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December 3, 2012

VIA EXPRESS MAIL

Rosemary Chiavetta, Secretary
Pennsylvania Public Utility Commission
Commonwealth Keystone Building
2nd Floor, 1 North
400 North Street
Harrisburg, PA 17120

RE: Philadelphia Gas Works Long Term Infrastructure Improvement Plan
Docket No. P-2012-

Dear Secretary Chiavetta,

Philadelphia Gas Works ("PGW") hereby files its Long Term Infrastructure Improvement Plan pursuant to 66 Pa.C.S.A. § 1352 and the Pennsylvania Public Utility Commission's August 2, 2012 Final Implementation Order (Docket No. M-2012-2293611). PGW requests that the following be entered as counsel for the Company in this proceeding:

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Please contact me if you have any questions regarding this filing.

Respectfully submitted,

Gregory J. Stunder

Enclosures

cc:

Chairman Robert F. Powelson
Vice Chairman John F. Coleman Jr.
Commissioner Wayne F. Gardner
Commissioner James H. Cawley
Commissioner Pamela A. Witmer
Bohdan R. Pankiw, Chief Counsel
Paul Diskin, Director of Technical Utility Services
Certificate of Service

PHILADELPHIA GAS WORKS
LONG TERM INFRASTRUCTURE IMPROVEMENT PLAN

I. INTRODUCTION

On February 14, 2012, Act 11[1] was signed into law, thereby providing Pennsylvania natural gas utility companies with a recovery mechanism (i.e. a Distribution System Improvement Charge ("DSIC")) for the costs related to distribution system repair, improvement and replacement. In order for a natural gas utility company to implement a DSIC, it must submit a Long-Term Infrastructure Improvement Plan ("LTIIP" or "Plan") and petition the Pennsylvania Public Utility Commission ("Commission") for review and approval of a proposed DSIC. Although Act 11 does not permit the submission of DSIC petitions before January 2, 2013, the Commission has encouraged the submission of LTIIPs before 2013. Accordingly, PGW is submitting the following LTIIP.

PGW has made substantial strides in its cast iron main and steel service[2] replacement programs over the last 15 years by replacing and/or removing approximately 250 miles of cast iron main and 150,000 steel services[3] with plastic and protected coated steel. The Company's primary objective for its LTIIP will continue to be improvement of safety and reliability of its infrastructure through the reduction of its cast iron main inventory and, after all cast iron main is removed from service, the removal of the Company's unprotected coated steel and ductile iron main.[4]

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[1] Act 11 of 2012 which amends Chapters 3, 13 and 33 of the Pennsylvania Public Utility Code.
[2] Services are also referred to as service lines".
[3] Based on 2011 and 1996 Annual DOT Gas Distribution System Reports.
[4] PGW prioritizes main replacement this way because the risk of a future incident on unprotected coated steel and ductile iron mains is inherently low compared to cast iron mains. Also, the risk of a future incident is low due to low operating pressures, the inherently slow development of leaks on unprotected coated steel and ductile iron mains and PGW's leak survey procedures. Similarly, PGW's risk of a future incident with its unprotected bare

In formulating its proposed accelerated replacement program for the 2013-2017 time period, PGW was informed both by its traditional risk management analysis programs[5] as well as experience from recent incidents at PGW and other natural gas distribution companies ("NGDCs"). PGW's goal was to identify categories of cast iron main that would be the most prudent to replace based on an overall evaluation of all serviceability[6] factors. That analysis produced the following recommended accelerated replacement program:

1) 12 inch and smaller high pressure main ("HP" or "10-35 psig")
2) 30 inch high pressure main ("HP" or "10-35 psig")
3) 8 inch and smaller low to intermediate pressure main ("LP/IP" or "4.5 inches WC to 5 psig")

PGW's proposed approach under this LTIIP will give greater priority to the removal of 12 inch and smaller HP mains (due to recent incidents with 12 inch main on PGW's and UGI's distribution systems) and 30 inch HP mains (due to PGW's recent discovery of localized corrosion on a section of 30 inch HP main), thereby removing these entire categories of main from PGW's system by 2023. It also accelerates the removal of 8 inch and smaller diameter LP/IP cast iron main. Currently, PGW is removing cast iron main from inventory at a rate of 18 miles per year for all sizes. If PGW's proposed LTIIP is approved, PGW will remove cast iron main from inventory at a rate of approximately 25 miles per year.

PGW believes that the costs of these proposed accelerated replacements are fully recoverable through the DSIC mechanism that it intends to propose in 2013. In order to assure that PGW's current financial situation is not adversely impacted, PGW will need to scale back

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and coated steel services is also low for the aforementioned reasons. Additionally, the risk profiles for plastic and protected coated steel mains and services do not indicate the need for replacement.

[5] As discussed later, these include PGW's Distribution Integrity Management Program ("DIMP"), benchmarking analyses/studies along with the Company's main replacement prioritization model.

[6] i.e., fit for service.

the accelerated replacement proposed in this LTIIP if the PUC declines to permit such full recovery through the DSIC.

The passage of Act 11 has provided a significant opportunity to accelerate the improvement of the safety and reliability of PGW's gas distribution system in the most cost effective manner and without creating financial challenges for the Company. Through this plan, PGW hopes to embrace this opportunity and believes that it has created a replacement plan that accelerates replacement in the most efficient and targeted manner possible. This, in turn, will provide benefits to PGW, its customers and Philadelphia in general.

II. LONG TERM INFRASTRUCTURE IMPROVEMENT PLAN

Act 11 and the Commission's August 2012 Implementation Order set forth the following elements to be included in a LTIIP:

A.) Identification of the types and age of eligible property owned or operated by the utility for which the utility would seek recovery under this subchapter.
B.) An initial schedule for the planned repair and replacement of eligible property.
C.) A general description of the location of the eligible property.
D.) A reasonable estimate of the quantity of eligible property to be improved.
E.) Projected annual expenditures to implement the plan and measures taken to ensure that the plan is cost effective.
F.) The manner in which the replacement of aging infrastructure will be accelerated and how the repair, improvement or replacement will ensure and maintain adequate, efficient, safe, reliable and reasonable service.[7]
G.) A workforce management and training plan designed to ensure that the utility will have access to a qualified workforce to perform work in a cost-effective, safe and reliable manner.[8]

The Commission's August 2012 Implementation Order also sets forth that: the appropriate LTIIP time frame is five to ten years; the LTIIP should coincide with longer term plans which address specific goals, including cast iron replacement plans, bare steel replacement plans; and the Plan

[7] 66 Pa.C.S. §1352(a) – elements A to F.
[8] *Implementation of Act 11 of 2012* (Docket No. M-2012-2293611) August 2, 2012, p. 18.

should meet overall system replacement goals.[9] Accordingly, PGW's LTIIP is a five year plan which is focused on the specific goal of accelerated cast iron main replacement (PGW's distribution system does not contain any bare steel mains) and meets the Company's overall system replacement goals set forth in Section F below.

A.) Identification of the types and age of eligible property for which PGW is seeking recovery

Identification Tools and Considerations

PGW utilized several tools to formulate the PGW LTIIP proposed here:

- PGW's Distribution Integrity Management Program ("DIMP").[10]
- The Advantica Benchmarking Analysis, Risk Analysis and Model, Replacement Analysis and Computerized Main Prioritization and Ranking Program issued on June 2, 2008.[11]
- The Advantica Main Replacement Prioritization Model.[12]
- The GL Noble Denton (formerly d/b/a Advantica) 12-Inch 10-35 psig Cast Iron Mains Benchmarking Study issued on September 7, 2012.[13]
- Field Observations and System Performance Analysis.

PGW's DIMP includes a demonstration that PGW understands its distribution system, identifies the threats to its distribution system, evaluates these threats, ranks the related risks and lists strategies to mitigate those risks. The Advantica Benchmarking Analysis, which was

[9] *Id.* at 19.
[10] See Appendix A for more information about DIMP.
[11] See Appendix B for the Executive Summary from the June 2, 2008 analysis. Additionally, see section F for further discussion.
[12] See Appendix C for the excerpt from the June 2, 2008 Advantica Analysis which discusses the Main Replacement Prioritization Model. Additionally, see Section F for further discussion.
[13] See Appendix D for the Executive Summary from the September 7, 2012 Advantica Study. Additionally, see section F for further discussion.

updated in 2008[14], has enabled PGW to compare and validate its main replacement program with similarly-situated NGDCs. Additionally, the Advantica Main Replacement Prioritization Model, another tool that PGW has utilized for several years, enables PGW to identify the specific segments of pipe that should receive replacement priority. Finally, PGW utilized the results of the GL Noble Denton Benchmarking Study to provide the Company with replacement strategies for 12 inch high pressure mains.

PGW also considered other factors in order to identify infrastructure property for inclusion in the LTIIP, such as the recent incidents involving 12 inch mains on the PGW and UGI systems, and PGW's recent discovery of localized corrosion on a section of 30 inch HP main (10-35 psig operating pressure) plus surrounding ground conditions that contribute to main corrosion. Additionally, the Company will continue to review all cast iron inventory for any high pressure mains that are between 12 inches and 30 inches (i.e., 16, 20 and 24 inches – all HP) and that are redundant or under-utilized. Accordingly, PGW has targeted several abandonment projects for pipe inventory in this range.

Based on the DIMP risk ranking, the Advantica and GL Noble Benchmarking studies, the 12 inch main incidents, recent field observations of its 30 inch HP main and the prudency of beginning an abandonment program for redundant or under-utilized HP main (i.e., the Abandonment Program), the Company's proposed accelerated replacement program during the 2013-2017 time period will replace the following cast iron main types (categorized by size and pressure):

1) 12 inch and smaller, high pressure ("HP" or "10-35 psig").

2) 30 inch, high pressure ("HP" or "10-35 psig").

[14] A predecessor consultant prepared a similar benchmarking analysis in 2000 which was subsequently updated in 2002 and 2004.

3) 8 inch and smaller, low to intermediate pressure ("LP/IP" or "4.5 inches WC to 5 psig").

All of the above property proposed to be replaced is characterized as piping, couplings and valves and are "DSIC eligible," under Act 11.[15] PGW also plans to replace the unprotected bare and unprotected coated steel services and meter sets associated with these cast iron mains, and the related eligible property includes gas services lines, fittings, valves, risers, meter bars and meters with attached AMR devices. Also included in the Plan are the costs related to abandoning two (2) regulator stations and 2,400 feet of 12 inch steel main[16] and replacing them with 2,400 feet of 20 inch steel main. These facilities, too, are DSIC eligible pursuant to Act 11.

An important assumption in PGW's proposed LTIIP is that the annual cost of the accelerated main replacement program (which is $22 million over and above the amount it currently spends for its 18 mile cast iron main replacement program), will be recovered through PGW's DSIC tariff. PGW intends to file for and receive authority to include in its tariff a DSIC rider, in accordance with Act 11 and the Commission's guidance. PGW believes that the entirety of its additional $22 million in expenditures for accelerated main replacement is eligible for and should be recoverable in its DSIC. However, if for any reason the PUC determines to prohibit or limit DSIC recovery for these expenditures, PGW would be required to correspondingly reduce its accelerated main replacement plan.

[15] 66 Pa.C.S.A.§ 1351.

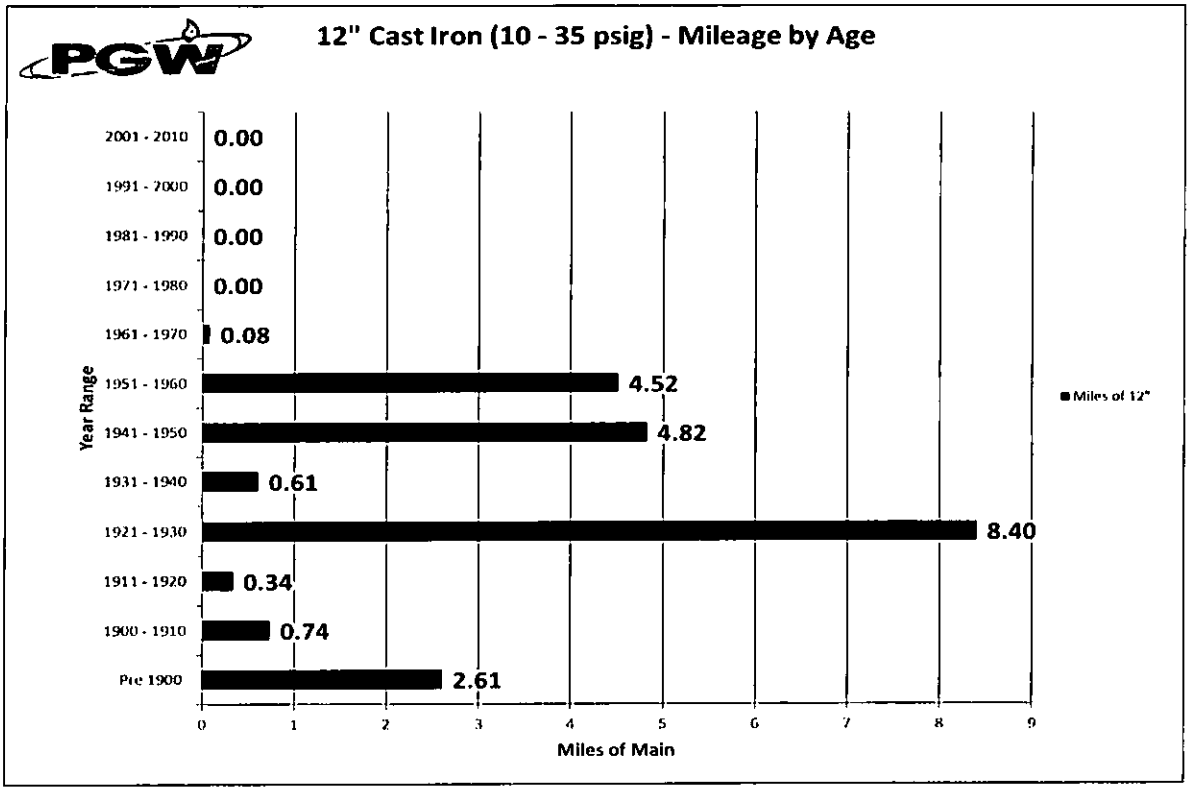
[16] Parts for the regulators on PGW's Somerton lateral are obsolete. In an effort to maintain public safety, load capacity studies were performed and concluded that this higher pressure line (150 psig) was no longer necessary. As a result, the Maximum Allowable Operating Pressure ("MAOP") of the line will be down rated and the obsolete regulator stations will be abandoned. New main will also be installed to maintain reliable service at a lower pressure. The cost to abandon these facilities and install new main is a more cost effective approach than the alternative of replacing, hydrostatically testing, maintaining and operating new regulator stations. Additionally, the reduced operating pressure reduces risk.

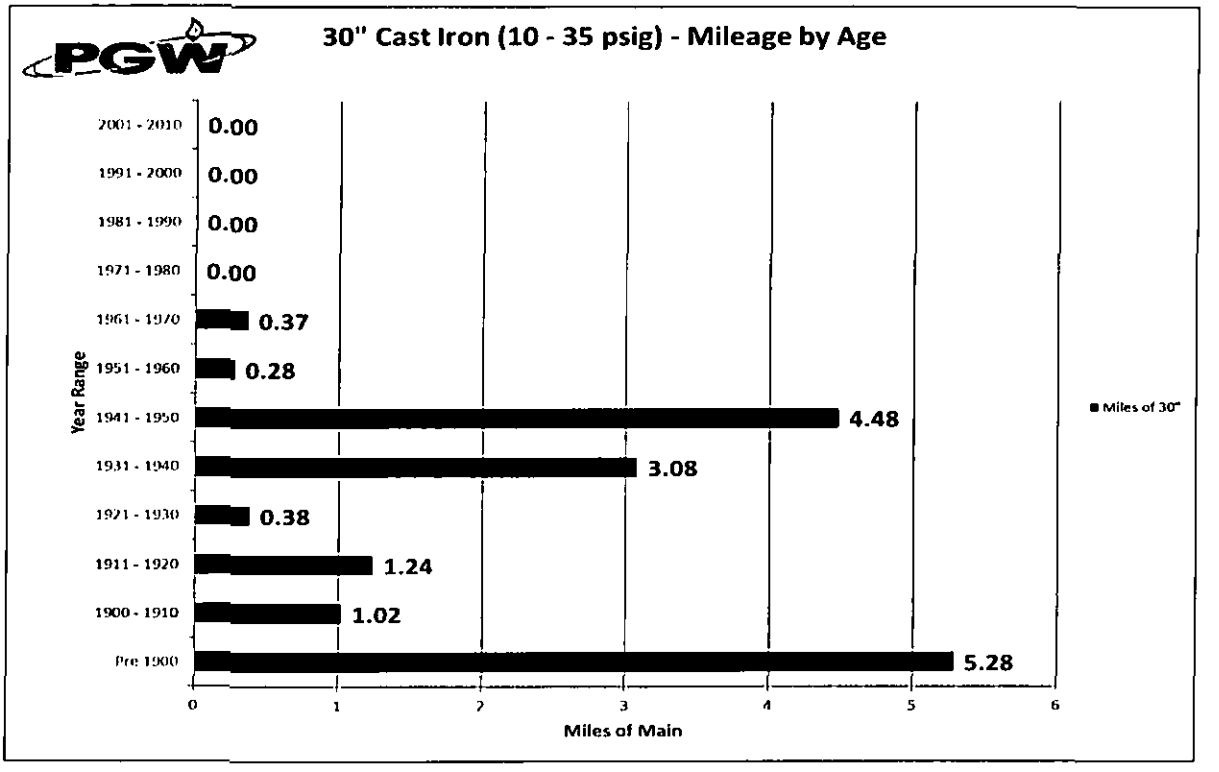
Age Range for Mains Included in LTIIP

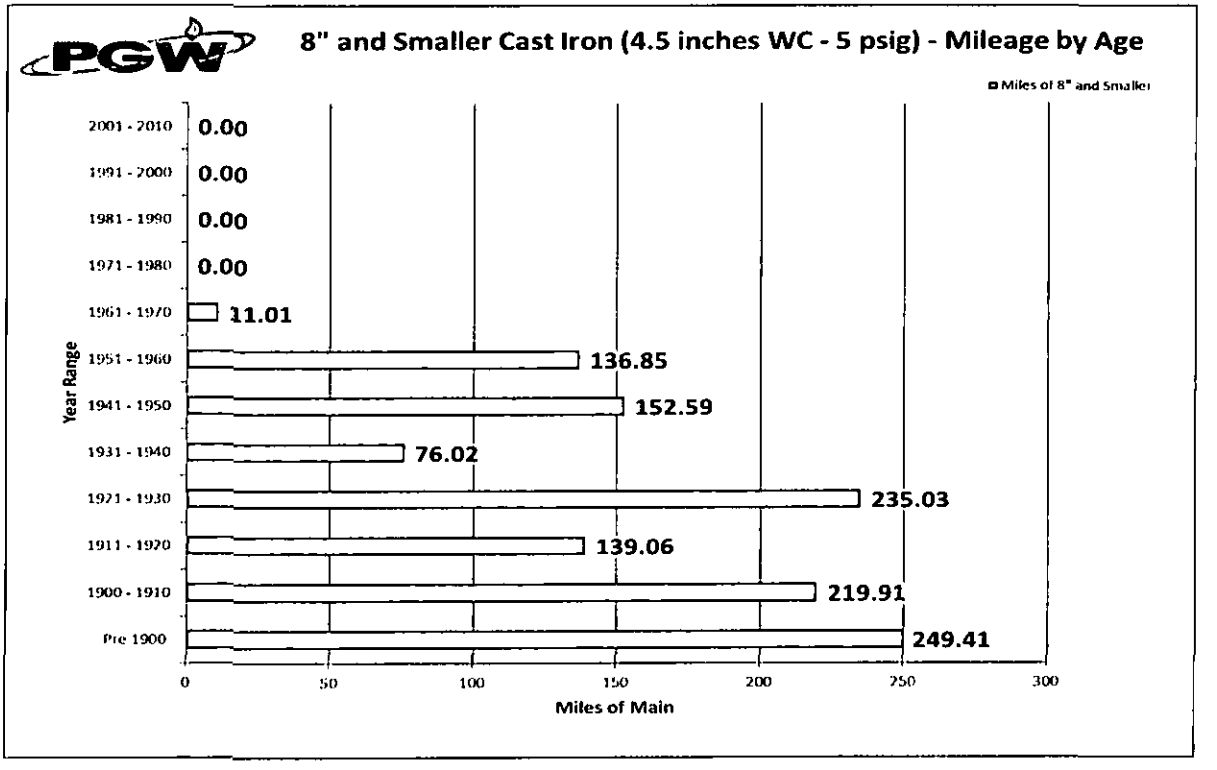
PGW's distribution system contains approximately 3,000 miles of mains and 3,000 miles of services. The following shows the approximate material composition of PGW's mains and services as of December 2011:

Mains	
Cast Iron	51%
Plastic & Protected Coated Steel	28%
Unprotected Coated Steel & Ductile Iron	21%
	100%
Services	
Plastic & Protected Coated Steel	72%
Bare Steel	23%
Unprotected Coated Steel	5%
	100%

The following charts show the total mileage by age range for the three cast iron main categories that PGW plans to replace during the five year period covered by this LTIIP:




30" Cast Iron (10 - 35 psig) - Mileage by Age
2001 - 2010
1991 - 2000
1981 - 1990
1971 - 1980
1961 - 1970
1951 - 1960
1941 - 1950
1931 - 1940
1921 - 1930
1911 - 1920
1900 - 1910
Pre 1900
0.00
0.00
0.00
0.00
0.37
0.28
4.48
3.08
0.38
1.24
1.02
5.28
Year Range
Miles of 30"
0
1
2
3
4
5
6
Miles of Main


8" and Smaller Cast Iron (4.5 inches WC - 5 psig) - Mileage by Age
Miles of 8" and Smaller
2001 - 2010
1991 - 2000
1981 - 1990
1971 - 1980
1961 - 1970
1951 - 1960
1941 - 1950
1931 - 1940
1921 - 1930
1911 - 1920
1900 - 1910
Pre 1900
0.00
0.00
0.00
0.00
11.01
136.85
152.59
76.02
235.03
139.06
219.91
249.41
Year Range
0
50
100
150
200
250
300
Miles of Main

B.) An initial schedule for the planned repair and replacement of eligible property

The first phase of PGW's LTIIP,[17] as described in the following chart of PGW's proposed accelerated replacement program, beginning during the Company's 2013 fiscal year (i.e. September 1, 2012 to August 31, 2013), will eliminate 343 miles of cast iron main with an estimated replacement cost of $776 million. Concurrent with this accelerated program, PGW will continue to remove 18 miles of cast iron main as part of its baseline main replacement program and the combined replacement total will be 1,258 miles of cast iron main with an estimated replacement cost of $2.43 billion. The following table shows the initial schedule for the complete replacement of this main:

PHASE 1 - ACCELERATED CAST IRON MAIN INVENTORY REDUCTION PROGRAMS BEGINNING IN 2013				
Size/Pressure	**Total Inventory Reduction Mileage**	**Cost**	**Begins**	**Completed**
12" & Smlr HP	22	$89,602,756	2013	2022
30" HP	16	$95,560,352	2013	2023
8" & Smlr LP/IP	**305**	**$590,630,499**	**2013**	**2063**
	343	**$775,793,606**		
Baseline 8" & Smlr LP/IP Program During Accelerated Inventory Reduction Period*				
Baseline*	915	$1,650,542,275	2013	2063
Acceleration	**305**	**$590,630,499**	**2013**	**2063**
8" & Smlr LP/IP	**1,220**	**$2,241,172,773**	**2013**	**2063**
Baseline + Accelerated - Phase 1				
12" & Smlr HP	22	$89,602,756	2013	2022
30" HP	16	$95,560,352	2013	2023
8" & Smlr LP/IP	**1,220**	**$2,241,172,773**	**2013**	**2063**
	1,258	**$2,426,335,881**		

[17] The first phase (i.e. "Phase 1") of PGW's Cast Iron Main Inventory Reduction Program begins during PGW's FY 2013. A table is provided in Section F.1. which outlines the Reduction Program for Phases 2 through 5.

C.) A general description of the location of the eligible property

1) There are approximately 22 miles of 12 inch and smaller HP cast iron main (10 to 35 psig) composed of 752 individual pipe segments[18] (segments vary in length from 1 foot to 2,000 feet) located throughout the city of Philadelphia.
2) There are approximately 16 miles of 30 inch HP cast iron main (10 to 35 psig) composed of 545 individual pipe segments (segments vary in length from 1 foot to 1,900 feet) located throughout the city of Philadelphia.
3) There are approximately 1,220 miles of 8 inch and smaller LP/IP cast iron main (4.5 inches WC to 5 psig) composed of 72,500 individual pipe segments (segments vary in length from 1 foot to 2,000 feet) located throughout the city of Philadelphia.

D.) A reasonable estimate of the quantity of eligible property to be improved

The information responsive to Section D is included in Section E.

E.) Projected annual expenditures to implement the plan and measures taken to ensure that the plan is cost effective

1. Projected annual expenditures to implement the plan

PGW's current base line main replacement program removes 18 miles of cast iron main annually and the Company will seek recovery, via the DSIC, for expenditures above the cost of the base line program on a pay as you go basis ("paygo") in its DSIC petition. More specifically, PGW does not plan to issue any long term debt to fund its accelerated main replacement program. Rather, it plans to seek recovery of $22 million annually via a DSIC surcharge for the first five years of its program and plans to spend a corresponding $22 million annually for its

[18] A segment is a section of main that shares all of the following characteristics: material, size, pressure and age.

accelerated main replacement program. PGW plans to fund the program via the DSIC on a paygo basis because absent such recovery, PGW would be required to issue long term debt to fund the acceleration and, in turn, seek recovery of the costs through a base rate proceeding. Such a process would not only increase costs to consumers and negatively affect PGW's cash flow and internally generated funds, but would also adversely affect PGW's debt to equity ratio. In turn, this could negatively affect PGW's bond ratings.[19]

PGW is projecting $22 million in annual spending because, in PGW's view, that is the amount permitted under the 5% consumer protection cap on DSIC revenue recovery. PGW is calculating the 5% cap based on distribution revenues (i.e. non-gas revenues) from its most recent base rate case.[20] At the projected $22 million spending level, the following is an estimate of the quantity of eligible property to be improved and the projected annual expenditures to implement the accelerated replacement plan:

[19] 52 Pa.Code § 69.2703.

[20] *PaPUC v. PGW* (Docket No. R-2009-2139884) Joint Petition for Settlement – May 12, 2010; Rates Effective – September 1, 2010.

Long Term Infrastructure Improvement Program Annual Schedule, Quantities and Expenditures
Five Year Period - FY 2013 to FY 2017

QUANTITIES	FY 2013 (miles)	FY 2014 (miles)	FY 2015 (miles)	FY 2016 (miles)	FY 2017 (miles)
CURRENT BASELINE PROGRAM					
8" & Smaller LP/IP	18.00	18.00	18.00	18.00	18.00
ACCELERATED PROGRAM					
12" HP	1.84	2.16	2.04	2.04	2.50
30" HP	1.45	1.70	1.86	1.78	1.38
8" & Smaller LP/IP	2.97	3.04	2.97	2.98	3.01
Abandonment for Non-Use	2.08	0.00	0.00	0.00	0.00
ACCELERATED TOTALS	8.33	6.90	6.87	6.79	6.89
Yearly Totals	26.33	24.90	24.87	24.79	24.89

EXPENDITURES	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Regulator Station / Valve Work	$2,500,000	$1,270,000	$500,000	$500,000	$500,000
12" HP	$6,785,800	$8,139,600	$7,832,651	$7,989,304	$10,001,673
30" HP	$7,782,600	$9,311,580	$10,399,838	$10,174,862	$8,059,790
8" & Smaller LP/IP (Additional)	$3,131,600	$3,278,820	$3,267,510	$3,335,833	$3,438,537
Abandonment for Non-Use	$1,800,000	$0	$0	$0	$0
Yearly Totals	$22,000,000	$22,000,000	$22,000,000	$22,000,000	$22,000,000

2. Measures taken to ensure that the plan is cost effective

PGW is taking the following measures to ensure that the LTIIP is cost effective:

1) As discussed above, PGW is proposing to fund the accelerated program[21] on a paygo basis. This type of funding avoids the issuance of long term debt, thereby saving ratepayers the related interest expense plus the cash flow that must be included in rates necessary to cover certain debt service coverage ratios.

2) As discussed in more detail in section F below, PGW's Main Prioritization Model reduces future breakage repair costs.

[21] i.e. the accelerated totals above the baseline 18 mile program.

3) As discussed in Section G below, PGW will utilize a competitive bidding process. Additionally, the Company is seeking new contractors for main installation in an effort to create a larger bidding pool and more competitive bid prices.

F.) The manner in which the replacement of aging infrastructure will be accelerated and how the repair, improvement or replacement will ensure and maintain adequate, efficient, safe, reliable and reasonable service

1. Acceleration

As set forth in more detail in the following table, PGW proposes to accelerate its replacement of its 8 inch and smaller cast iron main inventory (totaling 1,220 miles) by 17 years, and accelerating the replacement of all 12 inch and 30 inch high pressure cast iron main by more than 60 years.

PHASE 1 - ACCELERATED CAST IRON MAIN INVENTORY REDUCTION PROGRAMS BEGINNING IN 2013

Size/ Pressure	Inventory Reduction Mileage	Inventory Reduction Accelerated By:	ACCELERATED Inventory Reduction Program			PRE-ACCELERATION Inventory Reduction Program		
			Cost	Begins	Ends	Cost	Begins	Ends
12"& Smlr HP*	22	67 Years	$89M	2013	2022	$354M	2085	2089
30" HP**	16	62 Years	$95M	2013	2023	$344M	2080	2085
8"&Smlr LP/IP*	1,220	17 Years	$2.2B	2013	2063	$2.7B	2013	2080
	1,258		$2.4B	***		$3.4B	***	

* As discussed later in this Section, PGW is prioritizing the inventory reduction of this main using its Main Replacement Prioritization model.

** PGW is currently prioritizing the inventory reduction of this main based upon corrosion and soil studies coupled with past operational

*** The difference in cost between the accelerated and pre-acceleration program is due to an annual 2% inflation factor and different

Phase 1 of PGW's accelerated program beginning in 2013 accounts for a total of 1,258 miles of cast iron main replacement. PGW considers the replacement of the initial 1,258 miles to be its first priority based upon identifying threats, evaluating these threats and ranking the related

risks.[22] After establishing this initial accelerated program, PGW will begin the next four phases of its accelerated replacement program in 2022 for the remaining 265 miles of cast iron main. The replacement periods for Phases 2 through 5 have been scheduled based upon the same threat identification, threat evaluation and risk ranking procedures. The following table shows the replacement periods beginning in 2022 and the number of years that replacement will be accelerated for each main category:

PHASES 2 THROUGH 5
ACCELERATED CAST IRON MAIN INVENTORY REDUCTION PROGRAMS BEGINNING IN 2022

Size/Pressure	Inventory Reduction Mileage	Inventory Reduction Accelerated By:	ACCELERATED Inventory Reduction Program			PRE-ACCELERATION Inventory Reduction Program		
			Cost	Begins	Ends	Cost	Begins	Ends
PHASE 2:								
20" HP	46	**33 Years**	$446M	2022	2068	$1.2B	2089	2101
16" HP	15	**69 Years**	$87M	2023	2036	$372M	2101	2105
24" HP	1	**63 Years**	$8M	2023	2025	$27M	2088	2088
PHASE 3:								
12" IP	3	**42 Years**	$27M	2063	2063	$61M	2105	2105
16" IP	1	**42 Years**	$11M	2063	2063	$25M	2105	2105
10" / 12" LP	101	**14 Years**	$1.4B	2065	2091	$2.9B	2105	2105
16" LP	45	**50 Years**	$681M	2068	2085	$2.0B	2125	2135
PHASE 4:								
20" / 24" LP	38	**48 Years**	$878M	2085	2097	$127M	2135	2145
PHASE 5:								
30"&Lrgr LP	15	**49 Years**	$431M	2097	2100	$1.1B	2145	2149
	265		**$3.9B***			**$7.7B***		

* The difference in cost between the accelerated and pre-acceleration program is due to an annual 2% inflation factor and different inventory reduction time periods.

[22] As discussed in Section A above, PGW's Distribution Integrity Management Program identifies the threats to its distribution systems, evaluates these threats and ranks the related risks.

2. Ensuring and maintaining adequate, efficient, safe, reliable & reasonable service / ensuring that the plan is cost effective

a. PGW Studies and Evaluations Supporting Proposed LTIIP

In order to ensure that PGW's replacement program will maintain adequate, efficient, safe, reliable and reasonable service and ensure that the Plan is cost effective, PGW engaged Advantica in 2008 and GL Noble Denton[23] in 2012 to prepare benchmarking analyses and studies comparing PGW's replacement programs to other similarly situated utilities. As part of the 2008 engagement, PGW also implemented Advantica's Main Replacement Prioritization ("MRP") model which helps PGW assess the risk factors of PGW's 8 inch and smaller cast iron distribution system and prioritizes which pipe segments should be replaced. PGW is now implementing the same MRP model for a more focused review of its 12 inch and smaller high pressure cast iron main replacement program as part of the 2012 GL Noble Denton engagement.

i. Benchmarking Analysis, Risk Analysis and Model, Replacement Analysis and Computerized Main Prioritization and Ranking Program[24]

In 2008, PGW engaged Advantica to conduct a benchmarking study on the replacement of cast iron mains. This study benchmarked eight distribution utilities, including PGW, to determine cast iron main replacement strategies.[25] The seven other systems are all centered around a central inner city, and are thus considered to be the most-comparable benchmarks that could be used. These companies tended to operate large amounts of older, cast iron pipe and were predominantly located in the northeastern part of the U.S. The benchmarking study's most

[23] GL Noble Denton acquired Advantica in 2007 and Advantica eventually began doing business as "GL Noble Denton".

[24] See Appendix B for the Executive Summary from the June 2, 2008 analysis.

[25] The study also benchmarks a larger group of 27 companies (including PGW) for use as a broad comparison of industry standard practices.

notable comparison among the eight companies is the average percentage of cast iron main replaced each year.[26] Under this comparison, PGW's base line 18 mile replacement program was ranked as having the fifth highest replacement percentage of the eight companies. The study also provided PGW's ranking for a hypothetical replacement program of 24 miles which resulted in PGW's ranking moving up from the fifth highest to the second highest replacement percentage. This second highest ranking is important because it supports PGW's replacement program for the period of 2013 to 2017 which will replace approximately 25 miles of cast iron main annually (see Section D/E above).

ii. Advantica Main Replacement Prioritization Model[27]

The Advantica Main Replacement Prioritization ("MRP") model developed for PGW is based on a risk model originally developed for the gas industry in the United Kingdom ("UK"). The initial UK model was developed in 1980 and then refined beginning in 1995. The refinement of this model was based on actual historical failure data from one million cast iron and ductile iron pipe segments covering 20 years of failure data and 10 years of gas leakage which migrated into buildings and the related incident data. After being fully developed, a UK gas regulator endorsed the refined risk model in 2000 and this model is now used by all UK network gas companies as well as gas companies worldwide (including several U.S. natural gas distribution companies[28]).

[26] Based on a ten year average of cast iron main replacement for each of the eight companies.
[27] See Appendix C for the excerpt from the June 2, 2008 Advantica Analysis which discusses the Main Replacement Prioritization Model.
[28] The following U.S. natural gas distribution companies use the MRP Model: Philadelphia Gas Works (PA), Peoples Natural Gas (PA), Central Hudson Gas & Electric Corp. (NY), Consolidated Edison Company of New York (NY), Orange and Rockland Utilities, Inc. (NY), New Jersey Natural Gas Company (NJ), Public Service Electric & Gas Co (PSE&G) (NJ), City of Richmond (VA), Dominion Hope (WV), Michigan Consolidated Gas Co. (MichCon) (MI), Consumers Energy Company (MI), Nicor Gas (a division of AGL Resources) (IL) and MidAmerican Energy Company (IA).

PGW implemented Advantica's refined MRP model in 2008. As part of this implementation, PGW's detailed distribution system data (such as material, length, age, leak history, break history, etc.) for each pipe segment was input into the model. The model then analyzed the data, assessed the condition of each pipe segment and created a risk score for leakage / breakage per pipe segment. This scoring, in turn, is used by PGW to prioritize the replacement of pipe segments. Additionally, the MRP is a dynamic model and pipe segment data is updated annually so that the evolving condition of each pipe segment is factored into future risk scoring and replacement prioritization.

PGWs Advantica engagement also included evaluating a scenario in which PGW did not use a risk model for the prioritization of main replacement and compared it to various scenarios in which PGW did use a risk model with varying levels of cast iron main replacement. Advantica was able to evaluate these scenarios based upon its own modeling of extensive historical failure data from UK gas systems.[29] Advantica's assessment, after evaluating the PGW scenarios within the context its historical data model, concluded that prioritizing replacement by MRP risk score is the most effective way for PGW to:

- reduce serious incidents;
- reduce breakage repairs; and
- reduce future breakage repair costs.

As a result of the foregoing, PGW's main replacement program ensures and maintains adequate, efficient, safe, reliable and reasonable service because using the MRP model to prioritize main replacement reduces serious incidents. The main replacement program also ensures cost effectiveness because using the MRP model reduces future breakage repair costs.

[29] As referenced above, the MRP model contains actual historical failure data from one million cast iron and ductile iron pipe segments covering 20 years of failure data and 10 years of gas in building and incident data.

iii. GL Noble Denton (formerly d/b/a Advantica) 12-Inch 10-35 psig Cast Iron Mains Benchmarking Study[30]

In 2012, PGW engaged GL Noble Denton (formerly Advantica) to conduct a benchmark study on the replacement of large diameter cast iron mains. The study benchmarks nine distribution utilities, including PGW, to determine replacement strategies for 12-inch high pressure cast iron mains. The eight other systems are all centered around a central inner city predominantly located in the northeastern part of the U.S. and are thus considered to be the most-comparable benchmarks that could be used. These companies tended to operate large amounts of older, cast iron pipe. As part of the benchmark study, PGW requested that GL Noble Denton perform a replacement analysis on PGW's 12-inch cast iron mains to determine the proper replacement amount for reducing risk to an acceptable level.

Due to the recent incidents involving large diameter cast iron mains in the U.S., and the overall reduction of risk for the distribution system exhibited by PGW's marked reduction in all reportable incidents, GL Noble Denton concludes that replacing 2 miles of 12 inch high pressure cast iron main per year provides the proper balance of risk reduction for a utility operating in a congested area. Based on this conclusion, PGW is proposing to implement a replacement program beginning in 2013 (set forth above in Section D/E) which will remove an average of 2 miles annually of larger sized high pressure mains until all of its 12 inch high pressure mains are completely replaced (i.e., by 2022).

[30] See Appendix D for the Executive Summary from the September 7, 2012 study.

b. Distribution Integrity Management Program

PGW's LTIIP ensures and maintains adequate, efficient, safe, reliable and reasonable service because it reduces risk consistent with the Company's Distribution Integrity Management Program ("DIMP"). PGW developed its DIMP in response to a recent Pipeline and Hazardous Materials Safety Administration (PHMSA) regulation which requires NGDCs to develop a written integrity management plan which, among other things:

- demonstrates an operator's understanding of its system;
- identifies the threats to its distribution system;
- evaluates the risks associated with its distribution pipeline;
- determines the relative importance of each threat;
- estimates and ranks the risks posed to its pipeline; and
- identifies the measures to address risks.

The development of a DIMP is a comprehensive process which requires an NGDC to make an assessment of its entire distribution system. It is among the most appropriate resources to use when determining the main categories to be replaced. Accordingly, PGW relied on its DIMP when it developed its current main replacement plan.

c. Field Observations

When a main is exposed, PHMSA's Office of Pipeline Safety regulation at 49 CFR § 192.459 requires NGDCs to observe whether localized corrosion appears on the exposed main. Recently, PGW exposed a section of its 30 inch HP main and discovered localized corrosion. Consequently, PGW studied two smaller segments of the exposed main and also discovered

ground conditions which contribute to main corrosion.[31] As a result of the foregoing, PGW has included the replacement of 30 inch high pressure main in its LTIIP.

d. Prudent Replacement

PGW has determined that it's also prudent to continue its distribution system evaluation to determine if there are any segments of redundant or under-utilized main that can be removed from service and still maintain adequate, efficient, safe, reliable & reasonable service. As a result PGW has targeted several large segments of 20" & 12" main that can be removed from service and abandoned. Because PGW's distribution system is dynamic due to changing load requirements and customer demands, PGW will closely monitor its cast iron main inventory for opportunities to remove/abandon any high pressure main that is between 12 inches and 30 inches (i.e. 16, 20 and 24 inches – all HP). If any main segment is determined to be redundant or under-utilized among the 16, 20 and 24 inch HP main inventories, PGW will take the proper steps to remove these segments from service.

G.) The workforce management and training plan designed to ensure that the utility will have access to a qualified workforce to perform work in a cost-effective, safe and reliable manner

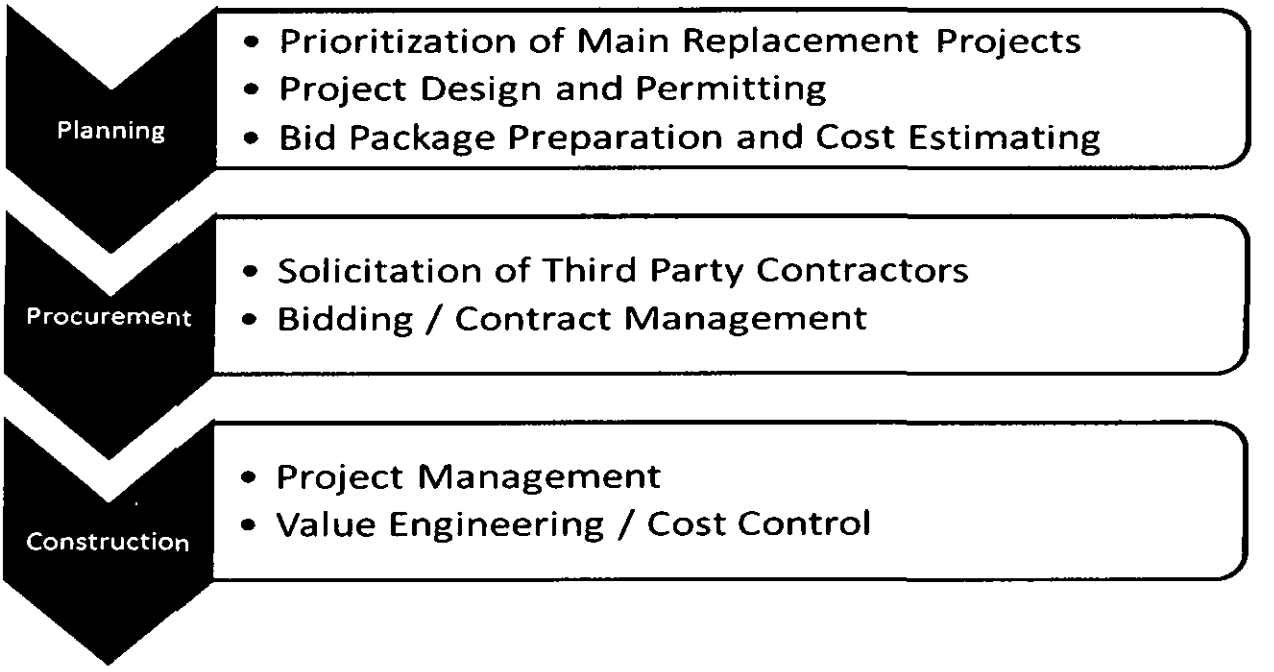
1. Workforce Management

As discussed in earlier sections of this document, PGW's baseline main replacement program currently removes 18 miles of 8" and smaller cast iron main and associated steel services annually. The proposed LTIIP is a continuation of PGW's current main replacement program, supplemented with accelerated 8" and smaller and 12" and larger cast iron main replacement. To ensure the proposed LTIIP is successful, PGW currently has departmental

[31] i.e. the soil pH and the moisture content of the soil.

structures and staffing in place for the prioritization, design, contracting, execution and cost control of main replacement projects.

Planning, Procurement and Construction

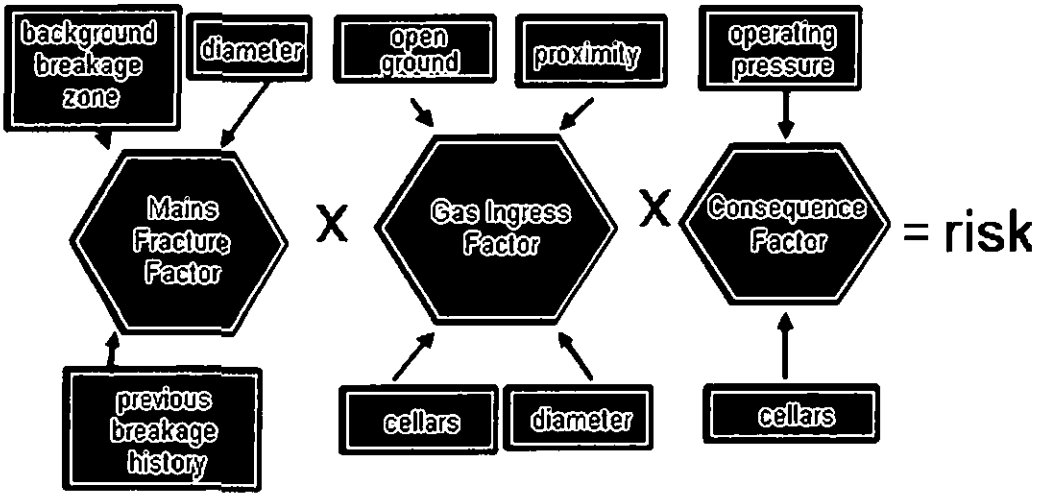


Planning

The Planning Section is responsible for designing, permitting, drafting and cost estimating the majority of PGW's main / service replacements and installations.

As stated above, PGW's current main replacement policy utilizes a Main Replacement Prioritization (MRP) program, developed by GL Noble Denton (formerly Advantica), which targets 8" and smaller cast iron mains for replacement based on parameters such as main size, break history, leak history, pipe age, service length (i.e. proximity to buildings) and gas leakage migration patterns into buildings. Each section of main in the system is evaluated and given a risk score based on a weighting scheme assigned to each parameter (i.e. risk, condition, gas

leakage migration patterns AKA front wall indicator, etc.). The sections of main are then ranked by their risk score to determine the priority of replacement.



MRP utilizes GIS[32] as its platform; this enables PGW to incorporate information from a variety of additional sources into the risk-and-condition assessment. The highest ranked main sections are then grouped into projects which incorporate surrounding cast iron mains in the project. After the projects are grouped, construction documents, bid packages for contractor assistance and project cost estimates are developed and sent to PGW's Supply Chain Department for distribution to third party contractors.

Procurement

PGW's Supply Chain Department administers a standardized public works contracting bid procedure as mandated by state and local law for soliciting contractors to perform main installation and paving restoration as part of the main replacement program. This process includes the following:

[32] GIS is a Geographic Information System which integrates hardware, software and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.

- Identification of Vendors;
- Issuance of the bid Request for Quotation (RFQ);
- Bid Evaluation and Vendor Selection;
- Internal Accounting Approvals / Board Approvals; and
- Awarding of Bid / Collection of Performance Bonding and Insurance Certificates.

Contractors for this specific type of work are qualified by PGW prior to being invited to bid. The qualification includes review of background information such as financial statements, safety performance, minority participation performance and training records.

Construction

After the contract is awarded, the Construction Section of PGW's Distribution Department is responsible for the execution of the contract. This group schedules, monitors and evaluates overall program / project progress and associated costs.

Third party contractors and PGW skilled workers are utilized for all main replacement projects. Third party contractors excavate, install, pressure test with air and backfill new mains under the direct supervision of a qualified PGW construction inspector. The construction inspector is required to monitor and confirm that PGW's installation standards, safety performance standards and all contractual obligations are met.

Once the new main has been installed and tested, PGW's workforce mobilizes to energize the new main, replace existing steel services or reconnect existing plastic services and de-energize the existing main under the supervision of a PGW construction supervisor. Under certain circumstances, such as short unanticipated cutouts or small replacement projects, PGW crews are also utilized to install main. At the present time, only PGW employees are authorized

and trained to work on live gas (currently energized gas mains and services). Additionally, four PGW supervisors monitor the work performed by PGW's workforce for quality, timeliness of work, safety performance and customer satisfaction.

Measures Taken / Action Items

In addition to PGW's current workforce structure for main replacement, proactive measures have been taken to increase the probability of a successful accelerated main replacement program. These measures include, but are not limited to:

- A clause allowing contractors to perform live gas work under certain circumstances was included in the most recent collective bargaining agreement between the Philadelphia Gas Works and Gas Works Employees' Union of Philadelphia, Local 686.
- PGW contracted with a consultant for main replacement design work to prepare construction drawings and associated documents. The use of this design consultant will help PGW with the increased drawing/document preparation workload related to the accelerated main replacement program. Additional consultants may be added depending upon work load.
- PGW has been soliciting the services of additional outside contractors to perform main installation in an effort to keep contracts cost competitive.
- PGW is currently evaluating the services of an outside project management consulting firm to assist in the development and execution of construction processes and procedures for our accelerated main replacement program.

- PGW is currently developing a Main Replacement Prioritization (MRP) program for 12" and larger cast iron main replacement in addition to the present 8" and smaller MRP program.
- PGW is currently evaluating the need of adding additional vehicles and mobile equipment for its increased replacement plan.

2. Training Plan

PGW Training

PGW's Distribution Department currently employs skilled workers to perform operation, maintenance and construction activities on PGW's distribution system. These employees are trained and qualified to the standards set forth in US Department of Transportation, Office of Pipeline Safety Regulation Title 49 CFR 192 Subpart N, via PGW's Natural Gas Pipeline System Operator Qualification Plan (effective April 26, 2001).

The purpose of the above mentioned Natural Gas Pipeline System Operator Qualification Plan is to ensure safe and efficient natural gas service by establishing objective criteria of required qualifications for all persons performing safety-sensitive operations and maintenance tasks on PGW's gas piping system. This plan also ensures, through evaluation, that each person performing safety sensitive tasks on PGW's pipeline system is: 1) able to perform these tasks; 2) able to recognize and respond appropriately to abnormal operating conditions; and 3) able to maintain necessary records to administer this plan.

PGW has a dedicated Training Section which provides classroom training as well as simulated and/or actual field training each time a PGW employee is promoted to a new position. Every employee is tested on their ability to perform every assigned task within an associated job

title. Employees are evaluated on their knowledge, skill and ability related to each task as well as their ability to react to abnormal operating conditions.

In addition to the classroom training for promotional job titles, PGW has instituted annual training classes for all field and management personnel that covers such tasks as: proper trench shoring techniques, leak investigation and migration practices, damage prevention methodologies, proper use of gas detection instrument, plastic pipe fusion qualifications, steel pipe welding qualifications and proper respirator use.

Contractor Training

In addition to the financial and technical screening performed by the Procurement Section, the Training Section tests and qualifies PGW's outside contractor workforce in plastic pipe fusion and steel welding practices. Additionally, now that the most recent Collective Bargaining Agreement permits outside contractors to work on live gas, the Training Section has established procedures to qualify contractors for live gas work.

III. CONCLUSION

PGW's LTIIP satisfies the requirements set forth by 66 Pa.C.S.A. §1352 and the Commission's Final Implementation Order by:

- identifying the types and age of eligible property owned or operated by the utility for which the utility will seek recovery;
- providing an initial schedule for the planned repair and replacement of eligible property;
- providing a general description of the location of the eligible property;
- providing a reasonable estimate of the quantity of eligible property to be improved;

- providing projected annual expenditures to implement the plan and demonstrating that measures taken will ensure that the plan is cost effective;
- identifying the manner in which the replacement of aging infrastructure will be accelerated and demonstrating how the repair, improvement or replacement will ensure and maintain adequate, efficient, safe, reliable and reasonable service; and
- providing a workforce management and training plan designed to ensure that the utility will have access to a qualified workforce to perform work in a cost-effective, safe and reliable manner.

As a result of the foregoing, PGW's LTIIP is adequate and sufficient to ensure and maintain adequate, efficient, safe, reliable and reasonable service. Accordingly, PGW respectfully requests that the Commission approve this Plan.

Distribution Integrity Management Program ("DIMP")

The Pipeline and Hazardous Materials Safety Administration (PHMSA) published the final rule establishing integrity management requirements for gas distribution pipeline systems on December 4, 2009 (74 FR 63906). Operators were given until August 2, 2011 to write and implement their Distribution Integrity Management Program ("DIMP").

The following is the complete text of the regulation which sets forth the DIMP elements:

49 C.F.R. § 192.1007 What are the required elements of an integrity management plan?

A written integrity management plan must contain procedures for developing and implementing the following elements:

(a) Knowledge. An operator must demonstrate an understanding of its gas distribution system developed from reasonably available information.

(1) Identify the characteristics of the pipeline's design and operations and the environmental factors that are necessary to assess the applicable threats and risks to its gas distribution pipeline.

(2) Consider the information gained from past design, operations, and maintenance.

(3) Identify additional information needed and provide a plan for gaining that information over time through normal activities conducted on the pipeline (for example, design, construction, operations or maintenance activities).

(4) Develop and implement a process by which the IM program will be reviewed periodically and refined and improved as needed.

(5) Provide for the capture and retention of data on any new pipeline installed. The data must include, at a minimum, the location where the new pipeline is installed and the material of which it is constructed.

(b) Identify threats. The operator must consider the following categories of threats to each gas distribution pipeline: corrosion, natural forces, excavation damage, other outside force damage, material or welds, equipment failure, incorrect operations, and other concerns that could threaten the integrity of its pipeline. An operator must consider reasonably available information to identify existing and potential threats. Sources of data may include, but are not limited to, incident and leak history, corrosion control records, continuing surveillance records, patrolling records, maintenance history, and excavation damage experience.

(c) Evaluate and rank risk. An operator must evaluate the risks associated with its distribution pipeline. In this evaluation, the operator must determine the relative importance of each threat and estimate and rank the risks posed to its pipeline. This evaluation must consider each applicable current and potential threat, the likelihood of failure associated with each threat, and the potential consequences of such a failure. An operator may subdivide its pipeline into regions with similar characteristics (e.g., contiguous areas within a distribution pipeline consisting of mains, services and other

appurtenances; areas with common materials or environmental factors), and for which similar actions likely would be effective in reducing risk.

(d) Identify and implement measures to address risks. Determine and implement measures designed to reduce the risks from failure of its gas distribution pipeline. These measures must include an effective leak management program (unless all leaks are repaired when found).

(e) Measure performance, monitor results, and evaluate effectiveness.

(1) Develop and monitor performance measures from an established baseline to evaluate the effectiveness of its IM program. An operator must consider the results of its performance monitoring in periodically re-evaluating the threats and risks. These *performance measures must include the following:*

(i) Number of hazardous leaks either eliminated or repaired as required by § 192.703(c) of this subchapter (or total number of leaks if all leaks are repaired when found), categorized by cause;

(ii) Number of excavation damages;

(iii) Number of excavation tickets (receipt of information by the underground facility operator from the notification center);

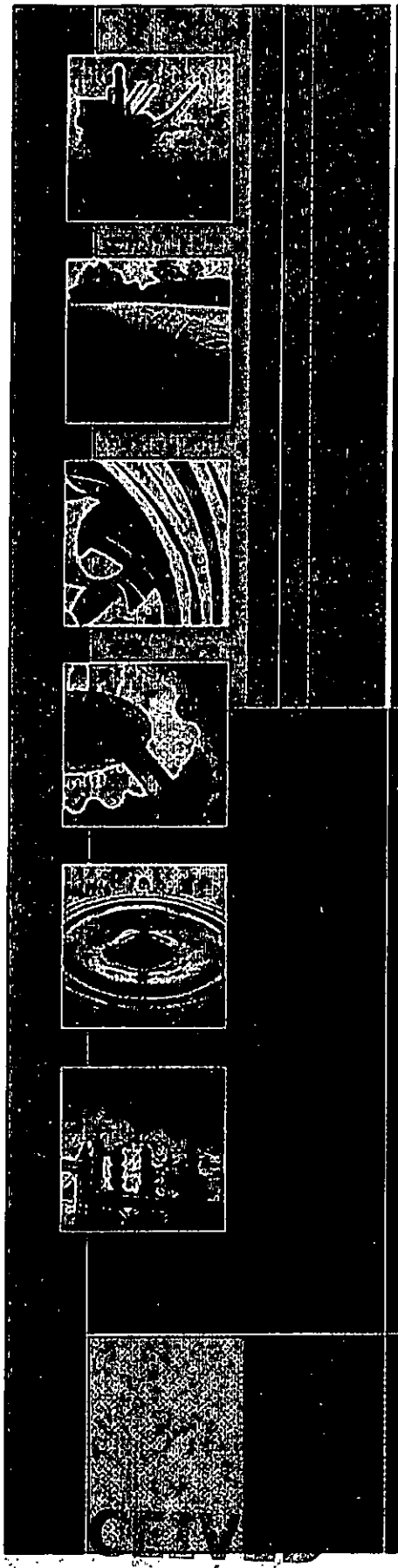
(iv) Total number of leaks either eliminated or repaired, categorized by cause;

(v) Number of hazardous leaks either eliminated or repaired as required by § 192.703(c) (or total number of leaks if all leaks are repaired when found), categorized by material; and

(vi) Any additional measures the operator determines are needed to evaluate the effectiveness of the operator's IM program in controlling each identified threat.

(f) Periodic Evaluation and Improvement. An operator must re-evaluate threats and risks on its entire pipeline and consider the relevance of threats in one location to other areas. Each operator must determine the appropriate period for conducting complete program evaluations based on the complexity of its system and changes in factors affecting the risk of failure. An operator must conduct a complete program re-evaluation at least every five years. The operator must consider the results of the performance monitoring in these evaluations.

(g) Report results. Report, on an annual basis, the four measures listed in paragraphs (e)(1)(i) through (e)(1)(iv) of this section, as part of the annual report required by § 191.11. An operator also must report the four measures to the state pipeline safety authority if a state exercises jurisdiction over the operator's pipeline.



ADVANTICA

A Germanischer Lloyd Company

STONERSOFTWARE

Benchmarking Analysis, Risk Analysis and Model, Replacement Analysis and Computerized Main Prioritization and Ranking Program

Philadelphia Gas Works
Final Report
June 2, 2008

Enhancing Safety and Performance

Executive Summary

Background

Advantica have been engaged by Philadelphia Gas Works (PGW) to carry out a study into their current mains replacement policy for cast iron and their future mains replacement requirements. As part of this study, a detailed benchmarking of their current position has been carried out by comparing their distribution system with that of comparable gas utilities in the U.S., in particular those centered on a central inner city. PGW have also agreed to implement Advantica's mains replacement software offering Mains Replacement Prioritization (MRP), to assist them in building future replacement plans, thus this report uses the results from some initial runs of MRP to determine recommended replacement levels with associated risk, going forward.

Benchmarking Study

The benchmarking study for PGW was extensive and the full results are contained within the main body of the report, but the main points arising from this exercise are detailed within this summary. PGW was compared with two separate groups of utilities. The larger group of 27 companies (including PGW) was used as a broad comparison of "industry standard" practices, and covered the utilities primarily in the eastern half of the U.S. Seven of the companies in the broader benchmark group were pulled out for a closer comparison to PGW. These seven gas distribution companies were selected by PGW as having systems most similar to PGW's system. The seven systems are all centered around a central inner city, and are thus considered to be the most-comparable benchmark that could be used. These companies tended to operate reasonable amounts of older, cast iron pipe and were predominantly located in the northeastern part of the U.S.

The statistics presented within this benchmarking study report are primarily publicly available and have been sourced from the "U.S. Department of Transportation's Annual Report for Gas Distribution System," covering the 10-year period ending in 2006.

The main points to emerge from this study are as follows:

1. Within the larger group of utilities, PGW has a much higher than average proportion of cast iron pipe. This will increase the overall risk from the system as breaks from cast iron pipe are one of the most common causes of incidents.
2. Within the smaller group of utilities, PGW has an average proportion of cast iron pipe. This smaller group contains 49% of all the cast iron in operation in the US, but only 5% of the population of all materials, showing that this group is close to PGW in terms of its material composition.
3. Within the larger group of utilities, PGW has the lowest percentage of polyethylene pipes. Polyethylene is considered to have the lowest risk of serious incidents due to its extreme resistance to joint leakage, fracture and corrosion.
4. Within the smaller group, PGW has the highest percentage of cast iron, the lowest percentage of polyethylene, and the lowest percentage of bare steel.

5. PGW's distribution of pipe by diameter is comparable with the smaller group, but PGW has much less small diameter (less than 2-inch) pipe in comparison with the larger group, since the majority of their system is operated at low pressure (6"wc) and PGW eliminated small diameter CI during the late 80's early 90's as part of its main replacement program.
6. PGW has one of the highest proportions of pre-1940 pipe within the larger group, but an average proportion when compared within the smaller group.
7. PGW has an average percentage of PE services within both the larger and smaller benchmark group.
8. PGW has one of the shortest average service line lengths within the larger group and the shortest within the smaller group. This is an important factor in the risk arising from main breaks and to a lesser extent for joint leaks, as gas will have shorter distance to migrate into nearby property.
9. When compared with other utilities, there is marked difference between the classification of leaks within PGW and elsewhere, in particular the high number of leaks classified as due to "natural forces," compared to other companies. PGW attributes 90% of their leaks to this cause, compared with only 14% for the larger group and 22% for the smaller group. This may be a real difference, or more likely, a difference of interpretation of the classifications.
10. In terms of unaccounted-for gas, PGW ranks as having one of the highest figures within the largest group and the highest within the smaller group, but previous studies have suggested that there may be a high level of unreliability associated with these figures.
11. Trends in joint and break leaks are not available via the DOT statistics, but Advantica carried out a separate, confidential survey, to determine figures from six companies (five from the smaller benchmark group and one from the larger group). The 10-year trend in cast iron breaks and joint leaks for PGW shows a reasonably level trend for breaks, suggesting that the current level of cast iron replacement is sufficient to stabilize the break rate. There is, however, a slight upward trend for joint leaks, suggesting that the replacement level should perhaps need adjusting upwards to reverse this trend or keep it level. It must be noted that weather also plays an important factor in the number of breaks per year that a utility experiences.
12. A comparison of joint leaks as a percentage of total leaks, from this anonymous group, has shown that PGW's percentage is average.
13. A comparison of incident rates over the period 1986 to 2004 has shown that the PGW rate was significantly higher than the average for all U.S. gas companies over this period, an average of just under 25 incidents per 100,000 miles of mains and services per year compared to a national average of around 7 per 100,000 miles per year. However, the general trend for PGW has shown a reduction in incidents in recent years.
14. The main cause of incidents within PGW has been recorded as "outside force." This is the same pattern as seen within the U.S. as a whole.
15. The largest source of incidents appears to be mains. This is seen for both PGW and the U.S. as a whole.
16. The vast majority of incidents within PGW occur on cast iron pipes, on 4 to 6-inch mains, on older pipes, within the winter months. This pattern is similar to the national situation.

Replacement policy

As well as examining PGW's current position in terms of operating statistics, Advantica has also examined PGW's position in relation to replacement levels, in particular those of cast iron. The main points of this examination are listed below.

1. In terms of replacing its cast iron population over the 10 year period ending in 2006, PGW rank in the lowest quartile within the larger group, having replaced a total 156.3 miles or approximately 8.8% of its' main from the starting point of 1,768 of the CI system compared to an average of 13%. For the smaller group however, it matches the average reduction. The ten (10) year average for replacement is 15.6 miles, the five year average is 20.2 miles and the most recent replacement level equates to just more than 18 miles per year.
2. PGW's replacement of cast iron over the period 2001 to 2006 has been approximately twice as high as in the years 1998 to 2000.
3. If PGW were to increase its replacement level to 24 miles per year, it would rank second highest in the smaller benchmark group. If it were to reduce replacement to 12 miles per year, it would rank second lowest.
4. If PGW continued to replace at its recent rate of 18 miles per year, using a random approach, its year of final replacement would be 2096. This compares with 2063 for the company with the best rate of replacement (24 miles) and 2291 for the company with the worst rate of replacement (12 miles).
5. Following discussion with PGW staff, regarding replacement techniques and the constraints imposed by working in an urban area, Advantica have suggested the following for reducing the costs of repairs and replacement of mains:
    - Revisit longer term contracts
    - Schedule larger replacement areas/projects
    - Discuss paving requirements with the City
6. As part of the survey conducted by Advantica, participants were asked for suggestions for replacement techniques which they would recommend for reducing costs. The details of these are contained within the main body of the report. Advantica has also provided PGW with a flowchart aid to selecting construction techniques.
7. Finally, the survey collected details of repair and replacement costs for each of the participants. PGW has a relatively low cost per repair of $1,660 per mains break repair, compared to an average of $3,300. PGW has an average replacement cost of $0.7 million per mile, comparing favorably to an overall average of $1.1.

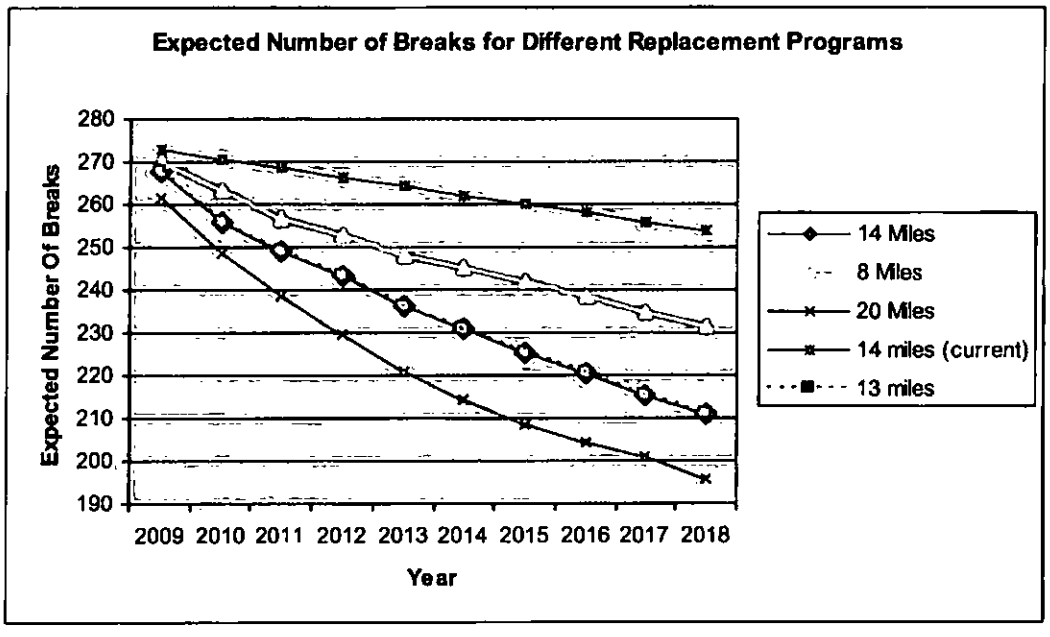
Alternative replacement scenarios using MRP

The previous two sections have examined the current status of PGW in terms of operating statistics and replacement policy. Advantica has also carried out some analysis to determine if the present policy can be improved by the application of MRP, Advantica's prioritization model. MRP has been populated with pipe details for PGW, namely pipe sizes, their geographical location, their associated leaks and information relating to service length. This has enabled

Advantica to generate a number of different replacement scenarios based upon different levels of risk-based replacement and their associated costs, to determine how effective they are at reducing breaks, avoiding breakage repair costs, and improving safety.

Replacement levels of 12 miles, 17 miles, 18 miles and 24 miles, using MRP, have been examined, together with 18 miles using PGW's current methodology. The results of running these scenarios are presented in the following graph, in terms of a reduction in expected breaks over a 10-year period by applying different annual rates of replacement and methodologies.

It is important to note that PGW's annual program is made up of prudent and enforced replacement. The prudent portion has historically been selected using PGW's current prioritization tool. The enforced has to be carried out due to city, state, federal and other utility projects outside the control of PGW. Traditionally, the enforced has accounted for around 4 miles per year. The scenarios which are presented within this report, using MRP, have removed 4 miles from the total to simulate the actual situation, thus the 18 mile scenario is actually 14 miles of cast iron, the 24 mile is actually 20 miles and so on. The output from MRP has been amended to produce a graphical output for breaks per year rather than leaks, as PGW has traditionally measured its replacement program against the trend in breaks not leaks. The following graph shows the results of applying MRP to a number of different scenarios, based upon different lengths of replacement.



As expected, the more pipe is replaced, the greater the reduction in breaks per year. The average breakage rate over the 10 year period 1997 to 2006 within PGW has been 370. MRP predicted a starting level of 275 for 2008. It is important to note that the output from MRP predicts the number of breaks associated with specific pipes. The average level of breaks of 370 is based upon all breaks, whether they are assigned to pipes or not. When PGW's historical data is examined

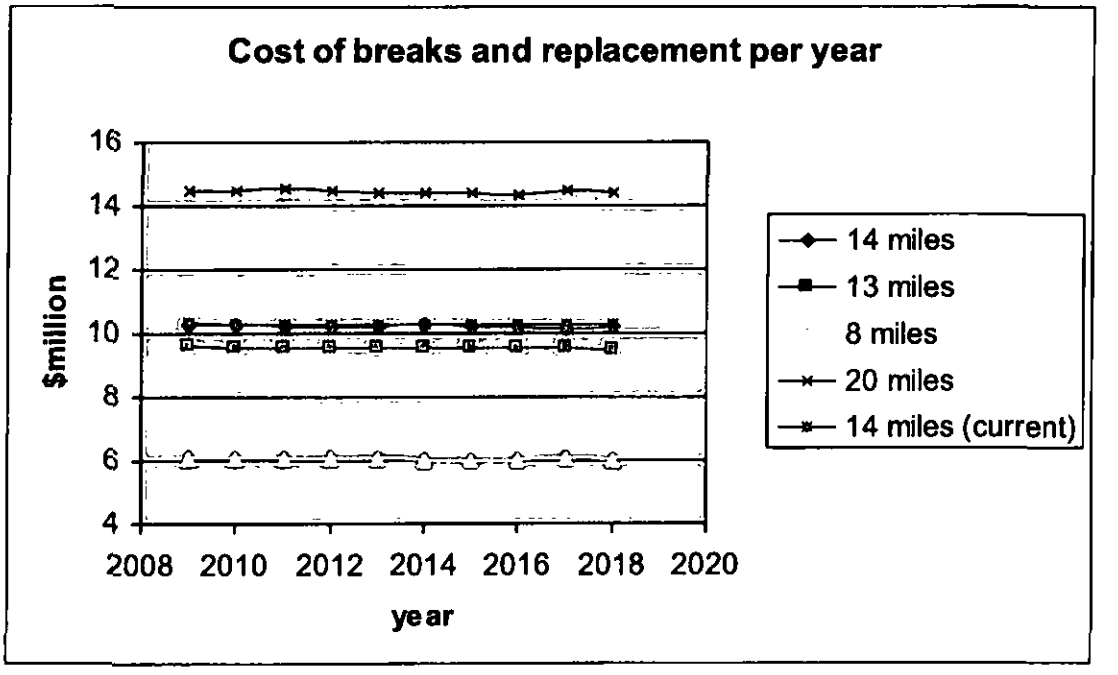
further to extract only those breaks associated with pipes, the average reduces to 254 – this is in comparison to a predicted average from MRP of 275.

The graph also shows that there is a distinct difference between 14 miles (18 miles total) using PGW's current policy versus 14 miles (18 miles total) using MRP. The level of predicted breaks for 13 or 14 miles is very similar, but the 14 mile scenario does reduce breaks slightly quicker than the 13 mile scenario. In terms of percentage reduction, the scenarios performances are summarized in the following table.

Scenario	Description	Breaks in year 0	Breaks in year 10	% reduction in length of cast iron	% reduction in breaks
A	18 miles of cast iron per year, random (14 miles prudent)	275	253	8%	8%
B	18 miles of cast iron per year (14 miles using MRP Risk)	275	209	8%	24%
C	17 miles of cast iron per year (13 miles using MRP risk)	275	211	7.5%	23%
D	12 miles of cast iron per year (8 miles using MRP Risk)	275	231	5%	16%
E	24 miles of cast iron per year (20 miles using MRP risk)	275	196	11%	29%

The previous table shows that the application of MRP is effective for all scenarios, in reducing cast iron breaks, and hence incidents; each one removing proportionally more breaks than the corresponding length replaced, and all of them more effective than the current policy. The table also shows that any move away from the 14 mile (18 mile total) program will reduce the effectiveness of reducing breaks and hence incidents.

The cost of replacement and repair has also been considered. An increase in replacement will increase replacement costs but reduce future breakage repair costs. The following graph summarizes the total cost of each scenario, in terms of replacement and breakage repair costs. The 14 mile (18 mile total) current and MRP scenarios have similar levels of costs, as the cost of replacement is the same in both cases, and is much greater than the cost of breakage repairs. However, as can be seen in the previous graph, the reduction in future breaks is much greater if MRP is used to prioritize the 14 miles.

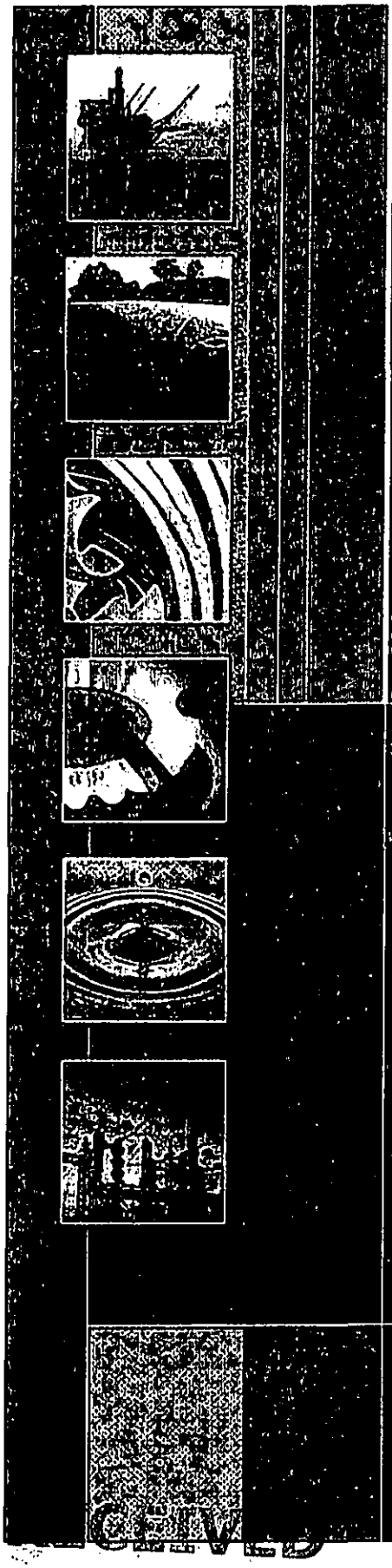


Conclusions and Recommendations

The results of the analysis carried out by Advantica have shown that PGW operates a distribution system which is typical of one operating in a central inner city area, where the mains population is very well established and there are constraints on the amount of replacement possible because of the density of other services and property.

Because of this particular type of system, PGW has a higher than average level of leaks and incidents, older than average pipes, and a lower than average polyethylene population. It is therefore imperative that any replacement policy is as effective as possible at identifying the pipe segments that present the greatest likelihood of leaks and incidents, and replacing them as early as possible in the program.

The application of MRP to the population of pipes within PGW has shown that PGW could continue to operate a policy of 18 miles per year, of prudent and enforced, but significantly reduce the level of future breaks, simply by identifying a different population of those 18 miles. It has been assumed that 4 miles of the 18 is still outside the control of PGW as it is enforced replacement, but the remaining 14 miles could be identified using the MRP risk model. This would identify those cast iron mains with the highest probability of breaking and causing an incident. This program will have a similar cost to the current 18-mile policy, but is estimated to produce significant savings in terms of breaks avoided over the subsequent 10-year period. An 18-mile program, directed by MRP over the next 10 years reduces the cast iron population by around 8% but the estimated reduction in breaks over the same period is 24%.



ADVANTICA

A Germanischer Lloyd Company

STONERSOFTWARE

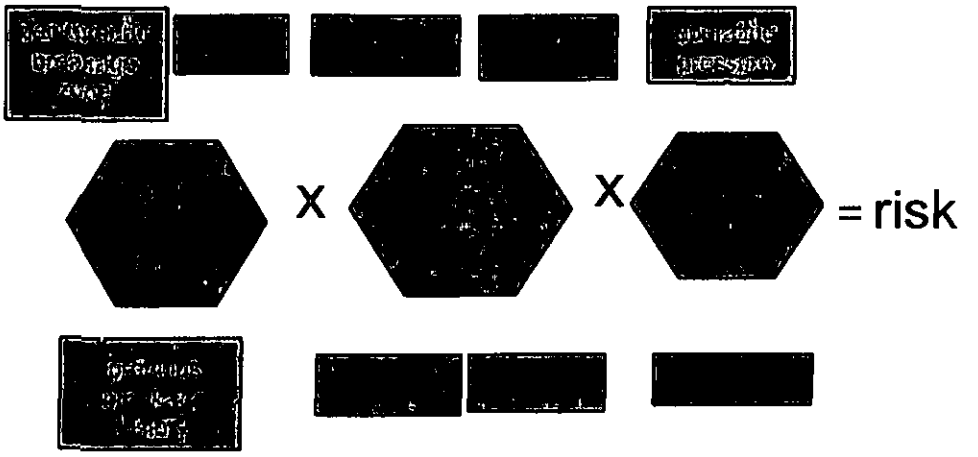
Benchmarking Analysis, Risk Analysis and Model, Replacement Analysis and Computerized Main Prioritization and Ranking Program

Philadelphia Gas Works
Final Report
June 2, 2008

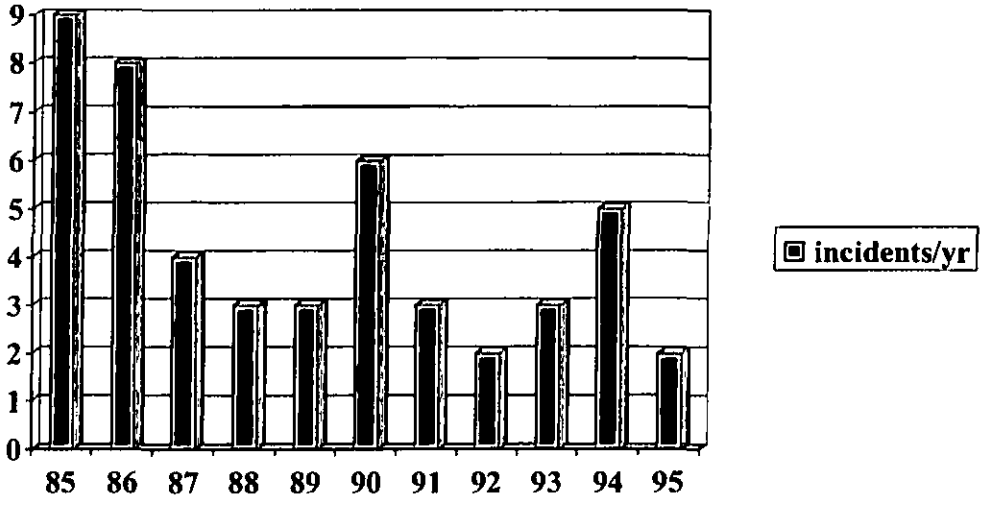
Enhancing Safety and Performance

Dynamic Risk Model

The dynamic risk model developed for PGW is based on the risk model developed for the UK gas industry. The original model, developed in the 1980s, was called the Points Scheme. It was based on modeling a three-stage process: gas leaking from a pipe segment, the gas migrating underground from the pipe into nearby property, and the gas subsequently building up to a flammable mixture and igniting, causing damage to the property and possible injury or fatality to any occupants. At each stage of the process, different elements were thought to act upon the likelihood of each stage occurring.



The Points Scheme was essentially a ranking program, and the Points Score for each pipe segment was used to compare one pipe against another in terms of its priority for replacement. The weightings within the model for each element were largely intuitive rather than based upon analysis of historical data. The model was used between 1985 and 1995 and recommended the annual replacement of approximately 1% of the cast iron population in use at the time, around 75,000 miles, at an approximate annual cost of $240 million. The 1% was selected to reach a target of replacing all cast iron above a Points threshold of 1200 points by 1995. This was deemed to be an acceptable level to reduce incidents to a level of around three per year and keep it stable over the coming years. Although the Points model was based on ranks rather than an actual measure of risk, there was a steady decrease in explosion incidents over the period, suggesting that the model had been reasonably successful at targeting pipes presenting the greatest risk.



In 1995, the development of a refined model began, based on analysis of actual historical failure. It was based on data from one million cast and ductile iron pipe segments, covering 20 years of failure data and 10 years of gas in building and incident data. The model kept the three-stage process but the weightings within the model and the relationship between the individual elements were generated by regression analysis performed on the data. The result was the Risk Model, now incorporated into MRP (Mains Replacement Prioritization), and the output from the model was a risk score for each pipe segment in terms of incidents per length per year. This allowed, for the first time, the reduction in risk to be numerically linked to the length (and hence cost) of replacement, so that replacement plans could be presented to the UK gas regulators, Ofgem (The Office of Gas and Electricity Markets), and the HSE (Health and Safety Executive). The model was finalized in 1999 and presented to HSE, who then endorsed it, and it was implemented across the UK in 2000. In 2002, following an inquiry into a serious incident in 1999, the UK gas industry was subject to an enforcement notice from HSE, forcing them to replace all cast and ductile iron mains within 100 feet of property in the following 30 years. The Risk Model is used by all network gas companies in the UK to prioritize that replacement.

The model is now in use within other gas utilities around the world and has recently been implemented within PGW. In order to install a version which is aligned with PGW's distribution system, the models within MRP have to be calibrated. This involves calculating the overall level of failures with PGW, and using this information to scale the models accordingly. This is because the MRP base models are based on data from the UK, and each utility will have a failure rate that is less or greater than this rate depending on such factors as previous replacement policies, or geographical location (affecting weather conditions), all of which will affect the overall level of leakage repairs.

MRP contains two models: Condition and Risk. Risk models the likelihood of a leak leading to a serious incident, (mains break) as described above, whereas Condition measures the first stage of the process only, i.e. the likelihood of a leakage repair.

The Condition model requires data for each pipe segment on material, age, length, previous leaks, and Background Failure Zone, or BFZ. These are "hotspots" of failure activity and are generated by examining all pipes, their locations, and their associated leaks. Previous analysis has shown a very strong link between the likelihood of a pipe leaking and the leakage behavior of other pipes in its vicinity. This is especially important when trying to determine how a pipe will behave when it has not yet experienced any leakage repairs. This normally accounts for over 90% of the system; therefore, any policy that relies on prioritizing replacement based on previous leaks alone will only be able to assess around 10% of the system. The introduction of BFZs means that all pipes will have factors associated with them that will discriminate them from their neighbors in terms of Condition or risk score.

All data required to generate Condition scores was loaded into MRP for PGW (taken from the Underground Facilities System (UFS) or Detail Main Maps (DMM)), and BFZs and Condition Scores were calculated. The predominant material in PGW is cast iron, and the predominant failure mode is joint leaks. The following picture shows the distribution of Background Joint Zones (BJZs) for the PGW area as generated by MRP. Areas in red are high zones, areas in green are medium, and areas in blue are low. Pipes lying within a high BJZ are much more likely to experience a joint leak than identical pipes lying within a low BJZ. The same theory is applicable to Background Breakage Zones and Background Corrosion Zones.

MRP will also calculate Risk scores for each pipe. The data required all relate to the pipe and its environment and include the following:

- Proximity of the pipe to nearby property
- The presence of basements in nearby property
- The type of ground surface between the pipe and nearby property (i.e. paved or open)
- The diameter of the pipe
- Its operating pressure.

For the implementation within PGW, the proximity has been estimated by the use of service length. Most properties have been assumed to have basements, and paved ground between the main and nearby property. The diameter and operating pressure are already known.

12-Inch 10-35 psig Cast Iron Mains Benchmark Study

November 29, 2012

For: Jeff Meyers
Philadelphia Gas Works

GL Noble Denton

I) Executive Summary

Background

GL Noble Denton has been engaged by the Philadelphia Gas Works (PGW) to conduct a benchmark study on the replacement of large diameter cast iron mains. The study benchmarks nine distribution utilities, including PGW, to determine replacement strategies for 12-inch diameter cast iron mains. As part of the benchmark study, PGW has requested that GL Noble Denton perform a replacement analysis on the 12-inch cast iron mains to determine the most efficient approach to replacing these pipes, using the MRP software, while managing the risk of the system.

Benchmarking Study

The benchmarking study for PGW was extensive and the full results are contained within the main body of the report, but the main points arising from this exercise are detailed within this summary. PGW was compared with eight distribution utilities. The eight systems are all centered around a central inner city, and are thus considered to be the most-comparable benchmark that could be used. These companies tended to operate large amounts of older, cast iron pipe and were predominantly located in the northeastern part of the U.S.

The statistics presented within this benchmarking study report are primarily publicly available and have been sourced from the "U.S. Department of Transportation's Annual Report for Gas Distribution System," covering the 7-year period ending in 2011.

The main points to emerge from this study are as follows:

1. PGW has a much higher than average amount of cast iron pipe (50.9% of its mains) compared to the other benchmark utilities. This tends to increase the overall risk from the system as breaks from cast iron pipe are one of the most common causes of incidents. (p. 14 – figure 4)
2. The nine distribution companies together contain 47.4% of all 12-inch cast iron mains (of all pressures) in the US and 39.8% of all cast iron mains in the US, even though they only account for 4.5% of the total mileage of mains in the U.S. These statistics verify the selection of the nine utilities as a very comparable benchmarking group. (p. 12 – figure 2)
3. PGW has a greater than average 12-inch cast iron (of all pressures) inventory (4.2%) as a percentage of all mains in PGW's system, compared to the other benchmark utilities. (p. 14 – figure 5)
4. PGW has made remarkable progress in lowering their number of reportable incidents over the 22-year period since 1980. From a high of 12 reportable incidents on PGW's system in 1982, there have only been two incidents on PGW's system in the last 6 years. Considering only the incidents that have involved cast iron, PGW has experienced only three of these in the last 10 years. (p. 31 – figure 20)

5. PGW had a below average number of incidents (1) as compared with the other benchmark companies, between the years 2010 and 2012, for all causes, sizes, and piping materials. (p. 34 – figure 23)
6. The majority of PGW's incidents from all causes occur in the January to February months. Incidents involving just cast iron mains also peak during this period, especially in January. This appears to agree with PGW's assessment of the major cause of incidents on their system – frost upheaval of the ground. (p 37 – figure 27)
7. PGW has the lowest leak rate of the six survey respondents for 12-inch 10-35 psig cast iron. (p.29 – figure 18)
8. PGW has the mean break rate of the survey respondents for 12-inch 10-35 psig cast iron. (p.29 – figure 19)

Replacement policy

As well as examining PGW's current position in terms of operating statistics, GL Noble Denton has also examined PGW's position in relation to replacement levels of 12-inch 10-35 psig cast iron. The main points of this examination are listed below.

1. According to responses from six surveyed companies, PGW replaces about an average amount of 12-inch 10-35 psig cast iron per year. The average includes two survey respondents that have small amounts of 12-inch cast iron in their system but have not replaced any of it. (p. 28-Figure 17)
2. The utility with the highest replacement mileage of the six surveyed companies replaces 4 miles of 12-inch 10-35 psig cast iron per year, or 2.8% of their 12-inch 10 psig & higher pressure cast iron inventory. (p. 28-Figure 17)
3. Two companies have not replaced any of their 12-inch 10-35 psig pressure cast iron. PGW replaced 1.01 miles per year, or 4.39% of their 12-inch 10-35 psig cast iron inventory. A replacement rate of 1 mile per year would be equivalent to a rate of 4.3%, while a replacement of 2 miles per year would equate to a rate of 8.7% per year. (p. 28-Figure 17)
4. According to the replacement analysis carried out by GL Noble Denton, replacing 2 miles of 10-35 psig 12-inch cast iron per year is the proper amount for reducing risk to an acceptable level. (p. 5 - see table below on next page)

Scenario	Description	*Cost of* Replacement (MM$) over 10 years	% reduction in length of elevated pressure 12-Inch cast iron	% reduction in incidents after 10 years
A	1 mile per year	38.55	47.90	96.07
B	2 miles per year	75.19	93.42	99.60
C	3 miles per year	80.48	100	100
D	5 miles per year	80.48	100	100

Conclusions and Recommendations

The results of the analysis carried out by GL Noble Denton have shown that PGW operates a distribution system which is typical of one operating in a central inner city area, where the mains population is very well established and there are constraints on the amount of replacement possible because of the density of other services and property.

Due to the recent instances of accidents on large diameter cast iron mains in the U.S., and the overall reduction of risk for the distribution system exhibited by PGW's marked reduction in all reportable incidents, GL Noble Denton concludes that 2 miles of 12 inch high pressure cast iron replacement per year provides the proper balance of risk reduction for a utility operating in a congested area.

CERTIFICATE OF SERVICE

I hereby certify that I have this day served a true copy of the foregoing document upon the participants listed below in accordance with the requirements of § 1.54 (relating to service by a participant).

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