be rehabilitated.

Structural and Nonstructural Spray or Spun Cast Systems

In-situ spray or spun cast coatings or structural solutions may be used to extend the life of an existing sewer by increasing its strength or protecting the existing surface from corrosion or abrasion. Coatings also may be used to improve hydraulic performance

- **Corrosion Protection** (nonstructural): Coatings for corrosion control limit or prevent damage to the pipe walls, often above the flow line in entry size sewer pipes. There are a variety of coatings available for rehabilitation applications to pipes of all diameters. Spray-on epoxy, polyurethane, polyurea and other chemical formulation coatings can be selected to match the application, pipe diameter or size and level of protection needed. Since coatings for corrosion control require a bond to the host pipe, the host pipe wall must be properly cleaned and dried.
- **Reinforced Shotcrete** (structural): Shotcrete is the application of concrete or mortar conveyed through a hose and pneumatically projected at high velocity onto the surface of the host pipe. Reinforcement in the form of wire mesh reinforcing rods can be used. Shotcrete includes both wet- and dry-mix processes, but the term *shotcrete* typically refers to the wet process: the dry-mix process typically is referred as *gunite*.

- **Centrifugally Cast Concrete (structural):** Centrifugally cast concrete pipe is used to rehabilitate culverts, storm sewers and sanitary sewers 30 to 120 inches in diameter. Once the host pipe is cleaned and prepared, the concrete is robotically spun cast onto the surface of the host pipe. Admixtures to the spun cast concrete can provide resistance to corrosion and future bacterial growth on the interior surface of the pipe.
- **Cast-in-Place Concrete (structural):** Rehabilitation with reinforced or non-reinforced concrete is an effective method for a variety of conduit shapes. The structural condition of the pipe determines if steel reinforcing is required. Slip or fixed-form construction practices are used for concrete placement typically in large diameter pipe (48 inches and greater) with adequate access for materials to be handled properly.

It is common practice for multiple technologies and more than one methodology to be deployed on a mainline sewer rehabilitation project. Most lining projects require minimal or a no infiltration environment, flow diversion and pipe cleaning. Coating projects may require flow diversion and specific surface preparation, depending on whether a bond to the host pipe or structure is required. Utilizing coating techniques requires removal of active infiltration. The underlying assumption accompanying sewer rehabilitation techniques is that they are: appropriate for the pipe condition, adequately designed and specified and installed correctly. Otherwise, the sewer rehabilitation may not be successful.

The summary matrix on page 6 is provided as an introduction to potential rehabilitation methods, type of rehabilitation, advantages and disadvantages and applicable pipe size. As noted on this matrix, not all sewer rehabilitation techniques are common to both mainline sewer and the lateral sewers connecting private homes and buildings. The summary matrix (See Page 6) should be considered as a starting point for evaluating rehabilitation alternatives and it is not intended to be comprehensive. It is advised that practitioners refer to industry references provided below and stay current with technical advancements, and continually adapt as appropriate.

Additional Resources

"Sanitary Sewers," a 2011 fact sheet developed by the WEF Collection Systems Committee
https://www.wef.org/globalassets/assets-wef/3---resources/topics/a-n/collection-systems/technical-resources/ss-fact-sheet-with-wider-margins-1.pdf

"Private Property Infiltration and Inflow" a 2015 fact sheet developed by the WEF Collection Systems Committee
https://www.wef.org/globalassets/assets-wef/3---resources/topics/a-n/collection-systems/technical-resources/ppii-fact-sheet_sep-2015.pdf

Existing Sewer Evaluation and Rehabilitation, MOP FD-6 (3rd Edition), a 2009 manual by WEF and the American Society of Civil Engineers
https://www.e-wef.org/Store/ProductDetails.aspx?productId=5302

"Private Sewer Laterals," a 2014 resource by the U.S. Environmental Protection Agency (EPA)
https://www3.epa.gov/region1/sso/pdfs/PrivateSewerLaterals.pdf

State of Technology for Rehabilitation of Wastewater Collection Systems, a 2010 EPA publication. Reference chapter 5 "Sewer Lateral Renewal Technologies."
nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P1008C45.TXT

National Database Structure for Life Cycle Performance of Assessment of Water and Wastewater Rehabilitation Technologies, EPA /600/R-14/251, January 2014
nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100LDG0.TXT

National Association of Sewer Service Companies (NASSCO). 2014. Overview Of Lateral And Main/Lateral Connection Lining And Sealing Technologies.
https://www.nassco.org/sites/default/files/lateral_rehab_white_paper.pdf

National Association of Sewer Service Companies (NASSCO). Specifications Guidelines.
https://www.nassco.org/resources/guideline-specs

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Sanitary Sewer Rehabilitation Summary Matrix

Technique	Type	Estimated Service Life (USEPA, 2014)	Advantages	Disadvantages	Potential Application, Pipe Diameter	Mainline /Lateral/ Manhole
Cementitious Coatings: Shotcrete or Gunite	Structural/ Non-Structural	20 or more years	All shapes and connections accommodated,	Address active infiltration, requires confined space entry	48" and larger	Yes / No / Yes
Spun Cast Concrete	Structural/ Non-Structural	Same as concrete pipe (Army Corps of Engineers)	Robotically applied. Antibacterial additive can be added when microbiologically induced corrosion is present.	Address active infiltrations	30 – 120"	Yes / No / No
Spray Polymer Coatings	Structural/ Non-Structural	50 years	Encapsulates sewer, can be designed for structural load, can improve flow coefficient	Sags and dips in pipe remain, service interrupted, must stop active infiltration	6" and larger as long as the host pipe wall can be properly cleaned and dried.	Yes / No / Yes
Cured-in-place-pipe (CIPP)	Structural	50 years	Prevents further degradation and collapse, improves flow coefficient	Sags and dips in pipe remain, service interrupted, infiltration may follow annular space	3" to 120"	Yes / Yes / Yes
Thermo-formed Pipe (Fold and Form)	Structural	20 or more years	Prevents further degradation and collapse, improves flow coefficient	Sags and dips in pipe remain, service interrupted, Infiltration may follow annular space	4" to 30"	Yes / Yes / Yes
Injection / Pressure Grouting	Non-structural	20-25 years	Seals leaking joints, stabilize supporting soils	Offset joints or longitudinal cracks may not seal	4"and greater	Yes / Yes / Yes
Sliplining	Structural	50 years	Quick insertion, some bends are accommodated	Circular and non -circular, loss of cross sectional area	4" to 144"	Yes / Yes / No
Spiral Wound Pipe	Structural	50 years	Prevents further degradation and collapse, improves flow coefficient	Sags and dips in pipe remain, service interrupted, Infiltration may follow annular space	6" to 144", Larger sizes on case by case basis	Yes / No / No