LEHIGH COUNTY AUTHORITY

LCA Main Office:
1053 Spruce Road
Wescosville, PA 18106
610-398-2503

Agendas & Minutes Posted:
www.lehighcountyauthority.org

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BOARD MEETING AGENDA – September 27, 2021 – 12:00 p.m.

In-Person or Virtual Meeting Attendance Options Available: Meetings of the LCA Board of Directors will be held at LCA's Main Office as well as online using the Zoom Meetings application, which includes a telephone option. Public participation is welcomed both in-person or virtually. Instructions for joining the meeting online or by phone are posted on the LCA website in the morning on the day of the meeting, prior to the start of each meeting. You may also issue comment to LCA via email to LCABoard@lehighcountyauthority.org in advance of any meeting or view the meeting at a later time by visiting the LCA website. Please visit https://www.lehighcountyauthority.org/about/lca-board-meeting-videos/ for specific instructions to join the meeting if you are attending virtually. If attending in-person at LCA's Main Office, please follow all safety and sanitation protocols posted.

1. Call to Order
   - NOTICE OF MEETING RECORDINGS

     Meetings of Lehigh County Authority's Board of Directors that are held at LCA's Main Office at 1053 Spruce Road, Wescosville, PA, may be recorded for viewing online at lehighcountauthority.org. Recordings of LCA meetings are for public convenience and internal use only and are not considered as minutes for the meeting being recorded, nor are they part of public record. Recordings may be retained or destroyed at LCA's discretion.
   - *Public Participation Sign-In Request*
2. Review of Agenda / Executive Sessions
   - Additions to Agenda (vote required if action will be taken)
3. Approval of Minutes
   - *September 13, 2021 Board meeting minutes*
4. Public Comments
5. Action / Discussion Items:

   FINANCE AND ADMINISTRATION
   - *Preliminary 2022 Budget Review (Discussion)*
   - *LCA Pension Plan – Mandatory Municipal Obligation (Information)* ***(grey)*** *(digital Board packet, pages 8-9)*

   WATER

   WASTEWATER
   - *Suburban Division – Heidelberg Heights 2021 and 2022 Sanitary Sewer Replacement Project – Construction Phase Authorization (Approval)* ***(yellow)*** *(digital Board packet, pages 10-14)*
6. Monthly Project Updates / Information Items (1st Board meeting per month)
7. Monthly Financial Review (2nd Board meeting per month) – **August report attached** (digital Board packet, pages 15-24)
8. Monthly System Operations Overview (2nd Board meeting per month) – **August report attached** (digital Board packet, pages 25-74)

9. Staff Comments
10. Solicitor's Comments
11. Public Comments / Other Comments
12. Executive Sessions
13. Adjournment

UPCOMING BOARD MEETINGS		
October 11, 2021	October 25, 2021	November 8, 2021

PUBLIC PARTICIPATION POLICY

In accordance with Authority policy, members of the public shall record their name, address, and discussion item on the sign-in sheet at the start of each meeting; this information shall also be stated when addressing the meeting. During the Public Comment portions of the meeting, members of the public will be allowed 5 minutes to make comments/ask questions regarding non-agenda items, but time may be extended at the discretion of the Chair; comments/questions regarding agenda items may be addressed after the presentation of the agenda item. Members of the public may not request that specific items or language be included in the meeting minutes.

REGULAR MEETING MINUTES
September 13, 2021

The Regular Meeting of the Lehigh County Authority Board of Directors was called to order at 12:04 p.m. on Monday, September 13, 2021, Chairman Brian Nagle presiding. The meeting was hybrid via in-person and video and audio advanced communication technology ("ACT"), using the Zoom internet application, including telephone option. Each Board member and other attendees of the meeting were able to hear each other attendee and be heard by each other attendee. The public could also participate in the meeting in-person or via ACT, using the Zoom internet application, including telephone option. A Roll Call of Board members present was taken. Chairman Brian Nagle, Scott Bieber, Linda Rosenfeld, Richard Bohner, Amir Famili, Jeff Morgan, and Norma Cusick were present for the duration of the meeting. Ted Lyons and Kevin Baker joined the meeting shortly after it began and were present for the duration of the meeting.

Solicitor Michael Gaul of KingSpry was present along with Authority Staff, Liesel Gross, Ed Klein, John Parsons, Phil DePoe, Susan Sampson, Andrew Moore, Chuck Volk, Chris Moughan, Lisa Miller, and Todd Marion.

Chairman Nagle stated that the Board received their electronic and hard copy of the Board packet in advance and asked if anyone did not receive their copy of the packet. A copy of the packet is also available online.

REVIEW OF AGENDA

There are no changes to the agenda but there will be an item for Staff comments.

APPROVAL OF MINUTES

August 23, 2021 Meeting Minutes

Richard Bohner noted a correction to the approval count on the minutes. The vote should be recorded as 7-0, not 6-0. On a motion by Richard Bohner, seconded by Scott Bieber, the Board approved the minutes of the August 23, 2021 Board meeting as corrected (8-0).

PUBLIC COMMENTS

None.

ACTION AND DISCUSSION ITEMS

Preliminary 2022 Budget Review

Liesel Gross reviewed the Authority's Budget development process that began in July. At today's meeting, staff will review the assumptions that are being incorporated into the 2022 Budget, and a preliminary review of the Budget figures will be provided at the next Board meeting in two weeks. Rates will be discussed at the first October meeting, and final Budget approval will be requested at the last meeting in October. The Authority's Budget is required to be approved by November 1st each year.

A presentation was shared with the Board to review the 2022 Budget assumptions, including a review of key factors by fund, preliminary Budget summary, and next steps.

Ms. Gross reviewed the expected impact of the COVID-19 pandemic on the 2022 Budget. The primary impact relates to recovery of past-due receivables, which increased significantly since March 2020. The Authority's customer assistance program and other collections efforts are intended to address this issue, and these efforts will continue in 2022.

Ms. Gross also reviewed several key strategic priorities that are being considered for addition to the 2022 Budget, and these items are being drawn from the preliminary Strategic Plan project that is still under way. Staffing needs to implement these strategies will be considered as the 2022 Budget proposal is being developed. Chairman Nagle asked for an explanation of the items listed in the strategic initiatives related to "onboarding." Ms. Gross explained that the Authority does not currently have a standard process for introducing new employees to the Authority's team, processes, culture, and training programs. In addition, when an employee is promoted into a supervisory position, the Authority does not have a standard orientation for those situations. The goals related to "onboarding" are referring to standardizing these processes.

Ms. Gross also reviewed other organizational issues affecting the 2022 Budget including compensation increases and insurance costs. Chairman Nagle asked if the workers compensation increase shown in the presentation is related to the Authority's performance or other factors. Ed Klein said this increase is being applied to all employers within the pool that the Authority participated in for workers compensation. He noted that while the increase is 16 percent, the Authority also expected to receive some credit funding back from the pool for strong performance, which will offset this increase.

Mr. Klein then reviewed the key factors that will impact the Authority by fund. In the Internal Services area, the 2022 Budget will be organized by department to increase visibility and accountability for expense management by the department managers. Within the Suburban Water fund, a key factor that will affect the 2022 Budget is the increase in water usage and rates related to the purchase of water from the Allentown system. Chairman Nagle asked if the Authority has considered increasing the use of groundwater wells to reduce the impact of the Allentown water cost increase. Phil DePoe explained that the Authority must develop a water supply plan to evaluate well supply capacity, and this study will take place in 2022. Mr. Klein noted that the Suburban Water rates will increase more than expected as a result of the additional expenses. Ms. Gross noted that a water rate study will be completed in 2022 to evaluate the rate structure since several major items have changed since the last rate study was completed. Jeff Morgan commented that the water purchase cost increase was tied to the updated water purchase agreement with Allentown, which ensures that capital costs for the water filtration plant are shared equitably among all municipalities. Scott Bieber asked if the rate study will be done in-house. Ms. Gross explained that the study is done by Keystone Alliance Consulting.

Mr. Klein then reviewed the Suburban Wastewater fund and key factors expected to impact the 2022 Budget. He noted that the sewer signatory revenues are being calculated and draft rates will be presented to the Authority Board and the signatories in October.

For the City Division, Mr. Klein explained the revenue impacts associated with the 2020 lease agreement amendment, with the next phase of rates going into effect on January 1, 2022. The 2020 bond refinancing will affect the debt service expenses in 2022. He also explained that some costs were previously classified as capital expenses, which now need to be moved into the operating budget. This will impact the operating budget by $610,000 in 2022.

The next steps include incorporating the strategic goals into the Budget, review of expenses in the Suburban Water and City Division funds, refine the borrowing requirements for Suburban Water

capital improvements, review Suburban Water rates, and review all capital improvements planned for 2022.

Mr. Klein showed the preliminary Budget figures in summary form, which are based on current assumptions as presented during the meeting. Scott Bieber asked what Suburban Water rates were included in the initial 2022 Budget results presented. Mr. Klein explained that he calculated the total revenue needed to cover the projected expenses, and this additional revenue equated to a 13 percent increase. Chairman Nagle and Ted Lyons both commented that they would like to see an explanation of the variances shown between 2021 Budget and 2021 Forecast. Kevin Baker commented about the effect of volume increases, and that over time the system growth could result in lower overall cost.

Suburban Division – Miscellaneous Act 537 Plan Updates

Phil DePoe gave a presentation regarding the regional Act 537 Sewage Facilities Plan, and the current work on the treatment alternatives analysis and financial planning tools.

Chairman Nagle asked for an explanation of the history of the regional plan and whether any prior regional sewage facilities plans have been completed. Mr. DePoe explained this would be the first regional Act 537 Plan for the Kline's Island Sewer System, and prior plans had been completed at the municipal level for each of the municipalities that use the system. He also noted that the last major upgrades to the regional system were completed in the 1970s and 1980s.

Mr. DePoe presented the two primary options to meet the future wastewater treatment capacity needs are: 1) continue to treat all wastewater at the Kline's Island Wastewater Treatment Plant in Allentown, which would need upgrades for dry-day and wet-weather flows; and 2) upgrade the Authority's Pretreatment Plant (PTP) in Fogelsville to a full treatment facility, which would require a Lehigh River discharge location and also dry-day and wet-weather upgrades. He explained that AECOM, Jacobs and Arcadis worked together since last year to study the PTP upgrade option with the goal of determining whether it is feasible and whether it should be retained as an option for the full alternatives analysis that will occur between 2021 and 2025 for the Act 537 planning process. The alternatives analysis covers regional sewer system needs from 2026 through 2050. The presentation reviewed the major assumptions and cost factors that were evaluated as part of this engineering study. The team also evaluated the Kline's Island option from a cost perspective to ensure the costs were being analyzed using comparable economic factors for inflation and construction considerations. The results showed the Kline's Island option would cost $386 million to $418 million. The PTP upgrade option would cost $436 million. Mr. DePoe explained these figures include the conveyance system upgrades that are needed in addition to the treatment plant upgrades. The costs are based on current construction prices, which may come down in the future as current pricing is highly inflated.

Chairman Nagle asked if all the municipal collection system improvements to remove inflow and infiltration (I&I) had been factored into these costs. Mr. DePoe explained the study only included cost evaluations for the regional components of the system. I&I reduction programs and system rehabilitation would be factored into the analysis at a later date.

Jeff Morgan asked if there were other options for a new discharge location that would be less costly due to the distance from the PTP, such as the Jordan Creek. Liesel Gross said the Jordan Creek discharge location was studied previously and ruled out due to stringent permit requirements that made this option cost prohibitive. Regarding the wet-weather improvements at the Kline's Island Wastewater Treatment Plant, Mr. Morgan asked if blending is still an option. Mr. DePoe explained

that the blending option was no longer being considered, but alternatives for wet-weather management at the plant are still under evaluation including the option of installing equalization tanks to hold back peak flows during wet-weather events.

Amir Famili asked if the cost escalations due to current economic conditions was factored into all of the options presented, and if any of the options were affected more by the current inflation of construction materials pricing. He also asked if operations and maintenance costs of each option were considered. Mr. DePoe explained that all options were analyzed based on current pricing for materials. Some components, such as pipe materials, are affected more by the current economic factors, so that was included in the cost estimates for the options that have more emphasis on conveyance system improvements. Operations and maintenance costs were not included in the current analysis but will be discussed and analyzed as the planning effort continues.

There was some additional discussion about the treatment alternatives and the benefits of the PTP upgrade option. The downstream conveyance system improvements would be significantly reduced if the PTP upgrade option is implemented, which may have environmental benefits. Mr. DePoe explained that due to these potential benefits, and because the cost difference between the options is not significant at this level of analysis, the PTP upgrade option would be included in the overall Act 537 Plan alternatives analysis that will be completed in the upcoming years. The next step in this evaluation is to consider major factors such as construction challenges, permitting, community drivers, environmental impact, sequencing, and the existing intermunicipal agreement structure.

Jeff Morgan left the meeting at 1:41 p.m.

Solicitor Mike Gaul asked if the alternatives evaluation included a review of land acquisition required for the projects. Mr. DePoe said land acquisition would be a major factor for either of the two treatment alternatives included in the study. The costs are included in the estimates, but the need to acquire significant easements would be evaluated further and will put pressure on the construction schedule for either option.

Scott Bieber left the meeting at 1:45 p.m.

Mr. DePoe presented an update on the Revenue Planning Tool, which was authorized by the Board in December 2020. The Revenue Planning Tool was developed in collaboration with AECOM to capture the financial obligations currently structured within the intermunicipal sewer agreements, so that the municipalities and the Authority can better understand the impact of the alternatives that are being considered within the Act 537 Planning process. The intermunicipal agreements are complex, and it is difficult to model financial impacts over time when there are multiple projects that would be phased in over many years. The tool is spreadsheet based in Microsoft Excel so staff will be able to use it to analyze a variety of scenarios. The tool allows up to 10 projects to be included in a single scenario, with each of the individual projects phased in over time.

Mr. DePoe displayed some examples of the inputs that could be entered into the Revenue Planning Tool, including project details by year, operations and maintenance costs, and capital costs with contingencies. The outputs of the financial model include cash flow impacts by municipality and by Authority fund, and net present value.

Some Board discussion followed regarding the use of the Revenue Planning Tool to analyze the treatment alternatives discussed previously. Mr. DePoe explained that Authority staff would be conducting extensive testing of the Revenue Planning Tool and the PTP upgrade option discussed previously could be used as a test case to learn how to use the model.

Chairman Nagle commented that the intermunicipal agreements are very complex and that the Revenue Planning Tool might help the Authority and the municipalities determine how to simplify the agreements. Liesel Gross explained that a review of the intermunicipal agreements is also part of the Act 547 Planning process, and the Pa. Department of Environmental Protection is looking for regional approaches to be considered. This will require the intermunicipal agreements to be reviewed and possibly revised. The Revenue Planning Tool is currently structured to evaluate financial impacts using the structure of the existing agreements. If the intermunicipal agreements are revised, the tool would need to be modified to analyze the new terms of the agreements at that time.

MONTHLY PROJECT UPDATES/INFORMATION ITEMS

Liesel Gross reviewed the September 2021 project update report that was sent out with the Board packet and highlighted key action and discussion items that will be on the agenda for upcoming meetings. She noted that the Strategic Planning work is moving forward and will be presented in October or November. Small group meetings are being scheduled with Board members over the next week to review progress to date. Board members who have not yet responded to the schedule request for these meetings should get back to Ms. Gross as soon as possible.

STAFF COMMENTS

Liesel Gross noted that the Strategic Plan item was already covered in the prior item and there were no further staff comments.

SOLICITOR'S COMMENTS

None.

PUBLIC COMMENTS / OTHER COMMENTS

None.

EXECUTIVE SESSION

None.

ADJOURNMENT

There being no further business, the Chairman adjourned the meeting at 2:00 p.m.

Richard Bohner
Secretary

LEHIGH COUNTY AUTHORITY 1053 SPRUCE ROAD, PO BOX 3348, ALLENTOWN, PA 18106
Phone: (610-398-2503); FAX (610-351-8363)

MEMORANDUM

Date Presented: September 27, 2021

To: Lehigh County Authority Board of Directors

From: Edward Klein, Chief Financial Officer

Subject: 2022 Minimum Municipal Obligation (MMO) for the Lehigh County Authority Pension Plan (39-448-6N)

Act 205 of 1984, as amended, governs the funding requirements for all municipal pension plans. The law requires the Chief Administrative Officer of each pension plan to inform the governing board of the municipality of the plan's expected financial obligation for the coming year. This must be done by the last business day in September.

The calculation of the 2022 MMO required an estimate of the 2021 W-2 wages of the employees covered by the plan. I have indicated on the attached worksheet my best estimate of the same. Questions on the pension cost calculation may be addressed to either myself or the Pennsylvania Municipal Retirement System at (800) 622-7968.

The MMO is the municipality's 2022 bill for this pension plan and must be paid by December 31, 2022. The obligation must be met with general fund monies or with any General State Aid to Municipal Pensions to which we may be entitled to under Act 205.

Edward Klein
Chief Financial Officer
edwardklein@lehighcountyauthority.org
(610) 398-2503, extension 160

Attachment: 2022 MMO Worksheet

The Minimum Municipal Obligation Worksheet (MMO)
For The
Lehigh County Authority Pension Plan (39-100-8 N)
For Plan Year 2022

CHARGES

Estimated 2021 W-2 Payroll For Covered Plan Members:	(A)	$10,239,737.21	
PMRS Determined Normal Cost Expressed as a Decimal:	(B)	.1205	
RESULT: (A) * (B) =			(C) $1,233,888.33
Administrative Charge (PMRS Determined) # of Plan Members times $20:			(D) 4,160.00
Amortization of Unfunded Liability (PMRS Determined)			(E) 474,640.00
TOTAL CHARGES: (C) + (D) + (E) =			(F) $1,712,688.33

CREDITS

Repeat Estimated 2021 W-2 Payroll For Covered Plan Members:	(A)	$10,239,737.21	
Employee Contribution Rate Expressed as a Decimal:	(G)	.01	
RESULT: (A) * (G) =			(H) $102,397.37
Amortization of the Actuarial Surplus (PMRS Determined)			(I) 0.00
TOTAL CREDITS: (H) + (I) =			(J) $102,397.37

MINIMUM MUNICIPAL OBLIGATION
(Based on 1/1/2019 Actuarial Valuation) **(MMO)** $1,610,290.96

Equals TOTAL CHARGES Minus
TOTAL CREDITS (F) - (J) = **(Please round numbers to dollars)**

Prepared By: Kathy A. Martin (Name) Kathy A. Martin (Signature)

Human Resources Manager (Title) 610 351 6322 (Telephone #)

Please complete the above worksheet with your best estimates and return a copy to the Pennsylvania Municipal Retirement System by October 4. The official copy must be shared with the plan's governing board by the last business day in September.

MEMORANDUM

Date: September 27, 2021

To: Lehigh County Authority Board of Directors

From: Charles Volk, P.E., and Jason Peters, Capital Works Project Coordinator

Subject: Suburban Division – Heidelberg Heights Sanitary Sewer Rehabilitation (Phases 4 & 5) – Construction Phase

MOTIONS / APPROVALS REQUESTED:

Construction Phase bid authorization.

No.	Item	Amount
1	Capital Project Authorization – Construction Phase	$558,630
2	Contract Award (construction)	$498,630
*	General Construction – Barrasso Excavation, Inc.	
3	Professional Services Authorization	$27,500
*	Construction Inspection – Keystone Consulting Engineers	

(*) Included in the Capital Project Authorization.

BACKGROUND

Annual sanitary sewer rehabilitation projects are required by DEP as part of the Heidelberg Heights Sanitary Sewer System Consent Order and Agreement (CO&A), which was executed by DEP and LCA in Spring 2019. The CO&A mandates implementation of a Corrective Action Plan (CAP), which was submitted to DEP in 2019 and is incorporated into the CO&A. The CO&A commits LCA to eliminating hydraulic overloads and bypasses at the Heidelberg Heights Wastewater Treatment Plant, which are caused by wet weather inflow and infiltration into the sanitary sewage collection system. The CO&A contains an implementation schedule that mandates the replacement of all original vitrified clay pipe (VCP) main line and public sewer laterals in the sanitary sewer system within five years. LCA is on schedule to satisfy the pipe replacement milestones of the CO&A.

PROJECT OVERVIEW

The original Phase 4 sanitary sewer rehabilitation project was bid in Spring 2021. LCA recommended rejection of bids at the April 26, 2021 Board meeting due to construction cost exceeding budget and lack of competitive bids. This project represents a "re-packaging" of that project with an expansion in scope to include the Phase 5 work as well, in an attempt to gain economy of scale. The Phase 4 work consists of the replacement of approximately 700 feet of 8-inch VCP sewer main and 20 residential sewer laterals along Thomson Street in the Heidelberg Heights sanitary sewage system. The Phase 5 work consists of the replacement of approximately 820 feet of 8-inch VCP sewer main and 12 residential sewer laterals along Glen Court in the development. Sewer laterals are to be replaced to the property line with a cleanout assembly installed

on each one. Existing manhole structures are to be re-used, with new frames, covers and watertight manhole chimney wrap to be installed, along with new watertight gaskets at manhole pipe connections. The contractor is responsible for temporary measures, including bypass pumping, in order to minimize sanitary sewer service disruption. Permanent roadway and lawn area restoration is included.

FUNDING
The annual projects are funded by the LCA Suburban Division.

BUDGET AMENDMENT
Not required

PROJECT STATUS
Board authorization of construction phase.

THIS APPROVAL – CONSTRUCTION PHASE BIDS:

BIDDING SUMMARY
This project consists of one contract. The project was advertised for bid via PennBid in August 2021 and bids were opened on September 15, 2021. Bids results are follows:

General Construction	
Bidder	**Bid Amount**
Barrasso Excavation, Inc.	**$498,630**
Doli Construction Corporation	**$638,320**
Joao & Bradley Co., Inc.	**$780,400**
Anrich, Inc.	**$816,182**
James T. O'Hara, Inc.	**$840,650**

The low bid was submitted by Barrasso Excavation, Inc., located in Oley, PA. The bid amount is in line with Capital Works' internal construction estimate and within the annual project budget amount (note this cost represents two annual projects). The Contractor has performed numerous similar sanitary sewer, storm sewer, and water utility projects in Berks County and surrounding areas and appears qualified to perform the work. The bid documents are satisfactory and LCA recommends award of bid to Barrasso Excavation, Inc.

PROFESSIONAL SERVICES
LCA's Capital Works staff will perform the day-to-day construction management and administration duties. Keystone Consulting Engineers will provide the following construction phase services:

- Provide full time construction inspection services
- Prepare daily inspection reports
- Verify daily job quantities
- Document installation (post construction photos)
- Attend progress meetings as required

- Prepare and verify punchlist completion
- Perform final inspection

PROJECT SCHEDULE

Based on LCA Board authorization of construction phase at the September 27 Board meeting, the Phase 4 work shall be completed prior to year end 2021, with the Phase 5 work to be finished by Spring 2022.

FUTURE AUTHORIZATIONS

Phase 6 sewer replacement project 2023 (final phase).

CAPITAL PROJECT AUTHORIZATION

PROJECT NO.:	SD-S-17	**BUDGET FUND:**	Suburban Div\Wastewater\Capital
PROJECT TITLE:	Suburban Division – Heidelberg Heights Sanitary Sewer Rehabilitation Project	**PROJECT TYPE:**	
		☒	Construction
		☐	Engineering Study
THIS AUTHORIZATION:	**$558,630**	☐	Equipment Purchase
TO DATE (W/ ABOVE)	**$558,630**	☐	Amendment

DESCRIPTION AND BENEFITS:

Heidelberg Heights Sanitary Sewer Rehabilitation Project (Phases 4 and 5):
This project is part of the annual sewer rehabilitation program in the Heidelberg Heights sanitary sewer system in accordance with the DEP Consent Order and Corrective Action Plan. The project consists of the replacement of approximately 1,520 feet of 8-inch sewer main pipe, replacement of 32 residential sewer laterals to the property line, lateral cleanout assembly installations, rehabilitation of manholes, and final restoration.

Previous Authorizations	
none	

REQUESTED THIS AUTHORIZATION	
Construction Phase	
Construction Contract – Barrasso Excavation, Inc.	$498,630
Construction Inspection Services – Keystone Consulting Engineers	$27,500
Staff	$7,500
Contingency	$25,000
Total This Authorization	**$558,630**

Future Authorization	
Annual sewage collection system rehabilitation projects	TBD

REVIEW AND APPROVALS:

Project Manager	Date	Chief Executive Officer	Date
Chief Capital Works Officer	Date	Chairman	Date

Lehigh County Authority

1053 Spruce Street * P.O. Box 3348 * Allentown, PA 18106-0348
(610)398-2503 * FAX (610)398-8413 * Email: service@lehighcountyauthority.org

PROFESSIONAL SERVICES AUTHORIZATION

Professional: KEYSTONE CONSULTING ENGINEERS
5012 Medical Center Circle,
Allentown, PA 18106

Date: September 27, 2021

Requested By: Jason Peters

Approvals

Department Head: _____

Chief Executive Officer: _____

Description of Services:

Suburban Division Facilities – Heidelberg Heights Sanitary Sewer Rehabilitation Project (Phases 4 and 5): Construction Inspection Services

Keystone Consulting Engineers, Inc. will perform construction phase inspection services for the construction of the Heidelberg Heights 2021 Sanitary Sewer Rehabilitation Project, in accordance with their proposal. The scope of services includes the following:

Professional Services
1. Attend pre-construction conference
2. Attend progress meetings
3. Draft contractor payment application review
4. Perform full time field inspection services
5. Perform Substantial Completion inspection and issue punchlist to LCA
6. Perform Final Completion inspection

.

Cost Estimate (not to be exceeded without further authorization): $27,500

Time Table and Completion Deadline: Assumes Phase 4 work will be substantially completed by the end of 2021, and Phase 5 will be substantially completed by Spring 2022.

(For Authority Use Only)

Authorization Completion:

Approval: _____ **Actual Cost:** _____ **Date:** _____

LEHIGH COUNTY AUTHORITY
FINANCIAL STATEMENTS
AUGUST 2021

LEHIGH COUNTY AUTHORITY
FINANCIAL STATEMENTS - SUMMARY
For the Period Ended August 31, 2021

	Consolidated Financial Statements														
	Month					Year To Date					FULL YEAR				
	Actual	Q3 FC	Prior Year	FC Var	PY Var	Actual	Q3 FC	Prior Year	FC Var	PY Var	Q3 FC	Budget	Prior Year	Bud Var	PY Var
Income Statement															
Suburban Water	(167,032)	(56,969)	(207,149)	(110,062)	40,117	555,202	713,832	1,002,008	(158,630)	(446,807)	1,139,599	183,548	456,932	956,051	682,667
Suburban Wastewater	(210,052)	(96,070)	126,730	(113,982)	(336,782)	1,702,048	1,855,679	3,606,684	(153,631)	(1,904,636)	1,361,873	1,175,879	2,774,420	185,994	(1,412,547)
City Division	771,572	636,333	(184,950)	135,239	956,522	3,334,185	3,109,339	(2,253,114)	224,846	5,587,299	(2,674,680)	865,692	(4,289,351)	(3,540,372)	1,614,672
Total LCA	394,488	483,293	(265,369)	(88,805)	659,857	5,591,435	5,678,850	2,355,579	(87,415)	3,235,856	(173,208)	2,225,119	(1,058,000)	(2,398,327)	884,792
Cash Flow Statement															
Suburban Water	184,545	159,302	(267,700)	25,243	452,244	464,677	411,451	(965,453)	53,226	1,430,130	(1,990,748)	(3,490,153)	(3,715,921)	1,499,405	1,725,174
Suburban Wastewater	1,018,782	879,500	(2,023,892)	139,282	3,042,674	856,802	751,692	(820,220)	105,110	1,677,023	4,011,826	2,321,828	448,089	1,689,999	3,563,737
City Division	1,243,765	1,115,450	2,473,609	128,315	(1,229,844)	8,217,580	7,997,459	1,274,722	220,121	6,942,858	2,766,312	4,663,547	2,036,187	(1,897,235)	730,126
Total LCA	2,447,091	2,154,252	182,018	292,840	2,265,074	9,539,059	9,160,602	(510,951)	378,457	10,050,011	4,787,391	3,495,222	(1,231,645)	1,292,169	6,019,036
Debt Service Coverage Ratio															
Suburban Water	0.79	0.95	0.41	(0.16)	0.38	1.50	1.54	1.42	(0.04)	0.08	1.65	1.20	1.26	0.45	0.39
Suburban Wastewater	3.12	4.98	8.95	(1.85)	(5.82)	10.06	10.38	14.45	(0.31)	(4.39)	10.23	8.17	12.61	2.06	(2.38)
City Division	2.23	2.15	1.79	0.08	0.44	1.93	1.91	1.69	0.02	0.24	1.51	1.62	1.40	(0.11)	0.11

LEHIGH COUNTY AUTHORITY
CONSOLIDATED FINANCIAL STATEMENTS
For the Period Ended August 31, 2021

	Consolidated Financial Statements															
	Month				Year To Date				Q3 FULL YEAR FORECAST				Full Year Budget			
STATEMENTS OF ACTIVITIES	**Sub W**	**Sub WW**	**City**	**LCA**	**Sub W**	**Sub WW**	**City**	**LCA**	**Sub W**	**Sub WW**	**City**	**LCA**	**Sub W**	**Sub WW**	**City**	**LCA**
Operating Revenues:																
User Charges	917,840	1,264,589	4,034,763	6,217,192	8,055,485	12,221,791	28,042,139	48,319,415	12,363,189	20,042,968	42,074,272	74,480,429	11,799,441	19,166,369	41,996,514	72,962,324
Connection & System Charges	122,357	221,171	146,262	489,790	594,677	774,284	1,799,571	3,168,533	929,234	866,588	2,867,867	4,663,690	912,039	865,588	3,947,981	5,725,607
Other Miscellaneous Revenues	15,269	30,145	41,405	86,819	45,529	32,091	89,764	167,384	32,750	2,225	66,807	101,782	30,944	628	59,249	90,821
Total Operating Revenues	**1,055,466**	**1,515,905**	**4,222,430**	**6,793,801**	**8,695,692**	**13,028,166**	**29,931,475**	**51,655,332**	**13,325,173**	**20,911,781**	**45,008,946**	**79,245,900**	**12,742,423**	**20,032,585**	**46,003,744**	**78,778,752**
Operating Expenses:																
Personnel	292,427	125,481	886,019	1,303,927	2,064,837	833,410	7,005,468	9,903,715	2,863,952	1,431,249	11,609,699	15,904,900	3,289,603	1,760,954	11,561,494	16,612,051
Shared Services - General & Administrative	126,852	52,484	235,927	415,264	431,841	174,213	1,134,037	1,740,091	647,961	191,599	1,585,674	2,425,234	663,734	155,415	1,739,417	2,558,565
Utilities	35,962	23,967	138,731	198,660	292,658	189,957	1,197,079	1,679,694	437,393	295,244	1,855,844	2,588,481	543,917	449,484	2,156,620	3,150,021
Materials and Supplies	38,930	13,497	114,434	166,861	243,295	98,184	882,967	1,224,446	338,588	230,668	1,445,412	2,014,667	501,582	500,563	1,765,642	2,767,787
Miscellaneous Services	351,725	610,992	186,008	1,148,725	2,342,488	4,224,802	834,349	7,401,638	3,719,855	6,620,131	1,738,302	12,078,289	3,564,076	6,358,021	1,979,996	11,902,093
Treatment and Transportation	-	509,165	-	509,165	-	2,560,759	5,813	2,566,572	-	3,712,079	12,165	3,724,244	-	3,977,539	12,000	3,989,539
Depreciation and Amortization	217,141	384,727	491,154	1,093,022	1,737,128	3,077,816	3,929,232	8,744,176	2,948,963	5,937,183	6,117,396	15,003,542	2,605,699	4,616,783	5,893,862	13,116,343
Major Maintenance Expenses	(141)	(2,001)	13,758	11,616	2,876	69,230	547,927	620,033	2,876	1,000,000	4,206,200	5,209,076	3,400	1,000,000	2,652,924	3,656,324
Other Miscellaneous	-	-	-	-	-	-	-	-	53,217	36,000	-	89,217	74,864	46,422	13,972	135,258
Total Operating Expenses	**1,062,896**	**1,718,312**	**2,066,031**	**4,847,240**	**7,115,122**	**11,228,371**	**15,536,870**	**33,880,364**	**11,012,805**	**19,454,153**	**28,570,692**	**59,037,650**	**11,246,874**	**18,865,181**	**27,775,927**	**57,887,982**
Net Operating Profit	**(7,430)**	**(202,408)**	**2,156,399**	**1,946,561**	**1,580,569**	**1,799,794**	**14,394,605**	**17,774,968**	**2,312,368**	**1,457,628**	**16,438,254**	**20,208,251**	**1,495,549**	**1,167,404**	**18,227,817**	**20,890,770**
Non-Operating Income (Expense)																
Interest Income	3,965	6,093	(2,092)	7,966	32,586	60,710	1,460	94,757	49,142	86,240	172,960	308,343	94,327	190,471	172,960	457,758
Interest (Expense)	(162,641)	(15,562)	(1,382,735)	(1,560,938)	(909,005)	(124,869)	(11,061,880)	(12,095,754)	(1,221,912)	(181,995)	(19,285,894)	(20,689,801)	(1,406,328)	(181,995)	(17,535,086)	(19,123,409)
Other Miscellaneous	(926)	1,824	-	899	(148,948)	(33,588)	-	(182,536)	-	-	-	-	-	-	-	-
Net Non-Operating Income (Expense)	(159,602)	(7,644)	(1,384,827)	(1,552,073)	(1,025,368)	(97,746)	(11,060,420)	(12,183,533)	(1,172,770)	(95,755)	(19,112,934)	(20,381,458)	(1,312,001)	8,475	(17,362,125)	(18,665,651)
Net Income (Loss)	**(167,032)**	**(210,052)**	**771,572**	**394,488**	**555,202**	**1,702,048**	**3,334,185**	**5,591,435**	**1,139,599**	**1,361,873**	**(2,674,680)**	**(173,208)**	**183,548**	**1,175,879**	**865,692**	**2,225,119**
CASH FLOW STATEMENT																
Cash Flows From Operating Activities																
Operating Revenues	1,055,466	1,515,905	4,222,430	6,793,801	8,695,692	13,028,166	29,931,475	51,655,332	13,325,173	20,911,781	45,008,946	79,245,900	12,742,423	20,032,585	46,003,744	78,778,752
Operating Expenses (ex D&A)	(845,755)	(1,333,585)	(1,574,877)	(3,754,218)	(5,377,994)	(8,150,555)	(11,607,638)	(25,136,188)	(8,063,842)	(13,516,970)	(22,453,296)	(44,034,108)	(8,641,176)	(14,248,398)	(21,882,064)	(44,771,639)
Non-Cash Working Capital Changes	175,316	940,207	(1,184,080)	(68,558)	(1,148,460)	(777,741)	(658,181)	(2,584,382)	(20,734)	952,935	(1,091,273)	(159,072)	3,418	(0)	50,001	53,419
Net Cash Provided by (Used in) Operating Activities	385,027	1,122,526	1,463,473	2,971,025	2,169,237	4,099,869	17,665,655	23,934,762	5,240,598	8,347,746	21,464,377	35,052,721	4,104,666	5,784,186	24,171,680	34,060,532
Cash Flows From Financing Activities																
Capital Contributions	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proceeds New Borrowing	-	-	-	-	21,679,902	-	-	21,679,902	21,679,902	-	-	21,679,902	-	-	2,000,000	2,000,000
Interest Payments	(1,387)	(12,879)	-	(14,266)	(840,277)	(110,625)	(5,772,543)	(6,723,445)	(1,242,211)	(181,995)	(11,565,086)	(12,989,292)	(1,406,328)	(181,995)	(11,565,086)	(13,153,409)
Principal Payments	(18,681)	(45,879)	-	(64,560)	(20,744,251)	(364,921)	-	(21,109,172)	(23,649,095)	(549,034)	(2,660,831)	(26,858,960)	(2,092,818)	(549,034)	(2,660,831)	(5,302,683)
Net Cash Provided by (Used in) Financing Activities	(20,068)	(58,758)	-	(78,826)	95,374	(475,546)	(5,772,543)	(6,152,715)	(3,211,404)	(731,029)	(14,225,917)	(18,168,350)	(3,499,146)	(731,029)	(12,225,917)	(16,456,092)
Cash Flows from Capital and Related Activities																
Non-Operating Income (Expenses)	(926)	1,824	-	899	(148,948)	(33,588)	(615,300)	(797,836)	-	-	(1,230,600)	(1,230,600)	-	-	(1,230,600)	(1,230,600)
Capital Expenditures, net	(183,454)	(56,904)	(217,616)	(457,973)	(1,683,255)	(2,055,643)	(3,061,692)	(6,800,590)	(4,068,784)	(2,952,131)	(3,414,508)	(10,435,423)	(4,190,000)	(2,921,800)	(6,224,576)	(13,336,376)
Net Cash Provided By (Used In) Capital and Related Activ	(184,379)	(55,080)	(217,616)	(457,075)	(1,832,203)	(2,089,231)	(3,676,992)	(7,598,426)	(4,068,784)	(2,952,131)	(4,645,108)	(11,666,023)	(4,190,000)	(2,921,800)	(7,455,176)	(14,566,976)
Cash Flows From Investing Activities																
Investments Converting To Cash	-	249,000	-	249,000	244,682	1,978,000	-	2,222,682	244,700	1,978,000	-	2,222,700	-	-	-	-
Purchased Invesments	-	(245,000)	-	(245,000)	(245,000)	(2,717,000)	-	(2,962,000)	(245,000)	(2,717,000)	-	(2,962,000)	-	-	-	-
Interest Income	3,965	6,093	(2,092)	7,966	32,586	60,710	1,460	94,757	49,142	86,240	172,960	308,343	94,327	190,471	172,960	457,758
Net Cash Provided By (Used In) Investing Activities	3,965	10,093	(2,092)	11,966	32,268	(678,290)	1,460	(644,561)	48,842	(652,760)	172,960	(430,957)	94,327	190,471	172,960	457,758
FUND NET CASH FLOWS	**184,545**	**1,018,782**	**1,243,765**	**2,447,091**	**464,677**	**856,802**	**8,217,580**	**9,539,059**	**(1,990,748)**	**4,011,826**	**2,766,312**	**4,787,391**	**(3,490,153)**	**2,321,828**	**4,663,547**	**3,495,222**
DEBT SERVICE RATIO																
Debt Service Ratio (Indenture Based)																
Total Operating Revenues	917,840	1,264,589	4,034,763	6,217,192	8,055,485	12,221,791	28,042,139	48,319,415	12,363,189	20,042,968	42,074,272	74,480,429	11,799,441	19,166,369	41,996,514	72,962,324
Total Operating Expenses (Cash Based)	(845,755)	(1,333,585)	(1,574,877)	(3,754,218)	(5,377,994)	(8,150,555)	(11,607,638)	(25,136,188)	(8,063,842)	(13,516,970)	(22,453,296)	(44,034,108)	(8,641,176)	(14,248,398)	(21,882,064)	(44,771,639)
Interest Income	3,965	6,093	(2,092)	7,966	32,586	60,710	1,460	94,757	49,142	86,240	172,960	308,343	94,327	190,471	172,960	457,758
Annual Lease Payment (City)	-	-	-	-	-	-	-	-	-	-	(1,230,600)	(1,230,600)	-	-	(1,230,600)	(1,230,600)
Total Non-Operating Revenues (Expenses)	136,700	253,140	187,667	577,507	491,258	772,787	1,889,336	3,153,381	961,984	868,813	2,934,675	4,765,472	942,983	866,216	4,007,230	5,816,428
Cash Available For Debt Service	212,751	190,237	2,645,461	3,048,448	3,201,335	4,904,733	18,325,297	26,431,365	5,310,474	7,481,051	21,498,010	34,289,535	4,195,575	5,974,657	23,064,040	33,234,271
Interest Paid	103,518	15,166	963,757	1,082,441	828,140	121,330	7,710,057	8,659,528	1,242,211	181,995	11,565,086	12,989,292	1,406,328	181,995	11,565,086	13,153,409
Debt Retirement (Principal Payments)	164,099	45,753	221,736	431,588	1,312,795	366,023	1,773,887	3,452,705	1,969,193	549,034	2,660,831	5,179,058	2,092,818	549,034	2,660,831	5,302,683
Total Debt Service	267,617	60,919	1,185,493	1,514,029	2,140,936	487,353	9,483,945	12,112,233	3,211,404	731,029	14,225,917	18,168,350	3,499,146	731,029	14,225,917	18,456,092
Debt Service Ratio	**0.79**	**3.12**	**2.23**	**2.01**	**1.50**	**10.06**	**1.93**	**2.18**	**1.65**	**10.23**	**1.51**	**1.89**	**1.20**	**8.17**	**1.62**	**1.80**

LEHIGH COUNTY AUTHORITY
FINANCIAL STATEMENTS - SUBURBAN WATER
For the Period Ended August 31, 2021

	Suburban - Water														
	Month					Year To Date					Full Year				
STATEMENTS OF ACTIVITIES	**Actual**	**Q3 FC**	**Prior Yr**	**FC Var**	**PY Var**	**Actual**	**Q3 FC**	**Prior Yr**	**FC Var**	**PY Var**	**Q3 FC**	**Budget**	**Prior Yr**	**Bud Var**	**PY Var**
Operating Revenues:															
User Charges	917,840	942,301	885,223	(24,461)	32,617	8,055,485	8,079,946	7,046,419	(24,461)	1,009,066	12,363,189	11,799,441	10,866,675	563,749	1,496,514
Connection & System Charges	122,357	91,383	21,624	30,974	100,732	594,677	563,703	469,231	30,974	125,447	929,234	912,039	860,596	17,195	68,638
Other Miscellaneous Revenues	15,269	1,455	1,260	13,814	14,009	45,529	26,930	14,345	18,599	31,184	32,750	30,944	105,508	1,806	(72,758)
Total Operating Revenues	**1,055,466**	**1,035,139**	**908,107**	**20,327**	**147,359**	**8,695,692**	**8,670,579**	**7,529,995**	**25,112**	**1,165,696**	**13,325,173**	**12,742,423**	**11,832,779**	**582,750**	**1,492,394**
Operating Expenses:															
Personnel	292,427	273,567	141,789	(18,859)	(150,637)	2,064,837	2,046,037	1,271,978	(18,801)	(792,859)	2,863,952	3,289,603	2,576,812	425,651	(287,140)
Shared Services - General & Administrative	126,852	124,114	116,456	(2,738)	(10,396)	431,841	535,522	592,750	103,681	160,909	647,961	663,734	300,465	15,772	(347,496)
Utilities	35,962	36,182	35,473	220	(490)	292,658	292,877	260,920	220	(31,737)	437,393	543,917	419,493	106,524	(17,900)
Materials and Supplies	38,930	41,270	40,460	2,340	1,531	243,295	234,112	181,417	(9,183)	(61,878)	338,588	501,582	279,430	162,994	(59,158)
Miscellaneous Services	351,725	308,970	441,902	(42,755)	90,177	2,342,488	2,299,447	1,648,665	(43,041)	(693,823)	3,719,855	3,564,076	3,645,096	(155,779)	(74,759)
Treatment and Transportation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Depreciation and Amortization	217,141	217,141	220,000	-	2,859	1,737,128	1,737,128	1,760,000	-	22,872	2,948,963	2,605,699	2,948,963	(343,264)	(0)
Major Maintenance Expenses	(141)	(141)	1,907	-	2,048	2,876	2,876	7,167	-	4,291	2,876	3,400	-	524	(2,876)
Other Miscellaneous	-	-	-	-	-	-	-	-	-	-	53,217	74,864	-	21,647	(53,217)
Total Operating Expenses	**1,062,896**	**1,001,103**	**997,987**	**(61,793)**	**(64,909)**	**7,115,122**	**7,147,999**	**5,722,898**	**32,877**	**(1,392,225)**	**11,012,805**	**11,246,874**	**10,170,259**	**234,070**	**(842,546)**
Net Operating Profit	**(7,430)**	**34,036**	**(89,880)**	**(41,466)**	**82,450**	**1,580,569**	**1,522,580**	**1,807,097**	**57,989**	**(226,528)**	**2,312,368**	**1,495,549**	**1,662,520**	**816,819**	**649,848**
Non-Operating Income (Expense)															
Interest Income	3,965	4,104	4,301	(139)	(336)	32,586	32,725	57,406	(139)	(24,820)	49,142	94,327	74,821	(45,185)	(25,679)
Interest (Expense)	(162,641)	(95,110)	(119,586)	(67,532)	(43,055)	(909,005)	(841,474)	(865,127)	(67,532)	(43,878)	(1,221,912)	(1,406,328)	(1,442,776)	184,416	220,864
Other Miscellaneous	(926)	-	(1,984)	(926)	1,058	(148,948)	-	2,632	(148,948)	(151,580)	-	-	162,366	-	(162,366)
Net Non-Operating Income (Expense)	**(159,602)**	**(91,005)**	**(117,269)**	**(68,596)**	**(42,333)**	**(1,025,368)**	**(808,749)**	**(805,089)**	**(216,619)**	**(220,278)**	**(1,172,770)**	**(1,312,001)**	**(1,205,589)**	**139,231**	**32,819**
Net Income (Loss)	**(167,032)**	**(56,969)**	**(207,149)**	**(110,062)**	**40,117**	**555,202**	**713,832**	**1,002,008**	**(158,630)**	**(446,807)**	**1,139,599**	**183,548**	**456,932**	**956,051**	**682,667**
CASH FLOW STATEMENT															
Cash Flows From Operating Activities															
Operating Revenues	1,055,466	1,035,139	908,107	20,327	147,359	8,695,692	8,670,579	7,529,995	25,112	1,165,696	13,325,173	12,742,423	11,832,779	582,750	1,492,394
Operating Expenses (ex D&A)	(845,755)	(783,962)	(777,987)	(61,793)	(67,768)	(5,377,994)	(5,410,871)	(3,962,898)	32,877	(1,415,097)	(8,063,842)	(8,641,176)	(7,221,296)	577,334	(842,546)
Non-Cash Working Capital Changes	175,316	174,399	(71,845)	917	247,160	(1,148,460)	(1,148,442)	(683,706)	(18)	(464,754)	(20,734)	3,418	(87,537)	(24,152)	66,804
Net Cash Provided by (Used in) Operating Activities	**385,027**	**425,576**	**58,276**	**(40,549)**	**326,751**	**2,169,237**	**2,111,266**	**2,883,392**	**57,971**	**(714,154)**	**5,240,598**	**4,104,666**	**4,523,946**	**1,135,932**	**716,652**
Cash Flows From Financing Activities															
Capital Contributions	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proceeds New Borrowing	-	-	-	-	-	21,679,902	21,679,902	-	-	21,679,902	21,679,902	-	-	21,679,902	21,679,902
Interest Payments	(1,387)	(3,253)	-	1,866	(1,387)	(840,277)	(919,818)	(727,206)	79,541	(113,071)	(1,242,211)	(1,406,328)	(1,756,050)	164,117	513,839
Principal Payments	(18,681)	(31,125)	(30,955)	12,444	12,274	(20,744,251)	(20,755,636)	(246,074)	11,386	(20,498,176)	(23,649,095)	(2,092,818)	(2,081,390)	(21,556,277)	(21,567,705)
Net Cash Provided by (Used in) Financing Activities	**(20,068)**	**(34,378)**	**(30,955)**	**14,310**	**10,887**	**95,374**	**4,447**	**(973,280)**	**90,927**	**1,068,654**	**(3,211,404)**	**(3,499,146)**	**(3,837,440)**	**287,742**	**626,037**
Cash Flows from Capital and Related Activities															
Non-Operating Income (Expenses)	(926)	-	(1,984)	(926)	1,058	(148,948)	-	2,632	(148,948)	(151,580)	-	-	162,366	-	(162,366)
Capital Expenditures, net	(183,454)	(236,000)	(542,337)	52,546	358,883	(1,683,255)	(1,736,688)	(3,184,921)	53,433	1,501,666	(4,068,784)	(4,190,000)	(5,043,931)	121,216	975,147
Net Cash Provided By (Used In) Capital and Related Activities	**(184,379)**	**(236,000)**	**(544,321)**	**51,621**	**359,942**	**(1,832,203)**	**(1,736,688)**	**(3,182,289)**	**(95,515)**	**1,350,086**	**(4,068,784)**	**(4,190,000)**	**(4,881,565)**	**121,216**	**812,781**
Cash Flows From Investing Activities															
Investments Converting To Cash	-	-	245,000	-	(245,000)	244,682	244,700	2,227,000	(18)	(1,982,318)	244,700	-	2,382,000	244,700	(2,137,300)
Purchased Invesments	-	-	-	-	-	(245,000)	(245,000)	(1,977,682)	-	1,732,682	(245,000)	-	(1,977,682)	(245,000)	1,732,682
Interest Income	3,965	4,104	4,301	(139)	(336)	32,586	32,725	57,406	(139)	(24,820)	49,142	94,327	74,821	(45,185)	(25,679)
Net Cash Provided By (Used In) Investing Activities	**3,965**	**4,104**	**249,301**	**(139)**	**(245,336)**	**32,268**	**32,425**	**306,724**	**(157)**	**(274,456)**	**48,842**	**94,327**	**479,138**	**(45,485)**	**(430,296)**
FUND NET CASH FLOWS	**184,545**	**159,302**	**(267,700)**	**25,243**	**452,244**	**464,677**	**411,451**	**(965,453)**	**53,226**	**1,430,130**	**(1,990,748)**	**(3,490,153)**	**(3,715,921)**	**1,499,405**	**1,725,174**
DEBT SERVICE RATIO															
Debt Service Ratio (Indenture Based)															
User Charges	917,840	942,301	885,223	(24,461)	32,617	8,055,485	8,079,946	7,046,419	(24,461)	1,009,066	12,363,189	11,799,441	10,866,675	563,749	1,496,514
Operating Expenses (Cash Based)	(845,755)	(783,962)	(777,987)	(61,793)	(67,768)	(5,377,994)	(5,410,871)	(3,962,898)	32,877	(1,415,097)	(8,063,842)	(8,641,176)	(7,221,296)	577,334	(842,546)
Interest Income	3,965	4,104	4,301	(139)	(336)	32,586	32,725	57,406	(139)	(24,820)	49,142	94,327	74,821	(45,185)	(25,679)
Annual Lease Payment (City)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-Operating Revenues (Expenses)	136,700	92,838	20,901	43,862	115,799	491,258	590,633	486,208	(99,375)	5,051	961,984	942,983	1,128,470	19,001	(166,486)
Cash Available For Debt Service	212,751	255,281	132,437	(42,530)	80,313	3,201,335	3,292,433	3,627,135	(91,098)	(425,801)	5,310,474	4,195,575	4,848,670	1,114,899	461,804
Interest Paid	103,518	103,518	146,338	-	(42,820)	828,140	828,140	1,170,700	-	(342,560)	1,242,211	1,406,328	1,756,050	(164,117)	(513,839)
Debt Retirement (Principal Payments)	164,099	164,099	173,449	-	(9,350)	1,312,795	1,312,795	1,387,594	-	(74,798)	1,969,193	2,092,818	2,081,390	(123,625)	(112,197)
Total Debt Service	267,617	267,617	319,787	-	(52,170)	2,140,936	2,140,936	2,558,294	-	(417,358)	3,211,404	3,499,146	3,837,440	(287,742)	(626,037)
Debt Service Ratio	**0.79**	**0.95**	**0.41**	**(0.16)**	**0.38**	**1.50**	**1.54**	**1.42**	**(0.04)**	**0.08**	**1.65**	**1.20**	**1.26**	**0.45**	**0.39**

LEHIGH COUNTY AUTHORITY
VARIANCE ANALYSIS - MONTH
For the Period Ended August 31, 2021

	Suburban - Water			
STATEMENTS OF ACTIVITIES	**Actual**	**Q3 FC**	**FC Var**	**Comments**
Operating Revenues:				
User Charges	917,840	942,301	(24,461)	
Connection & System Charges	122,357	91,383	30,974	
Other Miscellaneous Revenues	15,269	1,455	13,814	
Total Operating Revenues	**1,055,466**	**1,035,139**	**20,327**	**Lower user charges more than offset by higher system charges and higher miscellaneous revenues**
Operating Expenses:				
Personnel	292,427	273,567	(18,859)	
Shared Services - General & Administrative	126,852	124,114	(2,738)	
Utilities	35,962	36,182	220	
Materials and Supplies	38,930	41,270	2,340	
Miscellaneous Services	351,725	308,970	(42,755)	Higher cost of purchased water
Treatment and Transportation	-	-	-	
Depreciation and Amortization	217,141	217,141	-	
Major Maintenance Expenses	(141)	(141)	-	
Other Miscellaneous	-	-	-	
Total Operating Expenses	**1,062,896**	**1,001,103**	**(61,793)**	**Higher employee costs, higher G&A, higher purchaed water**
Net Operating Profit	**(7,430)**	**34,036**	**(41,466)**	**Higher operating expenses partially offset by higher operating revenues**
Non-Operating Income (Expense)				
Interest Income	3,965	4,104	(139)	
Interest (Expense)	(162,641)	(95,110)	(67,532)	
Other Miscellaneous	(926)	-	(926)	
Net Non-Operating Income (Expense)	**(159,602)**	**(91,005)**	**(68,596)**	**Higher interest expense**
Net Income (Loss)	**(167,032)**	**(56,969)**	**(110,062)**	**Lower net operating income along with higher interest expense**
CASH FLOW STATEMENT				
Cash Flows From Operating Activities				
Operating Revenues	1,055,466	1,035,139	20,327	
Operating Expenses (ex D&A)	(845,755)	(783,962)	(61,793)	
Non-Cash Working Capital Changes	175,316	174,399	917	
Net Cash Provided by (Used in) Operating Activities	**385,027**	**425,576**	**(40,549)**	**Higher operating expenses offset partly by higher operating revenues**
Cash Flows From Financing Activities				
Capital Contributions	-	-	-	
Proceeds New Borrowing	-	-	-	
Interest Payments	(1,387)	(3,253)	1,866	
Principal Payments	(18,681)	(31,125)	12,444	
Net Cash Provided by (Used in) Financing Activities	**(20,068)**	**(34,378)**	**14,310**	**Favorable variance on interest payments**
Cash Flows from Capital and Related Activities				
Non-Operating Income (Expenses)	(926)	-	(926)	
Capital Expenditures, net	(183,454)	(236,000)	52,546	
Net Cash Provided By (Used In) Capital and Related Activities	**(184,379)**	**(236,000)**	**51,621**	**Lower capex spending**
Cash Flows From Investing Activities				
Investments Converting To Cash	-	-	-	
Purchased Invesments	-	-	-	
Interest Income	3,965	4,104	(139)	
Net Cash Provided By (Used In) Investing Activities	**3,965**	**4,104**	**(139)**	
FUND NET CASH FLOWS	**184,545**	**159,302**	**25,243**	**Lower cash from operations more than offset by lower interest payments and lower capex**

LEHIGH COUNTY AUTHORITY
FINANCIAL STATEMENTS - SUBURBAN WASTEWATER
For the Period Ended August 31, 2021

	Suburban - Wastewater														
	Month					Year To Date					Full Year				
STATEMENTS OF ACTIVITIES	**Actual**	**Q3 FC**	**Prior Yr**	**FC Var**	**PY Var**	**Actual**	**Q3 FC**	**Prior Yr**	**FC Var**	**PY Var**	**Q3 FC**	**Budget**	**Prior Yr**	**Bud Var**	**PY Var**
Operating Revenues:															
User Charges	1,264,589	1,305,802	1,414,077	(41,213)	(149,489)	12,221,791	12,263,004	10,532,032	(41,213)	1,689,759	20,042,968	19,166,369	16,174,427	876,599	3,868,541
Connection & System Charges	221,171	262,695	77,105	(41,524)	144,066	774,284	815,808	3,099,857	(41,524)	(2,325,572)	866,588	865,588	3,584,347	1,000	(2,717,759)
Other Miscellaneous Revenues	30,145	60	60	30,085	30,085	32,091	1,985	240	30,106	31,851	2,225	628	6,194	1,597	(3,969)
Total Operating Revenues	**1,515,905**	**1,568,557**	**1,491,242**	**(52,652)**	**24,663**	**13,028,166**	**13,080,797**	**13,632,128**	**(52,632)**	**(603,963)**	**20,911,781**	**20,032,585**	**19,764,968**	**879,196**	**1,146,813**
Operating Expenses:															
Personnel	125,481	88,470	77,590	(37,011)	(47,891)	833,410	796,418	566,826	(36,992)	(266,584)	1,431,249	1,760,954	1,292,099	329,705	(139,150)
Shared Services - General & Administrative	52,484	13,044	63,365	(39,439)	10,881	174,213	134,695	266,287	(39,518)	92,073	191,599	155,415	91,502	(36,184)	(100,097)
Utilities	23,967	25,337	24,841	1,370	873	189,957	191,328	186,576	1,370	(3,382)	295,244	449,484	296,419	154,241	1,175
Materials and Supplies	13,497	31,198	30,587	17,701	17,089	98,184	111,618	116,941	13,434	18,757	230,668	500,563	232,039	269,895	1,371
Miscellaneous Services	610,992	605,211	521,776	(5,780)	(89,216)	4,224,802	4,219,021	3,817,218	(5,780)	(407,584)	6,620,131	6,358,021	6,193,489	(262,110)	(426,642)
Treatment and Transportation	509,165	510,425	252,378	1,261	(256,787)	2,560,759	2,562,020	2,014,676	1,261	(546,083)	3,712,079	3,977,539	2,906,958	265,460	(805,121)
Depreciation and Amortization	384,727	384,727	383,460	-	(1,267)	3,077,816	3,077,816	3,067,680	-	(10,136)	5,937,183	4,616,783	5,937,183	(1,320,400)	-
Major Maintenance Expenses	(2,001)	(2,000)	1,826	1	3,827	69,230	69,300	29,671	70	(39,559)	1,000,000	1,000,000	42,698	0	(957,302)
Other Miscellaneous	-	-	-	-	-	-	-	-	-	-	36,000	46,422	-	10,422	(36,000)
Total Operating Expenses	**1,718,312**	**1,656,414**	**1,355,822**	**(61,898)**	**(362,490)**	**11,228,371**	**11,162,216**	**10,065,875**	**(66,156)**	**(1,162,496)**	**19,454,153**	**18,865,181**	**16,992,387**	**(588,972)**	**(2,461,766)**
Net Operating Profit	**(202,408)**	**(87,857)**	**135,420**	**(114,551)**	**(337,828)**	**1,799,794**	**1,918,582**	**3,566,253**	**(118,787)**	**(1,766,459)**	**1,457,628**	**1,167,404**	**2,772,581**	**290,224**	**(1,314,953)**
Non-Operating Income (Expense)															
Interest Income	6,093	6,325	13,295	(231)	(7,202)	60,710	60,942	138,377	(231)	(77,667)	86,240	190,471	185,457	(104,230)	(99,216)
Interest (Expense)	(15,562)	(14,538)	(16,651)	(1,024)	1,089	(124,869)	(123,844)	(134,849)	(1,024)	9,980	(181,995)	(181,995)	(199,707)	-	17,712
Other Miscellaneous	1,824	-	(5,335)	1,824	7,159	(33,588)	-	36,902	(33,588)	(70,490)	-	-	16,089	-	(16,089)
Net Non-Operating Income (Expense)	**(7,644)**	**(8,213)**	**(8,690)**	**569**	**1,046**	**(97,746)**	**(62,902)**	**40,431**	**(34,843)**	**(138,177)**	**(95,755)**	**8,475**	**1,839**	**(104,230)**	**(97,594)**
Net Income (Loss)	**(210,052)**	**(96,070)**	**126,730**	**(113,982)**	**(336,782)**	**1,702,048**	**1,855,679**	**3,606,684**	**(153,631)**	**(1,904,636)**	**1,361,873**	**1,175,879**	**2,774,420**	**185,994**	**(1,412,547)**
CASH FLOW STATEMENT															
Cash Flows From Operating Activities															
Operating Revenues	1,515,905	1,568,557	1,491,242	(52,652)	24,663	13,028,166	13,080,797	13,632,128	(52,632)	(603,963)	20,911,781	20,032,585	19,764,968	879,196	1,146,813
Operating Expenses (ex D&A)	(1,333,585)	(1,271,687)	(972,362)	(61,898)	(361,223)	(8,150,555)	(8,084,400)	(6,998,195)	(66,156)	(1,152,360)	(13,516,970)	(14,248,398)	(11,055,204)	731,428	(2,461,766)
Non-Cash Working Capital Changes	940,207	938,056	(305,832)	2,151	1,246,039	(777,741)	(778,383)	(2,181,435)	642	1,403,694	952,935	(0)	(878,011)	952,935	1,830,946
Net Cash Provided by (Used in) Operating Activities	**1,122,526**	**1,234,925**	**213,048**	**(112,399)**	**909,478**	**4,099,869**	**4,218,015**	**4,452,498**	**(118,146)**	**(352,629)**	**8,347,746**	**5,784,186**	**7,831,752**	**2,563,559**	**515,993**
Cash Flows From Financing Activities															
Capital Contributions	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proceeds New Borrowing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Payments	(12,879)	(12,900)	(13,689)	21	810	(110,625)	(111,000)	(111,465)	375	840	(181,995)	(181,995)	(164,692)	-	(17,304)
Principal Payments	(45,879)	(45,600)	(44,948)	(279)	(931)	(364,921)	(364,400)	(361,381)	(521)	(3,540)	(549,034)	(549,034)	(542,065)	-	(6,969)
Net Cash Provided by (Used in) Financing Activities	**(58,758)**	**(58,500)**	**(58,637)**	**(258)**	**(121)**	**(475,546)**	**(475,400)**	**(472,846)**	**(146)**	**(2,700)**	**(731,029)**	**(731,029)**	**(706,757)**	**-**	**(24,272)**
Cash Flows from Capital and Related Activities															
Non-Operating Income (Expenses)	1,824	-	(5,335)	1,824	7,159	(33,588)	-	36,902	(33,588)	(70,490)	-	-	16,089	-	(16,089)
Capital Expenditures, net	(56,904)	(307,250)	(754,264)	250,346	697,360	(2,055,643)	(2,312,865)	(4,489,151)	257,222	2,433,508	(2,952,131)	(2,921,800)	(8,381,452)	(30,331)	5,429,322
Net Cash Provided By (Used In) Capital and Related Activities	**(55,080)**	**(307,250)**	**(759,599)**	**252,170**	**704,519**	**(2,089,231)**	**(2,312,865)**	**(4,452,249)**	**223,634**	**2,363,018**	**(2,952,131)**	**(2,921,800)**	**(8,365,363)**	**(30,331)**	**5,413,232**
Cash Flows From Investing Activities															
Investments Converting To Cash	249,000	249,000	249,000	-	-	1,978,000	1,978,000	3,167,000	-	(1,189,000)	1,978,000	-	5,156,000	1,978,000	(3,178,000)
Purchased Invesments	(245,000)	(245,000)	(1,681,000)	-	1,436,000	(2,717,000)	(2,717,000)	(3,653,000)	-	936,000	(2,717,000)	-	(3,653,000)	(2,717,000)	936,000
Interest Income	6,093	6,325	13,295	(231)	(7,202)	60,710	60,942	138,377	(231)	(77,667)	86,240	190,471	185,457	(104,230)	(99,216)
Net Cash Provided By (Used In) Investing Activities	**10,093**	**10,325**	**(1,418,705)**	**(231)**	**1,428,798**	**(678,290)**	**(678,058)**	**(347,623)**	**(231)**	**(330,667)**	**(652,760)**	**190,471**	**1,688,457**	**(843,230)**	**(2,341,216)**
FUND NET CASH FLOWS	**1,018,782**	**879,500**	**(2,023,892)**	**139,282**	**3,042,674**	**856,802**	**751,692**	**(820,220)**	**105,110**	**1,677,023**	**4,011,826**	**2,321,828**	**448,089**	**1,689,999**	**3,563,737**
DEBT SERVICE RATIO															
Debt Service Ratio (Indenture Based)															
User Charges	1,264,589	1,305,802	1,414,077	(41,213)	(149,489)	12,221,791	12,263,004	10,532,032	(41,213)	1,689,759	20,042,968	19,166,369	16,174,427	876,599	3,868,541
Operating Expenses (Cash Based)	(1,333,585)	(1,271,687)	(972,362)	(61,898)	(361,223)	(8,150,555)	(8,084,400)	(6,998,195)	(66,156)	(1,152,360)	(13,516,970)	(14,248,398)	(11,055,204)	731,428	(2,461,766)
Interest Income	6,093	6,325	13,295	(231)	(7,202)	60,710	60,942	138,377	(231)	(77,667)	86,240	190,471	185,457	(104,230)	(99,216)
Annual Lease Payment (City)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-Operating Revenues (Expenses)	253,140	262,755	71,830	(9,615)	181,310	772,787	817,793	3,136,999	(45,006)	(2,364,212)	868,813	866,216	3,606,630	2,597	(2,737,817)
Cash Available For Debt Service	190,237	303,194	526,840	(112,958)	(336,604)	4,904,733	5,057,340	6,809,213	(152,607)	(1,904,480)	7,481,051	5,974,657	8,911,310	1,506,394	(1,430,259)
Interest Paid	15,166	15,166	13,724	-	1,442	121,330	121,330	109,794	-	11,536	181,995	181,995	164,692	-	17,304
Debt Retirement (Principal Payments)	45,753	45,753	45,172	-	581	366,023	366,023	361,377	-	4,646	549,034	549,034	542,065	-	6,969
Total Debt Service	60,919	60,919	58,896	-	2,023	487,353	487,353	471,171	-	16,181	731,029	731,029	706,757	-	24,272
Debt Service Ratio	**3.12**	**4.98**	**8.95**	**(1.85)**	**(5.82)**	**10.06**	**10.38**	**14.45**	**(0.31)**	**(4.39)**	**10.23**	**8.17**	**12.61**	**2.06**	**(2.38)**

LEHIGH COUNTY AUTHORITY
VARIANCE ANALYSIS - MONTH
For the Period Ended August 31, 2021

	Suburban - Wastewater			
STATEMENTS OF ACTIVITIES	**Actual**	**Q3 FC**	**FC Var**	**Comments**
Operating Revenues:				
User Charges	1,264,589	1,305,802	(41,213)	Lower residential/commercial revenues and lower hauler revenues
Connection & System Charges	221,171	262,695	(41,524)	Lower tapping fees
Other Miscellaneous Revenues	30,145	60	30,085	
Total Operating Revenues	**1,515,905**	**1,568,557**	**(52,652)**	**Lower user charges and lower system charges partially offset by higher miscellaneous revenues**
Operating Expenses:				
Personnel	125,481	88,470	(37,011)	
Shared Services - General & Administrative	52,484	13,044	(39,439)	
Utilities	23,967	25,337	1,370	
Materials and Supplies	13,497	31,198	17,701	
Miscellaneous Services	610,992	605,211	(5,780)	
Treatment and Transportation	509,165	510,425	1,261	
Depreciation and Amortization	384,727	384,727	-	
Major Maintenance Expenses	(2,001)	(2,000)	1	
Other Miscellaneous	-	-	-	
Total Operating Expenses	**1,718,312**	**1,656,414**	**(61,898)**	**Higher employee costs and higher G&A**
Net Operating Profit	**(202,408)**	**(87,857)**	**(114,551)**	**Lower operating revenues and higher operating expenses**
Non-Operating Income (Expense)				
Interest Income	6,093	6,325	(231)	
Interest (Expense)	(15,562)	(14,538)	(1,024)	
Other Miscellaneous	1,824	-	1,824	
Net Non-Operating Income (Expense)	**(7,644)**	**(8,213)**	**569**	
Net Income (Loss)	**(210,052)**	**(96,070)**	**(113,982)**	**Lower net operating income**
CASH FLOW STATEMENT				
Cash Flows From Operating Activities				
Operating Revenues	1,515,905	1,568,557	(52,652)	
Operating Expenses (ex D&A)	(1,333,585)	(1,271,687)	(61,898)	
Non-Cash Working Capital Changes	940,207	938,056	2,151	
Net Cash Provided by (Used in) Operating Activities	**1,122,526**	**1,234,925**	**(112,399)**	**Lower net operating profit**
Cash Flows From Financing Activities				
Capital Contributions	-	-	-	
Proceeds New Borrowing	-	-	-	
Interest Payments	(12,879)	(12,900)	21	
Principal Payments	(45,879)	(45,600)	(279)	
Net Cash Provided by (Used in) Financing Activities	**(58,758)**	**(58,500)**	**(258)**	
Cash Flows from Capital and Related Activities				
Non-Operating Income (Expenses)	1,824	-	1,824	
Capital Expenditures, net	(56,904)	(307,250)	250,346	
Net Cash Provided By (Used In) Capital and Related Activities	**(55,080)**	**(307,250)**	**252,170**	**Lower capex**
Cash Flows From Investing Activities				
Investments Converting To Cash	249,000	249,000	-	
Purchased Invesments	(245,000)	(245,000)	-	
Interest Income	6,093	6,325	(231)	
Net Cash Provided By (Used In) Investing Activities	**10,093**	**10,325**	**(231)**	
FUND NET CASH FLOWS	**1,018,782**	**879,500**	**139,282**	**Lower cash from operations and lower capex**

LEHIGH COUNTY AUTHORITY
FINANCIAL STATEMENTS - CITY DIVISION
For the Period Ended August 31, 2021

	City Division														
	Month					Year To Date					Full Year				
STATEMENTS OF ACTIVITIES	**Actual**	**Q3 FC**	**Prior Yr**	**FC Var**	**PY Var**	**Actual**	**Q3 FC**	**Prior Yr**	**FC Var**	**PY Var**	**Q3 FC**	**Budget**	**Prior Yr**	**Bud Var**	**PY Var**
Operating Revenues:															
User Charges	4,034,763	3,983,731	3,341,992	51,032	692,771	28,042,139	27,991,107	24,298,067	51,032	3,744,072	42,074,272	41,996,514	37,983,675	77,757	4,090,597
Connection & System Charges	146,262	142,912	135,128	3,351	11,134	1,799,571	1,796,221	1,039,305	3,351	760,266	2,867,867	3,947,981	2,768,043	(1,080,113)	99,824
Other Miscellaneous Revenues	41,405	5,438	2,265	35,967	39,140	89,764	45,054	28,205	44,711	61,560	66,807	59,249	51,620	7,558	15,187
Total Operating Revenues	**4,222,430**	**4,132,081**	**3,479,385**	**90,350**	**743,045**	**29,931,475**	**29,832,381**	**25,365,577**	**99,094**	**4,565,897**	**45,008,946**	**46,003,744**	**40,803,338**	**(994,797)**	**4,205,608**
Operating Expenses:															
Personnel	886,019	926,491	821,683	40,472	(64,336)	7,005,468	7,045,940	6,583,971	40,472	(421,496)	11,609,699	11,561,494	11,012,535	(48,205)	(597,164)
Shared Services - General & Administrative	235,927	233,221	202,082	(2,706)	(33,845)	1,134,037	1,252,975	1,825,547	118,938	691,511	1,585,674	1,739,417	1,482,737	153,743	(102,937)
Utilities	138,731	118,601	116,219	(20,130)	(22,512)	1,197,079	1,177,099	1,127,401	(19,980)	(69,678)	1,855,844	2,156,620	1,815,047	300,775	(40,797)
Materials and Supplies	114,434	114,449	86,623	14	(27,811)	882,967	862,010	806,829	(20,956)	(76,138)	1,445,412	1,765,642	1,393,271	320,230	(52,141)
Miscellaneous Services	186,008	177,081	427,719	(8,927)	241,711	834,349	806,137	950,386	(28,212)	116,037	1,738,302	1,979,996	1,958,582	241,694	220,280
Treatment and Transportation	-	-	-	-	-	5,813	5,058	4,959	(755)	(854)	12,165	12,000	11,926	(165)	(239)
Depreciation and Amortization	491,154	491,154	490,000	-	(1,154)	3,929,232	3,929,232	3,920,000	-	(9,232)	6,117,396	5,893,862	6,117,396	(223,534)	-
Major Maintenance Expenses	13,758	13,800	67,249	42	53,490	547,927	548,100	931,517	173	383,591	4,206,200	2,652,924	4,206,199	(1,553,276)	(1)
Other Miscellaneous	-	-	-	-	-	-	-	-	-	-	-	13,972	-	13,972	-
Total Operating Expenses	**2,066,031**	**2,074,796**	**2,211,574**	**8,765**	**145,543**	**15,536,870**	**15,626,550**	**16,150,610**	**89,680**	**613,740**	**28,570,692**	**27,775,927**	**27,997,693**	**(794,766)**	**(572,999)**
Net Operating Profit	**2,156,399**	**2,057,284**	**1,267,811**	**99,115**	**888,588**	**14,394,605**	**14,205,831**	**9,214,968**	**188,774**	**5,179,637**	**16,438,254**	**18,227,817**	**12,805,645**	**(1,789,563)**	**3,632,610**
Non-Operating Income (Expense)															
Interest Income	(2,092)	399	522	(2,491)	(2,614)	1,460	4,003	158,184	(2,543)	(156,724)	172,960	172,960	162,075	(0)	10,885
Interest (Expense)	(1,382,735)	(1,421,350)	(1,453,283)	38,615	70,548	(11,061,880)	(11,100,495)	(11,626,266)	38,615	564,386	(19,285,894)	(17,535,086)	(17,257,071)	(1,750,808)	(2,028,823)
Other Miscellaneous	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Non-Operating Income (Expense)	**(1,384,827)**	**(1,420,951)**	**(1,452,761)**	**36,124**	**67,934**	**(11,060,420)**	**(11,096,491)**	**(11,468,081)**	**36,072**	**407,662**	**(19,112,934)**	**(17,362,125)**	**(17,094,996)**	**(1,750,809)**	**(2,017,938)**
Net Income (Loss)	**771,572**	**636,333**	**(184,950)**	**135,239**	**956,522**	**3,334,185**	**3,109,339**	**(2,253,114)**	**224,846**	**5,587,299**	**(2,674,680)**	**865,692**	**(4,289,351)**	**(3,540,372)**	**1,614,672**
CASH FLOW STATEMENT															
Cash Flows From Operating Activities															
Operating Revenues	4,222,430	4,132,081	3,479,385	90,350	743,045	29,931,475	29,832,381	25,365,577	99,094	4,565,897	45,008,946	46,003,744	40,803,338	(994,797)	4,205,608
Operating Expenses (ex D&A)	(1,574,877)	(1,583,642)	(1,721,574)	8,765	146,697	(11,607,638)	(11,697,318)	(12,230,610)	89,680	622,972	(22,453,296)	(21,882,064)	(21,880,297)	(571,232)	(572,999)
Non-Cash Working Capital Changes	(1,184,080)	(1,183,387)	892,805	(693)	(2,076,885)	(658,181)	(659,664)	(4,136,165)	1,483	3,477,983	(1,091,273)	50,001	(203,446)	(1,141,274)	(887,826)
Net Cash Provided by (Used in) Operating Activities	**1,463,473**	**1,365,051**	**2,650,616**	**98,421**	**(1,187,143)**	**17,665,655**	**17,475,399**	**8,998,803**	**190,257**	**8,666,853**	**21,464,377**	**24,171,680**	**18,719,594**	**(2,707,303)**	**2,744,783**
Cash Flows From Financing Activities															
Capital Contributions	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proceeds New Borrowing	-	-	-	-	-	-	-	-	-	-	-	2,000,000	-	(2,000,000)	-
Interest Payments	-	-	-	-	-	(5,772,543)	(5,772,543)	(6,627,694)	(0)	855,151	(11,565,086)	(11,565,086)	(10,853,413)	-	(711,673)
Principal Payments	-	-	-	-	-	-	-	-	-	-	(2,660,831)	(2,660,831)	(2,430,261)	-	(230,570)
Net Cash Provided by (Used in) Financing Activities	**-**	**-**	**-**	**-**	**-**	**(5,772,543)**	**(5,772,543)**	**(6,627,694)**	**(0)**	**855,151**	**(14,225,917)**	**(12,225,917)**	**(13,283,674)**	**(2,000,000)**	**(942,243)**
Cash Flows from Capital and Related Activities															
Non-Operating Income (Expenses)	-	-	-	-	-	(615,300)	(615,300)	-	-	(615,300)	(1,230,600)	(1,230,600)	(533,258)	-	(697,342)
Capital Expenditures, net	(217,616)	(250,000)	(177,529)	32,384	(40,087)	(3,061,692)	(3,094,099)	(1,254,571)	32,407	(1,807,121)	(3,414,508)	(6,224,576)	(3,028,551)	2,810,068	(385,958)
Net Cash Provided By (Used In) Capital and Related Activities	**(217,616)**	**(250,000)**	**(177,529)**	**32,384**	**(40,087)**	**(3,676,992)**	**(3,709,399)**	**(1,254,571)**	**32,407**	**(2,422,421)**	**(4,645,108)**	**(7,455,176)**	**(3,561,809)**	**2,810,068**	**(1,083,300)**
Cash Flows From Investing Activities															
Investments Converting To Cash	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Purchased Invesments	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Income	(2,092)	399	522	(2,491)	(2,614)	1,460	4,003	158,184	(2,543)	(156,724)	172,960	172,960	162,075	(0)	10,885
Net Cash Provided By (Used In) Investing Activities	**(2,092)**	**399**	**522**	**(2,491)**	**(2,614)**	**1,460**	**4,003**	**158,184**	**(2,543)**	**(156,724)**	**172,960**	**172,960**	**162,075**	**(0)**	**10,885**
FUND NET CASH FLOWS	**1,243,765**	**1,115,450**	**2,473,609**	**128,315**	**(1,229,844)**	**8,217,580**	**7,997,459**	**1,274,722**	**220,121**	**6,942,858**	**2,766,312**	**4,663,547**	**2,036,187**	**(1,897,235)**	**730,126**
DEBT SERVICE RATIO															
Debt Service Ratio (Indenture Based)															
User Charges	4,034,763	3,983,731	3,341,992	51,032	692,771	28,042,139	27,991,107	24,298,067	51,032	3,744,072	42,074,272	41,996,514	37,983,675	77,757	4,090,597
Operating Expenses (Cash Based)	(1,574,877)	(1,583,642)	(1,721,574)	8,765	146,697	(11,607,638)	(11,697,318)	(12,230,610)	89,680	622,972	(22,453,296)	(21,882,064)	(21,880,297)	(571,232)	(572,999)
Interest Income	(2,092)	399	522	(2,491)	(2,614)	1,460	4,003	158,184	(2,543)	(156,724)	172,960	172,960	162,075	(0)	10,885
Annual Lease Payment (City)	-	-	-	-	-	-	-	-	-	-	(1,230,600)	(1,230,600)	(533,258)	-	(697,342)
Non-Operating Revenues (Expenses)	187,667	148,350	137,393	39,317	50,274	1,889,336	1,841,274	1,067,510	48,062	821,826	2,934,675	4,007,230	2,819,663	(1,072,555)	115,012
Cash Available For Debt Service	2,645,461	2,548,837	1,758,333	96,624	887,128	18,325,297	18,139,066	13,293,152	186,231	5,032,145	21,498,010	23,064,040	18,551,858	(1,566,029)	2,946,153
Interest Paid	963,757	963,757	887,639	-	76,118	7,710,057	7,710,057	7,101,111	-	608,947	11,565,086	11,565,086	10,853,413	-	711,673
Debt Retirement (Principal Payments)	221,736	221,736	95,753	-	125,983	1,773,887	1,773,887	766,023	-	1,007,864	2,660,831	2,660,831	2,430,261	-	230,570
Total Debt Service	1,185,493	1,185,493	983,392	-	202,101	9,483,945	9,483,945	7,867,134	-	1,616,811	14,225,917	14,225,917	13,283,674	-	942,243
Debt Service Ratio	**2.23**	**2.15**	**1.79**	**0.08**	**0.44**	**1.93**	**1.91**	**1.69**	**0.02**	**0.24**	**1.51**	**1.62**	**1.40**	**(0.11)**	**0.11**

LEHIGH COUNTY AUTHORITY
VARIANCE ANALYSIS - MONTH
For the Period Ended August 31, 2021

	City Division			
STATEMENTS OF ACTIVITIES	**Actual**	**Q3 FC**	**FC Var**	**Comments**
Operating Revenues:				
User Charges	4,034,763	3,983,731	51,032	
Connection & System Charges	146,262	142,912	3,351	
Other Miscellaneous Revenues	41,405	5,438	35,967	
Total Operating Revenues	**4,222,430**	**4,132,081**	**90,350**	**Higher user charges, higher system charges, and higher miscellaneous**
Operating Expenses:				
Personnel	886,019	926,491	40,472	
Shared Services - General & Administrative	235,927	233,221	(2,706)	
Utilities	138,731	118,601	(20,130)	
Materials and Supplies	114,434	114,449	14	
Miscellaneous Services	186,008	177,081	(8,927)	
Treatment and Transportation	-	-	-	
Depreciation and Amortization	491,154	491,154	-	
Major Maintenance Expenses	13,758	13,800	42	
Other Miscellaneous	-	-	-	
Total Operating Expenses	**2,066,031**	**2,074,796**	**8,765**	**Favorable employee costs partially offset by higher G&A, higher utilities, and higher services**
Net Operating Profit	**2,156,399**	**2,057,284**	**99,115**	**Higher operating revenues along with lower operating expenses**
Non-Operating Income (Expense)				
Interest Income	(2,092)	399	(2,491)	
Interest (Expense)	(1,382,735)	(1,421,350)	38,615	
Other Miscellaneous	-	-	-	
Net Non-Operating Income (Expense)	**(1,384,827)**	**(1,420,951)**	**36,124**	**Lower interest expense**
Net Income (Loss)	**771,572**	**636,333**	**135,239**	**Higher net operating income along with lower interest expense**
CASH FLOW STATEMENT				
Cash Flows From Operating Activities				
Operating Revenues	4,222,430	4,132,081	90,350	
Operating Expenses (ex D&A)	(1,574,877)	(1,583,642)	8,765	
Non-Cash Working Capital Changes	(1,184,080)	(1,183,387)	(693)	
Net Cash Provided by (Used in) Operating Activities	**1,463,473**	**1,365,051**	**98,421**	**Higher cash generated by operations**
Cash Flows From Financing Activities				
Capital Contributions	-	-	-	
Proceeds New Borrowing	-	-	-	
Interest Payments	-	-	-	
Principal Payments	-	-	-	
Net Cash Provided by (Used in) Financing Activities	**-**	**-**	**-**	
Cash Flows from Capital and Related Activities				
Non-Operating Income (Expenses)	-	-	-	
Capital Expenditures, net	(217,616)	(250,000)	32,384	
Net Cash Provided By (Used In) Capital and Related Activities	**(217,616)**	**(250,000)**	**32,384**	**Lower capex**
Cash Flows From Investing Activities				
Investments Converting To Cash	-	-	-	
Purchased Invesments	-	-	-	
Interest Income	(2,092)	399	(2,491)	
Net Cash Provided By (Used In) Investing Activities	**(2,092)**	**399**	**(2,491)**	
FUND NET CASH FLOWS	**1,243,765**	**1,115,450**	**128,315**	**Higher cash from operations along with lower capex**

LEHIGH COUNTY AUTHORITY
CASH & INVESTMENT SUMMARY
For the Period Ended August 31, 2021

	Suburban Water				Suburban Wastewater				City Division				Total			
	8/31/2021 Actual	2021 Forecast	2021 Budget	2020 Actual	8/31/2021 Actual	2021 Forecast	2021 Budget	2020 Actual	8/31/2021 Actual	2021 Forecast	2021 Budget	2020 Actual	8/31/2021 Actual	2021 Forecast	2021 Budget	2020 Actual
Cash																
Operating																
Unrestricted	7,474,860	5,019,443	1,173,430	5,206,224	(2,361,187)	793,934	4,315,728	(217,015)	7,456,171	4,546,547	19,638,366	1,378,275	12,569,843	10,359,924	25,127,525	6,367,484
Restricted	-	-	2,532,181	-	-	272	0	272	20,060,336	18,916,139	1,614,754	23,992,616	20,060,336	18,916,411	4,146,935	23,992,888
Total Operating	7,474,860	5,019,443	3,705,611	5,206,224	(2,361,187)	794,206	4,315,728	(216,743)	27,516,507	23,462,686	21,253,120	25,370,891	32,630,180	29,276,335	29,274,460	30,360,372
Capital																
Unrestricted	431,608	431,608	2,037,248	2,037,248	10,672,896	10,672,896	7,672,019	7,672,019	3,367,136	4,322,434	169,980	169,980	14,471,640	15,426,938	9,879,247	9,879,247
Restricted	-	-	-	-	338,302	337,932	337,932	337,932	7,500,035	7,500,052	7,500,000	7,500,000	7,838,337	7,837,984	7,837,932	7,837,932
Total Capital	431,608	431,608	2,037,248	2,037,248	11,011,198	11,010,828	8,009,951	8,009,951	10,867,171	11,822,486	7,669,980	7,669,980	22,309,977	23,264,922	17,717,179	17,717,179
Other Restricted																
Debt Reserves	1,660,173	1,660,166	1,043,094	1,858,493	-	-	-	-	31,329,440	28,976,677	37,684,197	28,454,669	32,989,613	30,636,843	38,727,291	30,313,162
Escrow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Other Restricted	1,660,173	1,660,166	1,043,094	1,858,493	-	-	-	-	31,329,440	28,976,677	37,684,197	28,454,669	32,989,613	30,636,843	38,727,291	30,313,162
Total Cash	9,566,642	7,111,217	6,785,954	9,101,965	8,650,010	11,805,034	12,325,679	7,793,208	69,713,117	64,261,849	66,607,297	61,495,540	87,929,770	83,178,100	85,718,930	78,390,713
Investments																
Operating																
Unrestricted	1,979,919	1,497,825	2,136,930	1,497,825	-	5,387,746	6,757,276	5,387,746	-	-	-	-	1,979,919	6,885,571	8,894,206	6,885,571
Restricted	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Operating	1,979,919	1,497,825	2,136,930	1,497,825	-	5,387,746	6,757,276	5,387,746	-	-	-	-	1,979,919	6,885,571	8,894,206	6,885,571
Capital																
Unrestricted	1,000,117	1,000,000	1,000,000	1,000,000	6,875,158	1,000,000	1,000,000	1,000,000	-	-	-	-	7,875,274	2,000,000	2,000,000	2,000,000
Restricted	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Capital	1,000,117	1,000,000	1,000,000	1,000,000	6,875,158	1,000,000	1,000,000	1,000,000	-	-	-	-	7,875,274	2,000,000	2,000,000	2,000,000
Other Restricted																
Debt Reserves	-	244,924	-	244,924	-	-	-	-	-	-	-	-	-	244,924	-	244,924
Escrow	5,702,170	4,210,752	4,236,279	4,210,752	-	-	-	-	-	-	-	-	5,702,170	4,210,752	4,236,279	4,210,752
Total Other Restricted	5,702,170	4,455,676	4,236,279	4,455,676	-	-	-	-	-	-	-	-	5,702,170	4,455,676	4,236,279	4,455,676
Total Investments	8,682,205	6,953,501	7,373,209	6,953,501	6,875,158	6,387,746	7,757,276	6,387,746	-	-	-	-	15,557,362	13,341,247	15,130,485	13,341,247
Total Cash and Investments	**18,248,847**	**14,064,718**	**14,159,163**	**16,055,466**	**15,525,168**	**18,192,780**	**20,082,955**	**14,180,954**	**69,713,117**	**64,261,849**	**66,607,297**	**61,495,540**	**103,487,132**	**96,519,347**	**100,849,415**	**91,731,960**
Summary																
Cash																
Unrestricted	7,906,468	5,451,051	3,210,679	7,243,472	8,311,708	11,466,830	11,987,747	7,455,004	10,823,306	8,868,981	19,808,346	1,548,255	27,041,483	25,786,862	35,006,772	16,246,731
Restricted	1,660,173	1,660,166	3,575,275	1,858,493	338,302	338,204	337,932	338,204	58,889,811	55,392,868	46,798,951	59,947,285	60,888,286	57,391,238	50,712,158	62,143,982
Total Cash	9,566,642	7,111,217	6,785,954	9,101,965	8,650,010	11,805,034	12,325,679	7,793,208	69,713,117	64,261,849	66,607,297	61,495,540	87,929,770	83,178,100	85,718,930	78,390,713
Investments																
Unrestricted	2,980,035	2,497,825	3,136,930	2,497,825	6,875,158	6,387,746	7,757,276	6,387,746	-	-	-	-	9,855,193	8,885,571	10,894,206	8,885,571
Restricted	5,702,170	4,455,676	4,236,279	4,455,676	-	-	-	-	-	-	-	-	5,702,170	4,455,676	4,236,279	4,455,676
Total Investments	8,682,205	6,953,501	7,373,209	6,953,501	6,875,158	6,387,746	7,757,276	6,387,746	-	-	-	-	15,557,362	13,341,247	15,130,485	13,341,247
Total Cash and Investments	**18,248,847**	**14,064,718**	**14,159,163**	**16,055,466**	**15,525,168**	**18,192,780**	**20,082,955**	**14,180,954**	**69,713,117**	**64,261,849**	**66,607,297**	**61,495,540**	**103,487,132**	**96,519,347**	**100,849,415**	**91,731,960**

Lehigh County Authority

System Operations Review - August 2021

Presented: September 27, 2021

Critical Activities	System	Description	Aug-21	2021 Totals	2020 Totals	Permit
			Daily Avg (MGD)	Daily Avg (MGD)	Daily Avg (MGD)	Daily Max (MGD)
Water Production	Allentown	Total	23.29	22.27	21.37	39.0
		Schantz Spring	6.93	7.41	7.31	9.0
		Crystal Spring	3.74	3.74	3.80	4.0
		Little Lehigh Creek	12.63	11.08	10.17	30.0
		Lehigh River	0.00	0.04	0.09	28.0
	Central Lehigh	Total	12.13	11.21	10.24	19.04 MGD Avg
		Feed from Allentown	7.89	7.48	6.71	7.0 MGD Avg 10.5 MGD Max
		Well Production (CLD)	4.24	3.73	3.53	8.54 MGD Avg
		Sum of all (12) other Suburban Water Systems	0.13	0.13	0.15	1.71 Sum of all wells
Wastewater Treatment		Kline's Island	32.38	32.74	32.27	40.0
		Pretreatment Plant	5.30	5.33	4.94	5.75 (design capacity)
		Sum of all (5) other Suburban WW Systems	0.22	0.20	0.21	0.36

		Aug-21	2021 Totals	2020 Totals	2019 Totals
Precipitation Totals (inches)		7.82	30.0	49.57	60.66
Compliance Reports Submitted to Allentown		18	201	275	278
Notices of Violation (NOVs)	(Allentown + Suburban)	1	2	2	1
Sanitary Sewer Overflows (SSOs)/Bypasses	(Allentown + Suburban)	3	10	44	37
Main Breaks Repaired	Allentown	1	17	19	20
	Suburban	0	10	17	12
Customer Service Phone Inquiries	(Allentown + Suburban)	1,231	11,956	16,772	22,992
Water Shutoffs for Non-Payment	(Allentown + Suburban)	203	1,136	280	1,956
Injury Accidents	(Allentown + Suburban)	0	6	10	10
Emergency Declarations	Allentown	0	0	(4)@$750,058	(2)@ $152,053
	Suburban	0	(1) @ $48,000	(1)@$110,000	(1) @ $19,335

Significant Repairs/Upgrades: During July and August, 2021, two of the Allentown concrete water storage tanks were taken off-line for a full interior rehabilitation. The 16th Ward Tank, a 300,000 gallon reservoir built in 1958, and the 19th Ward Tank, a 150,000 gallon reservoir built in 1960, were blasted and painted for likely the first time since their installations. Both had been cleaned previously using divers, but this was the first time that either tank had been taken fully off-line for interior maintenance. Of particular concern was the fact that the 16th Ward Tank serves part of Salisbury Township. The 16th Ward Tank has been completed and the 19th Ward tank is currently underway.

Description of NOVs and/or SSOs: There were two (2) bypasses, one (1) SSO and (1) NOV for August 2021. The NOV was for Wynnewood WWTP, with both the PaDEP notice and the LCA response included within the packet. Heidelberg Heights WWTP experienced two (2) bypasses. The first bypass was 8/19-8/20 and totalled ~28,000 gallons resulting from 2.1" rain. The second bypass was 8/23-8/26 and totalled ~250,000 gallons resulting from 3.4" rain. The Heidelberg Heights WWTP also experienced an SSO, when the EQ tank overflowed approximately 110 gallons on 8/23, resulting from the previously mentioned rainfall event of 3.4".

Other Highlights: Please see the summary memo and condition assessment report related to the Huck Line attached.

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

August 10, 2021

NOTICE OF VIOLATION

Delivered via email

Lehigh County Authority
P.O. Box 3348
1053 Spruce Street
Allentown, PA 18106

Attention: Andrew Moore, Compliance Manager

Re: Sewage
Wynnewood Terrace
NPDES Permit No. PA0036081
North Whitehall Township, Lehigh County

Dear Mr. Moore:

Lehigh County Authority has notified The Department of Environmental Protection ("Department") of overflows that have occurred at the Wynnewood Terrace wastewater treatment plant. NPDES Permit No. PA0036081, Part B.I.F. states the permittee shall take all reasonable steps to minimize or prevent any discharge, sludge use or disposal in violation of this permit that has a reasonable likelihood of adversely affecting human health or the environment. According to reports submitted by Lehigh County Authority, the following overflows occurred within the treatment plant:

Date	Location
3/14/2018	Equalization Tank
8/4/2018	Equalization Tank
8/13/2018	Equalization Tank
8/14/2018	Equalization Tank
8/4/2020	Equalization Tank

NPDES Permit No. PA0036081, Part B.I.H. prohibits the overflow of wastewater, or other untreated discharge from a separate sanitary sewer system (which is not a combined sewer system), which results from a flow in excess of the carrying capacity of the system or from some other cause prior to reaching the headworks of the sewage treatment facility. The following Sanitary Sewer Overflows ("SSOs") were reported by Lehigh County Authority:

Date	Location
8/4/2018	Main Lift Station
8/14/2018	Main Lift Station
8/4/2020	Main Lift Station

Review of Lehigh County Authority's Discharge Monitoring Reports ("DMRs") has indicated a pattern of effluent violations with respect to the limitations set forth in NPDES Permit No. PA0036081. Specifically, the violations are as follows:

Monitoring Period	Parameter	Permit Limit	Reported Value
June 2018	Fecal Coliform *Instantaneous Maximum*	1,000/100 ml	> 2,420/100 ml
August 2019	Fecal Coliform *Instantaneous Maximum*	1,000/100 ml	> 2,419/100 ml
September 2019	Fecal Coliform *Geo Mean*	200/100	997/100 ml
September 2019	Fecal Coliform *Instantaneous Maximum*	1,000/100 ml	> 2,420/100 ml
December 2019	Fecal Coliform *Instantaneous Maximum*	10,000/100 ml	> 12,098/100 ml
January 2020	$CBOD_5$ *Monthly Average*	40 mg/L	42 mg/L
May 2020	Ammonia-Nitrogen *Monthly Average*	20 mg/l	27.7 mg/l
May 2020	Fecal Coliform *Instantaneous Maximum*	1,000/100 ml	> 2,420/100 ml
January 2020	Fecal Coliform *Instantaneous Maximum*	10,000/100 ml	> 12,098/100 ml

Further review revealed a late DMR submission. NPDES Permit No. PA0036081, Part A.III.B.4. states that DMR's must be received by the Department no later than 28 days following the end of the monitoring period. The following DMR was received late:

Monitoring Period	Date Due	Date Received
August 2016	September 28, 2016	September 29, 2016

On April 11, 2019 the Department conducted an inspection of the Wynnewood Terrace wastewater treatment plant. The Department collected two grab samples for analysis of Total Residual Chlorine. The results of the analysis, when compared to the limitations set forth in NPDES Permit No. PA0036081, Part A.I.A. revealed the following violation:

Parameter	Permit Limit	Analytical Result
Total Residual Chlorine *Instantaneous Maximum*	2.8 mg/L	5.0 mg/L
Total Residual Chlorine *Instantaneous Maximum*	2.8 mg/L	4.4 mg/L

Please be advised that failure to comply with the terms and conditions of your NPDES Permit is a violation of said permit and the Clean Streams Law of Pennsylvania, Act of June 22, 1937, P.L. 1987, as amended, 35 P.S. Section 691.1 et seq. ("The Clean Streams Law") and subjects Lehigh

County Authority to appropriate enforcement action including, but not limited to, civil penalty assessment. It should further be noted that the above listed discharges of sewage are a violation of Section 201 of the Clean Streams Law of Pennsylvania, Act of June 22, 1937, P.L. 1987 as amended, 35 P.S. Section 691.1 et seq. ("The Clean Streams Law").

The Department requests that the Lehigh County Authority respond in writing to this Notice within 15 days of its receipt. Said response should indicate the cause of the above-described non-compliance and the steps that will be or have been taken to ensure future compliance.

This Notice of Violation is neither an order nor any other final action of the Department. It neither imposes nor waives any enforcement action available to the Department under its statutes. If the Department determines that an enforcement action is appropriate, you will be notified of the action.

If you have any questions concerning this correspondence, you may contact me at 610-861-2135.

Sincerely,

Scott T. Confer
Water Quality Specialist
Clean Water Program

cc: North Whitehall Township

LEHIGH COUNTY AUTHORITY 1053 SPRUCE ROAD * P.O. BOX 3348 * ALLENTOWN, PA 18106-0348
610-398-2503 * FAX 610-398-8413 * www.lehighcountyauthority.org
email: AndrewMoore@lehighcountyauthority.org

August 24, 2021

Mr. Scott Confer
Water Quality Specialist
Pennsylvania Department of Environmental Protection
Bethlehem District Office
4530 Bath Pike
Bethlehem, PA 18017-9044

Re: Wynnewood Terrace Notice of Violation
NPDES Permit No. PA0036081
North Whitehall Township, Lehigh County

Dear Mr. Confer:

The Lehigh County Authority (LCA) is in receipt of the Notice of Violation electronically delivered on August 10th, 2021. The following is the required response to the sanitary sewer overflows and permit exceedances that occurred between August 2016 and January 2021.

Plant Background

The Wynnewood Terrace WWTP was constructed in 1980 by the developer to serve the Wynnewood Terrace subdivision, located in North Whitehall Township. Sewer service is provided to 217 residential and 2 commercial properties. LCA acquired the system in 2003. At times the plant was having difficulties meeting its permitted limits and was reaching the end of its useful life. In 2017 LCA initiated the design phase to replace the facility. Construction began in 2019 and was completed in October 2020. With the new plant constructed, LCA has been able to achieve compliance with NPDES No. PA0036081.

Sanitary Sewer Overflows

On March 14, 2018, a sanitary sewer overflow (SSO) was discovered at the plant's equalization tank. A fernco coupling on an air lift pump was disconnected causing a small volume of wastewater to discharge on the ground. After correcting the issue, the fitting was routinely examined for tightness in order to avoid additional SSOs from this location.

In 2018 Lehigh County experienced rainfall in amounts which far exceeded the typical yearly average. On August 4, 13, and 14, 2018, SSOs were observed at the equalization tank and main lift station.

Extensive rainstorms occurred during this period, releasing over 4.5" in consecutive storms. Inflow and infiltration hydraulically overloaded the equalization tank and lift station causing the overflows. After each event, the affected areas were cleaned of solids and treated with lime for disinfection.

$CBOD_5$

In January 2020, the $CBOD_5$ monthly average exceeded the permitted limit. Upon investigation, it was determined the aeration system's air diffusers were partially clogged, and therefore not functioning properly. After modifying the delivery piping and replacing the diffusers, the proper aeration was able to occur, and the plant was able to achieve effluent compliance.

Ammonia-Nitrogen

In May 2020, the ammonia-nitrogen monthly average exceeded the permitted limit. The nitrification process requires ample dissolved oxygen for bacteria to convert ammonia to nitrate. Due to a deteriorating plant, sufficient oxygen was no longer being supplied to complete the nitrification process. While a new plant was being constructed, a portable blower was brought onsite. Delivery piping was installed in June and an additional blower was placed online June 4, 2020. After the modification, sufficient dissolved oxygen levels were able to be reached within the aeration reactors and the plant was able to achieve compliance.

Fecal Coliform

The prior Wynnewood WWTP used sodium hypochlorite for disinfection before discharge to the Lehigh River. Ample contact time must be utilized for effective disinfection with sodium hypochlorite. The plant had frequent issues of short circuiting causing insufficient contact time and incomplete mixing. The result of this was inconsistent fecal deactivation which caused permit exceedances in June 2018, August 2019, September 2019, December 2019, and May 2020. LCA does not have record of a fecal coliform exceedance in January 2020 as listed on the NOV letter. However, one was reported for the January 2021 monitoring period. This exceedance occurred at the newly constructed Wynnewood WWTP, which uses ultraviolet disinfection. The cause of these exceedances cannot be contributed to a direct cause. To mitigate future exceedances, LCA will increase the maintenance of the UV system. The manufacturer of the system recommends replacing the bulbs on an annual basis due to lost intensity or increased risk of failure. In the future, LCA will replace them every six months and increase the cleaning schedule to weekly.

Reporting

In September 2016, a daily effluent monitoring reported was submitted one day late for the August 2016 monitoring period. This occurred during a transition period of personnel. Staff have been retrained on the proper process and the importance of timely submittals.

Inspection

The Department conducted an inspection on April 11, 2019, in which two total residual chlorine results were above the instantaneous maximum limit. The samples were collected during a period of low effluent flow due to a weekly process adjustment. The sodium hypochlorite feed was not adjusted to account for the low flow causing high results. To minimize this issue, dichlorination tablets were used for future low flow events. The current facility uses ultraviolet disinfection; therefore, this is no longer a concern.

Summary

The majority of the violations outlined in this Notice of Violation are attributed to aging and malfunctioning equipment and outdated processes that have been addressed through a complete replacement of the Wynnewood Terrace WWTP. The new plant was placed into service in October 2020, and LCA expects to see a significant improvement in plant performance as a result.

Lehigh County Authority is committed to our regulatory responsibilities, and we always strive for full compliance. If you have any questions, please do not hesitate to call me at 610-437-7681.

Sincerely,

Andrew Moore
Compliance Manager

cc: Liesel Gross, LCA
John Parsons, LCA

LEHIGH COUNTY AUTHORITY 1053 SPRUCE ROAD * P.O. BOX 3348 * ALLENTOWN, PA 18106-0348
610-398-2503 * FAX 610-398-8413 * www.lehighcountyauthority.org
email: service@lehighcountyauthority.org

MEMORANDUM

TO: LCA Board of Directors
FROM: John Parsons, Chief Operating Officer
Jason Gruber, Manager of Distribution and Collection
DATE: September 17, 2021
RE: Condition Assessment Report for 36" and 30" DIP

On December 14-15, 2020, Pure Technologies (a Xylem brand) in coordination with Gannet Fleming Inc, performed a condition assessment of approximately 1.09 miles of 36" and 30" Class 50 DIP that was installed in 1983. A total of 328 individual pipes were analyzed. The assessment included 2,624' of 36" DIP located from 17th/Chew to 17th/Union and 3,128' of 30" DIP located from 17th/Chew to 22nd/Chew.

Of the 328 individual pipe segments inspected, there were two (2) anomalies found on the 36" DIP that were indicative of pipe wall loss. These two locations are separated by 1,992'. Pipe wall loss in these (2) sections had an estimated depth of 35%-40% of the nominal pipe wall thickness. There were five (5) anomalies found on the 30" DIP that were indicative of pipe wall loss. These five locations were all within approximately 252' of each other. Pipe wall loss in these (5) sections had an estimated depth of 30%-40% of the nominal pipe wall thickness.

Based on thorough reviews of the data collected, Pure Technologies presented six (6) recommendations moving forward. All six (6) are listed below, along with the current status for each.

1. Perform a structural analysis, including Finite Element Analysis, on the identified sections of 30" DIP. **Noted, and tentatively planned for later in 2021.**
2. Perform transient pressure monitoring for at least 30 days to evaluate current operating pressures and if surge conditions exist. **Flow testing was done at 17th/Elm for 30 days this past summer. Average line pressure was 92 psi, with a maximum pressure of 95 psi.**
3. Perform an acoustic leak survey while the pipes are on-line to access lower defect detection thresholds and further evaluate pipe joints, and potential pipe leaks and/or trapped air. **LCA will use in-house staff and equipment to perform a leak survey on both sized pipelines. Exact timing TBD.**
4. Perform further investigation of the identified sections of 30" DIP because of their close proximity. See #5. **This is planned for Fall, 2021. See #1.**
5. Excavate some/all of the (7) identified sections and verify pipe wall loss. Collect soil samples for corrosion testing. **Several identified sections will be excavated later this fall. Depending on**

findings, there is a possibility that all seven (7) defect areas will be exposed and evaluated. Some pipe sections, fittings, etc have been ordered and once received, the test digs will be scheduled.

6. Perform another electromagnetic inspection in five (5) years to monitor and evaluate further deterioration. **Noted, but subject to change depending on findings.**

Depending on the results of #1-5 above, and particularly #5, further action may be warranted. When excavations occur, Pure Technologies will supply field support, dig sheets, identification of locations, and verification of distress. Pure will use non-destructive field testing to accomplish this. Afterwards, the Pure report will be updated and resubmitted based on any new and/or revised findings. Should any excavated pipe be replaced, consideration will be given to calibrate the replaced pipe to quantify pipe loss defects.

The six (6) recommendations and action items will be reviewed and updated as needed based on the dig tests and the subsequent update of the findings.

Xylem's report is attached to this memo for those who would like to review the details of this assessment.

xylem
Let's Solve Water

PureRobotics® Condition Assessment Report

30- and 36-inch DIP Transmission Main

Gannet Fleming, Inc. and Lehigh County Authority

August 2021

pure TECHNOLOGIES
a xylem brand

3040 Route 22 West, Suite 130 | Branchburg, NJ 08858 | Tel: +1 (908) 526-6600 | **xylem.com**

Quality Assurance and Quality Control Statements

This report has been prepared and reviewed in accordance with the Quality Assurance and Quality Control procedures of Pure Technologies, a Xylem brand:

August 11, 2021

C.J. Roebuck, P.E. — Date
Project Manager

Editorial Review Statement

This report has been prepared and reviewed for editorial content in accordance with the Quality Assurance and Quality Control procedures of Pure Technologies, a Xylem brand:

June 11, 2021

Linda Konopka — Date
Editorial Reviewer

Technical Review Statement

This report has been prepared and reviewed for technical correctness in accordance with the Quality Assurance and Quality Control procedures of Pure Technologies, a Xylem brand:

August 5, 2021

Anna Santino, P.E. — Date
Technical Reviewer

Contractual Review Statement

This report has been reviewed for contractual completeness in accordance with the Quality Assurance and Quality Control procedures of Pure Technologies, a Xylem brand:

June 15, 2021

David Smith — Date
Contractual Reviewer

Confidentiality Clause

TABLE OF CONTENTS

Executive Summary

On December 14 and 15, 2020, Pure Technologies, a Xylem brand (Pure Technologies), conducted an electromagnetic inspection of the ductile iron pipe (DIP) in the 30-inch and 36-inch Transmission Main. The evaluation was performed using Pure Technologies' proprietary PureRobotics® platform, a non-destructive electromagnetic inspection technology. The purpose of the inspection was to locate and identify pipes that have indications of pipe wall loss defects. The inspection covered a cumulative distance of 1.09 miles and spanned a total of 328 pipes between 17th Street and Chew Street and 22nd Street and Chew Street and between 17th Street and Chew Street and 17th Street and Union Street. The electromagnetic inspection scope is presented in Table ES.1.

Table ES.1: Scope of the Electromagnetic Inspection

Pipeline	Diameter (inches)	Start Station[1]	End Station[1]
DIP Transmission Main	36	17+30	43+54
	30	43+90	75+18

[1]*Station numbers are approximated from the plan and profile drawings and electromagnetic data.*

Pure Technologies' evaluation of the 30-inch and 36-inch DIP Transmission Main concluded that of the 328 inspected pipes, seven (7) anomalies characteristic of pipe wall loss were detected across a total of seven (7) pipes. The results are summarized below.

- 36-inch Section
  - Two (2) pipes were identified with a pipe wall loss anomaly.
  - The area of a pipe wall loss anomaly ranged from 12 to 13 square inches.
  - The pipe wall loss anomalies were quantified with an estimated depth ranging from 35 percent to 40 percent of the nominal pipe wall thickness.
- 30-inch Section
  - Five (5) pipes were identified with a pipe wall loss anomaly.
  - The area of a pipe wall loss anomaly ranged from 11 to 16 square inches.
  - The pipe wall loss anomalies were quantified with an estimated depth ranging from 30 percent to 40 percent of the nominal pipe wall thickness.

As part of the inspection, structural analysis of the 36-inch DIP Transmission Main was also performed, and an AWWA C150 design check was completed to determine if the nominal pipe wall thickness was adequate for current loading conditions. Based on the C150 design and normal operating pressures, the nominal wall thickness exceeds the minimum required wall thickness over the length of the inspected pipeline. Therefore, the installed pipe wall thickness of 0.43-inches is greater than the minimum required thickness, including all allowances, in the structural design check. Results are presented in Section 4.2.

A finite element model was developed for the 36-inch DIP Transmission Main and subjected to similar internal and external loading to create a chart with the pipe design's Yield Limits based on pressure, earth/live loading, and pipe wall defect depth and dimension. The Yield Limit identifies the specific wall thickness required to maintain an un-deformed state, the elastic zone. This parameter is used to determine the safety of the pipeline. Any wall thickness measurements less than this limit should be considered for rehabilitation or replacement. Figure ES.1 presents the results of the FEA on the 36-inch DIP Transmission Main, any pressures and defect lengths can be evaluated on the graph to determine respective Yield. Pure Technologies used a maximum working pressure of 200 psi (70 psi operating plus 130 psi design surge) to evaluate the minimum defect size to Yield, which was determined to be four (4) inches in length at 80 percent corrosion.

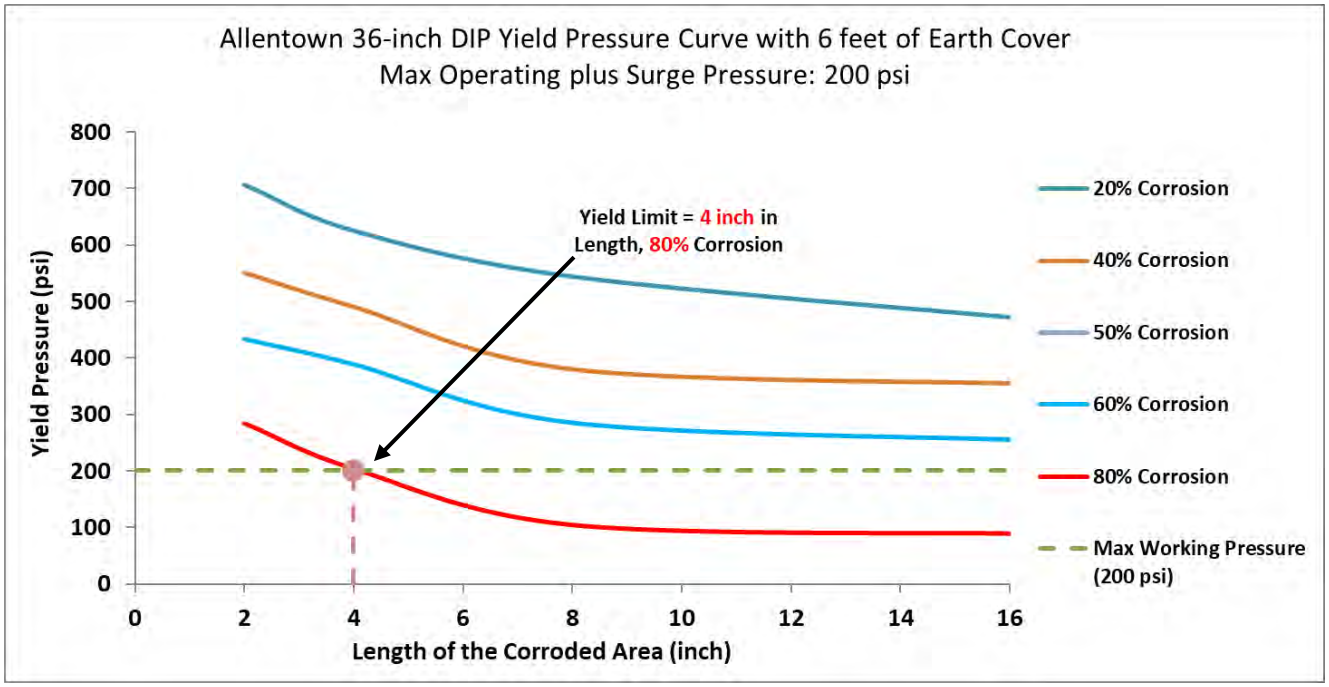


Figure ES.1: Finite Element Analysis Results for 36-inch DIP Transmission Main

Recommendations

Based on the PureRobotics inspection and structural analysis performed on December 14 and 15, 2020, Pure Technologies recommends the following:

1. Perform a Structural Analysis that includes an FEA to determine the structural significance of the identified distress on the 30-inch DIP Transmission Main.
2. Perform transient pressure monitoring for a minimum of 30 days with hydraulic analysis to evaluate operating pressures and determine if pressure surges are occurring during normal operation of the pipeline. If measured pressures exceed the provided operating and design surge pressures used, then the distressed pipes will need to be re-evaluated in the structural analysis.

3. The electromagnetic data collected by the PureRobotics' tool has an estimated minimum defect detection threshold of three (3) inches by 30 percent wall loss. To evaluate the transmission main for defects below this threshold and the condition of the pipe joints, perform an acoustic survey while the pipeline is in operation to identify potential leaks or pockets of trapped air in the pipeline that could not be detected during the PureRobotics inspection.
4. Pure Technologies recommends investigating the distressed pipes on the 30-inch transmission main due to the close proximity of these distressed pipes to determine the cause.
5. Due to the failure history on the 36-inch DIP Transmission Main, consider excavating distressed pipe on the 30-inch and 36-inch DIP Transmission Mains to perform verification of the pipe wall loss defects identified and collect soil samples for corrosion testing.
    a. If pipe is excavated, Pure Technologies will provide under the current contract field support, including creation of dig sheets, mark out of the locations, and verification of the distress using non-destructive external wall thickness measurements. Additionally, Pure Technologies will provide a revised report incorporating and summarizing the verification findings.
    b. Consider performing calibration on replaced pipe to provide necessary information to quantify pipe wall loss defects.
6. Reinspect the 30-inch and 36-inch DIP Transmission Main electromagnetically in five (5) years to monitor and evaluate deterioration of the identified distress and condition of the transmission main.

1. Project Background

1.1. Pipeline Description

Gannet Fleming contracted Pure Technologies to perform an electromagnetic inspection and condition assessment of the 30-inch and 36-inch ductile iron pipe (DIP) Water Transmission Main, which is owned and operated by the Lehigh County Authority. The inspection used Pure Technologies' PureRobotics platform and covered approximately 5,800 feet (1.09 miles) of the transmission main. The inspected portion of the transmission main is composed of 30-inch and 36-inch Class 50 DIP and was installed by Mele Construction Company in 1983, which is a nominal pipe wall thickness of 0.39-inches and 0.43-inches, respectively. The same access location was used to inspect the 30-inch DIP Transmission Main towards the west along West Chew Street and the 36-inch DIP Transmission Main towards the south along North 17th Street.

1.2. Project Scope

In December of 2020, Pure Technologies conducted an electromagnetic inspection of the DIP in the 30-inch and 36-inch DIP Transmission Main using the PureRobotics inspection platform. The purpose of the inspection was to locate and identify pipes that have indications of pipe wall loss defects. Corrosion is the primary cause of failure in metallic pipelines. Since the only structural component is the pipe wall itself, any loss in cross-sectional area due to corrosion has an immediate impact on the overall strength of the pipe. Structural engineering was performed on the 36-inch DIP Transmission Main to provide information regarding the structural capacity of the pipe under the current loading conditions and evaluate the condition of the identified pipe wall loss defects.

1.3. Reviewed Documents

To complete the assessment of the 30-inch and 36-inch DIP Transmission Main, Pure Technologies reviewed the following documents:

(1981). Project No. 17-40, Allentown, PA West End Feeder 30" DIP Water Main. City of Allentown, PA: Department of Public Work.

(1981). Project No. 17-40, Allentown, PA West End Feeder 36" DIP Water Main. City of Allentown, PA: Department of Public Work.

United States Pipe and Foundry Company, LLC. Report of Investigation. D.A. Hughes, Jr. Bessemer, Alabama. May 2020.

1.4. DIP Overview

Commercial introduction of DIP occurred in the mid-1950s and became the material of choice for ferrous pressure pipe by the early 1970s. Ductile iron is produced by adding specified amounts of magnesium, cerium, or sodium alloy to a molten iron with low phosphorus and low sulfur content. The magnesium alloy changes the microstructure by causing the elemental carbon to

form spheroidal or nodular graphitic shapes, contrasting with the flake form found in spun-cast iron. This consistent microstructure of spheroidal graphite, when combined with an annealing process, increases both the strength of the iron and its ductility. Therefore, the wall thickness of DIP is significantly less than cast iron pipe (CIP) while providing the same structural capacity.

The required thickness for DIP is determined via three (3) considerations: limiting stress in the pipe wall due to internal pressure (working and surge), limiting stress due to external load (soil and traffic), and limiting the horizontal deflection of the pipe. The latter is primarily intended to prevent cracking of a cement mortar lining. For internal pressure, the hoop tensile stress is limited to 50 percent of the minimum yield strength (42 kips per square inch [ksi]). For external load, the bending stress is limited to either 50 percent of the design bending stress (48 ksi) or 66.7 percent of the minimum yield strength.

One of the challenges in assessing DIP is determining if the pipe has undergone any loss of wall thickness due to internal or external corrosion. The reason for this difficulty relates to the manufacturing process and the casting thickness tolerances established in AWWA C151. Table 1.1: DIP Casting Tolerance compares the casting thickness tolerance for various diameters.

Table 1.1: DIP Casting Tolerance

Diameter Range (inches)	Casting Tolerance (inches)
3-8	0.05
10-12	0.06
14-42	0.07
48	0.08
54-64	0.09

There is also an allowance for a further thickness variation of 0.02 inches within 12 inches.

DIP manufacturers do not publish or release information on actual manufacturing tolerances. However, Pure Technologies has observed through multiple condition assessment projects for DIP that most of the variance is apparent along the length of the barrel rather than around the circumference. This occurrence is related to the casting process, in which the molten iron is fed into a spinning mold and centrifugal force is employed to distribute the iron around the circumference. There is no maximum thickness tolerance in AWWA C151; therefore, it is reasonable to expect to see a similar thickness distribution on the plus side of the nominal. This wide variance makes it difficult to obtain in-situ wall thickness (or stiffness) measurements and produce conclusive evidence that wall loss has occurred without visual confirmation. Measured thicknesses would have to be in excess of this manufacturing tolerance to conclusively determine that wall loss has occurred. Therefore, unless significant wall loss is observed through initial condition assessment activities, the data should be used as a baseline and compared to future inspection results in order to develop a higher confidence in management and rehabilitation/replacement strategies. A typical DIP cross section can be seen in Figure 1.1.

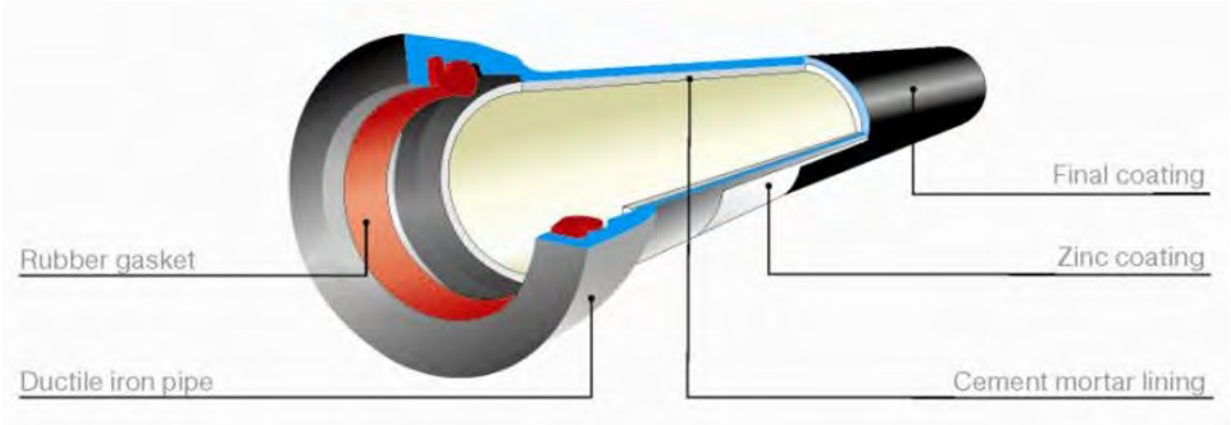


Figure 1.1: Cross Section of a DIP

2. Inspection Overview

The PureRobotics electromagnetic inspection took place on December 14 and 15, 2020. Preparation work for the inspection was completed on December 14. The Pure Technologies on-site team was supported by Gannet Fleming, Inc. and Lehigh County Authority. On December 14, the PureRobotics tool was inserted into the transmission main at 17th Street and Chew Street.

2.1. Description of the PureRobotics Platform

PureRobotics is a modular multi-sensor robotic inspection platform that uses electromagnetics to identify areas of pipe wall loss in metallic pipes. The tool creates an electromagnetic field that interacts with the pipe wall as it moves through the pipeline. Where pipe wall loss defects exist, the electromagnetic field is changed. This field data is recorded by the detectors and stored onboard the tool. Post-inspection, analysts identify, quantify, and locate areas of wall loss defects.

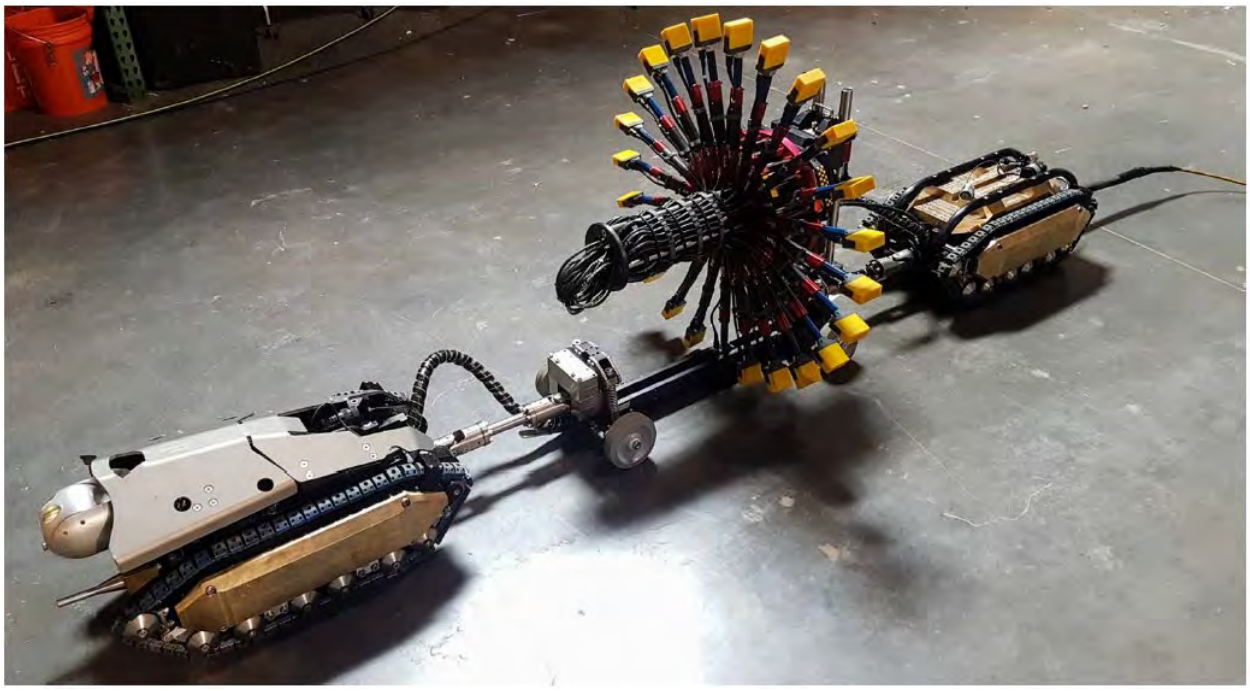


Figure 2.1: PureRobotics Inspection Platform

The tool is made up of several modules containing the electronics, computers, and batteries required for generating and collecting electromagnetic inspection data (Figure 2.1). The exciter is located in the body of the tool while the detectors are positioned circumferentially at the tips of the petals, so they are as close as possible to the pipe wall. Electromagnetic inspections evaluate the electromagnetic signature of the pipe wall to identify anomalies that are produced by variations in the pipe thickness due to wall loss or manufacturing defects. Various characteristics associated with an electromagnetic anomaly (length, magnitude, signal shift, etc.) are evaluated. If calibration information is available with specifications similar to the pipeline being inspected,

then quantification of the size and depth of pipe wall loss anomalies can be provided (refer to Section 3.3 for more details on calibration).

2.2. PureRobotics Insertion

The PureRobotics tool was inserted into the 30-inch and 36-inch DIP Transmission Main at an installed 36x36x24-inch tee at 17th Street and Chew Street (STA 43+72) and inspecting upstream to the butterfly valve (BFV) at 22nd Street and Chew Street (STA 75+23) and downstream to the BFV at 17th Street and Union Street. Figure 2.2 below shows the general alignment aerial of the inspection scope. Figure 2.3 (next page) below shows the insertion of the PureRobotics tool into the transmission main.

Figure 2.2: General Alignment of 30-inch and 36-inch DIP Transmission Main

Figure 2.3: PureRobotics Insertion

3. Inspection Results

3.1. Electromagnetic Inspection Results

Electromagnetic data was collected on December 14 and 15, 2020, for the 30-inch and 36-inch DIP Transmission Main using the PureRobotics electromagnetic inspection platform. The inspected section spanned an overall distance of 1.09 miles and a total of 328 pipes. Pure Technologies' inspection schedule is presented in Table 3.1.

Table 3.1: Inspection Summary

Date	Pipeline	Diameter (inches)	Start Station	End Station	Distance
December 14 and 15, 2020	DIP Transmission Main	36	17+30	43+54	0.50 miles
		30	43+90	75+18	0.59 miles
Total Distance					1.09 miles

All station numbers are approximated from plan and profile drawings.

The reported distance is based on electromagnetic data, and accounts for partially inspected pipes and non-inspected sections.

A visual summary of the inspection results is presented in Figure 3.1.

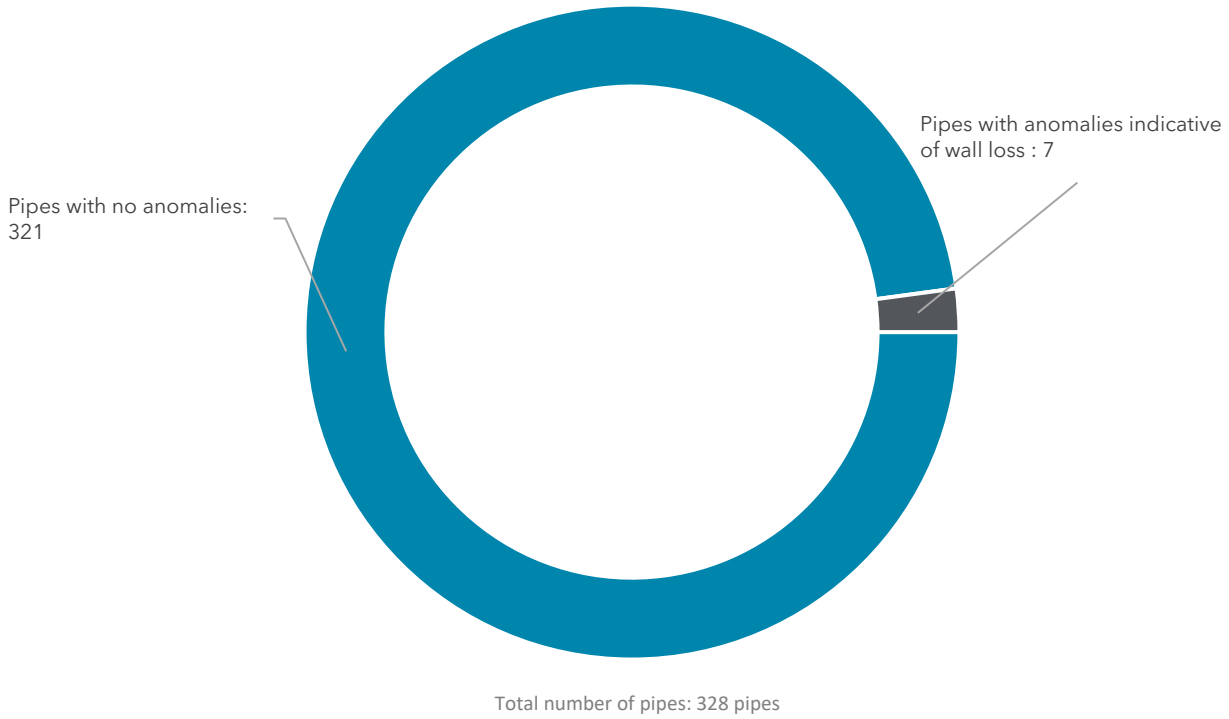


Figure 3.1: Inspection Results

3.1.1. Pipes with Pipe Wall Anomalies

Of the 328 inspected pipes, seven (7) pipes had electromagnetic anomalies consistent with pipe wall loss defects.

- 36-inch Section
    - Two (2) pipes were identified with a pipe wall loss anomaly.
    - The area of a pipe wall loss anomaly ranged from 12 to 13 square inches.
    - The pipe wall loss anomalies were quantified with an estimated depth ranging from 35 percent to 40 percent of the nominal pipe wall thickness, based on calibration testing performed at other sites.
- 30-inch Section
    - Five (5) pipes were identified with a pipe wall loss anomaly.
    - The area of a pipe wall loss anomaly ranged from 11 to 16 square inches.
    - The pipe wall loss anomalies were quantified with an estimated depth ranging from 30 percent to 40 percent of the nominal pipe wall thickness, based on calibration testing performed at other sites.

Table 3.2 details each pipe wall loss anomaly.

- The Pure Reference Number is the unique pipe number assigned by Pure Technologies for reference only and does not correlate with existing pipeline information.
- The Pipe Wall Anomaly Longitudinal Position is measured from the low station joint of the pipe to the center of the anomaly and is rounded to the nearest 0.5 feet.
- The Pipe Wall Anomaly Circumferential Position is looking towards the high station joint and is rounded to the nearest five (5) degrees. The 12 o'clock position is at zero (0) degrees. Refer to Figure 3.2 for the radial layout of circumferential degrees and clock position.
- The Pipe Wall Anomaly Area is based on the longitudinal length and the number of sensors that detected the anomaly. The anomaly is assumed to be square and is rounded to the nearest square inch.
- The Estimated Depth of Pipe Wall Loss is the average estimated percentage of relative pipe wall thickness across the anomaly area based on Pure Technologies' calibration testing performed at other sites and is rounded to the nearest five (5) percent.

Wall loss anomalies identified in the electromagnetic data are quantified by calculating the overall volumetric loss of the pipe wall. To visualize the volumetric change, the anomaly is reported as an estimated square area and percentage of relative loss of the pipe wall thickness across the anomaly area. Although anomalies with a large area and shallow depth of pipe wall loss will have similar characteristics in the electromagnetic data as anomalies with a small area and deeper depth of pipe wall loss, the overall volumetric loss will remain the same.

The estimated size of pipe wall loss anomalies is dependent on the proximity of the exciter and detector coils located on the PureRobotics inspection platform to the pipe wall. Calculations of the area and the depth of pipe wall anomalies is based on calibration testing at other sites, which assumes that the PureRobotics inspection platform was centered in the pipeline during the inspection.

A visual representation of the electromagnetic data of pipes identified to have pipe wall loss is detailed in Section 3.1.2.

Table 3.2: Pipes with Anomalies Consistent with Wall Loss

Pure Reference Number	Low Station	Pipe Length (feet)	Pipe Wall Anomaly Longitudinal Position (feet from Low Station)	Pipe Wall Anomaly Circumferential Position (degrees - looking toward High Station)	Pipe Wall Anomaly Area (square inches)	Estimated Depth of Pipe Wall Loss (% of nominal thickness)	Note
36-inch Section							
10011	18+73	18	11.5	330	12	35%	1
10125	38+65	18	8.0	45	13	40%	2
30-inch Section							
11025	48+14	18	11.5	210	11	35%	1
11026	48+32	18	12.0	150	13	40%	1
11033	49+58	18	11.5	105	13	40%	1
11038	50+48	18	12.0	315	16	35%	1
11039	50+66	18	11.5	60	13	30%	1

Note:

1. *Pipe wall loss anomaly is reported with less certainty due to variation in pipe property.*
2. *Pipe wall loss anomaly is reported with less certainty due to lack of signal repeatability.*

The electromagnetic data signal is sensitive not only to physical differences in pipe properties, but it is also sensitive to any magnetic differences in the metallic components of the pipe. Variations of a pipe's magnetic properties results in variations in the electromagnetic data, which can impact the detection capabilities and accuracy in the estimations of the pipe wall loss anomaly. For instance, the American Water Works Association's (AWWA) C150 Design Standard states that DIP may be manufactured with a wall thickness tolerance varying from 0.05 to 0.09 inches, depending on diameter, which may vary from pipe to pipe or along the length of one individual pipe.

Noise in the electromagnetic data was observed and affected the overall data quality. The noise was likely caused by tuberculation on the pipe wall which created a rough and uneven driving surface resulting in tool movement during data acquisition.

The affected pipes are listed in the Pipe List (Appendix B).

3.1.2. Electromagnetic Pipe Diagrams

To visualize the results, two-dimensional rollout graphs were created to illustrate the recorded electromagnetic data of each pipe identified with pipe wall loss defects.

Each rollout graph is laid out as if the pipes are split down the length of the crown and rolled out flat. The X-axis represents the distance, in feet, from the low station joint of the pipe. The Y-axis denotes the circumferential position of a pipe with reference to the clock position, where 12 o'clock represents the crown of the pipe and 6 o'clock represents the invert of the pipe. Figure 3.2 shows the radial layout of circumferential degrees and clock position when looking towards high station joint.

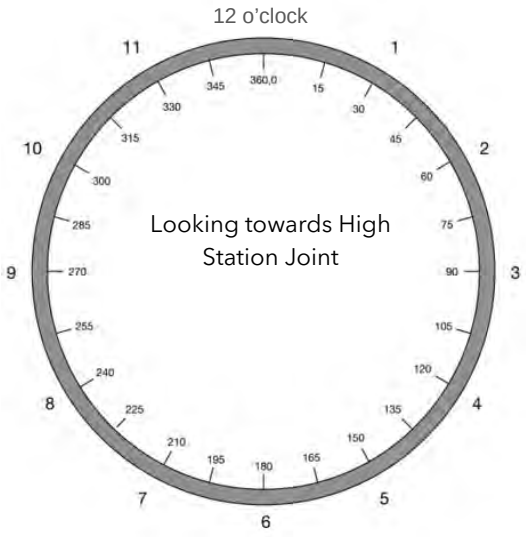
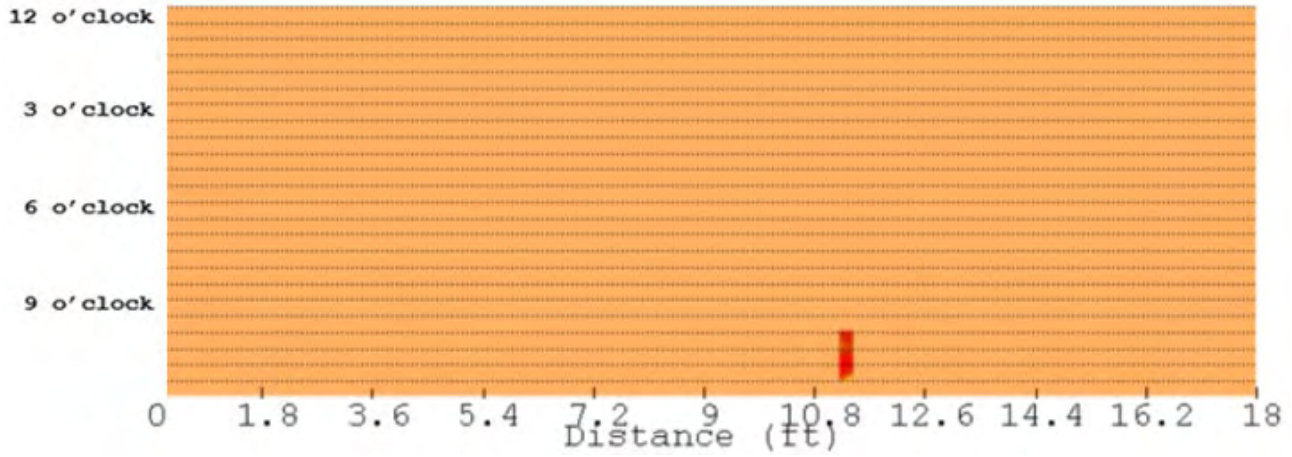


Figure 3.2: Radial Layout of Circumferential Degrees and Clock Position

The rollout graphs for the identified pipe wall loss anomalies in the 30-inch and 36-inch DIP Transmission Main are presented on the next page. The colors in these figures are meant for reference only to indicate the longitudinal and circumferential location of the anomalies on the pipes and cannot be used to infer pipe depth. The red color represents the location of the identified pipe wall loss defects.

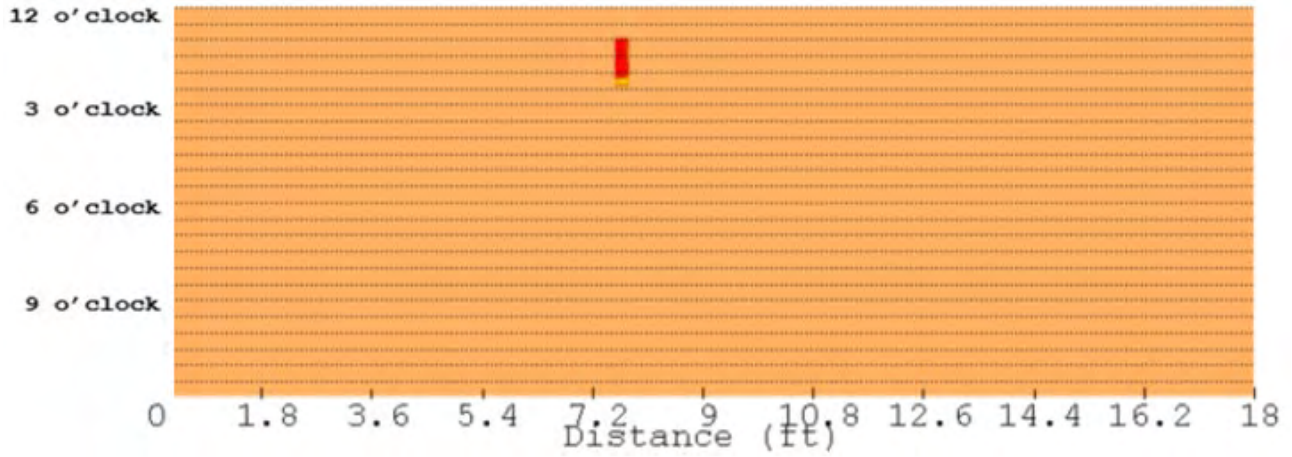
Pure Reference Number 10011

Pipe rollout graph:



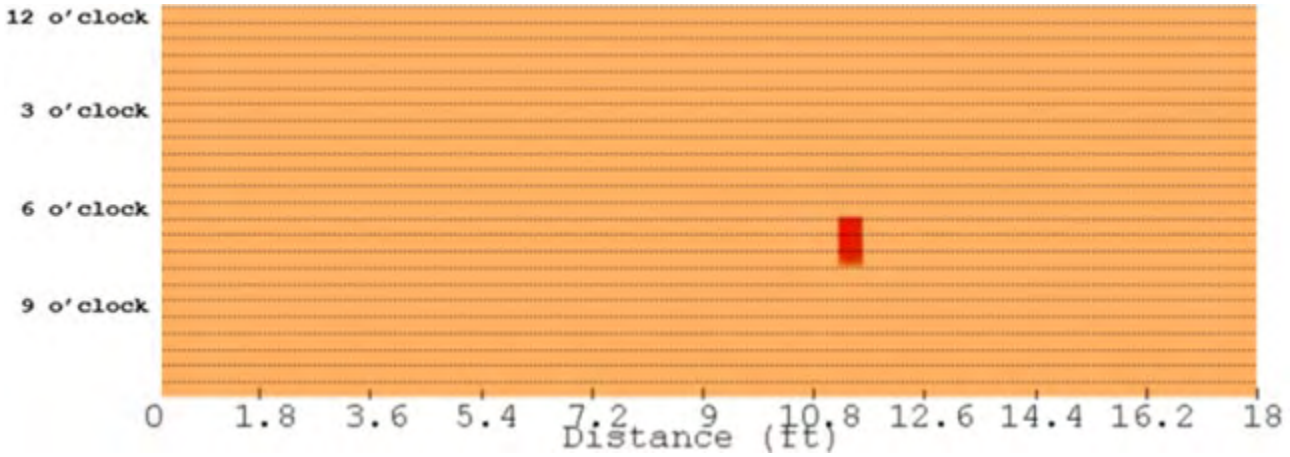
Pure Reference Number 10125

Pipe rollout graph:



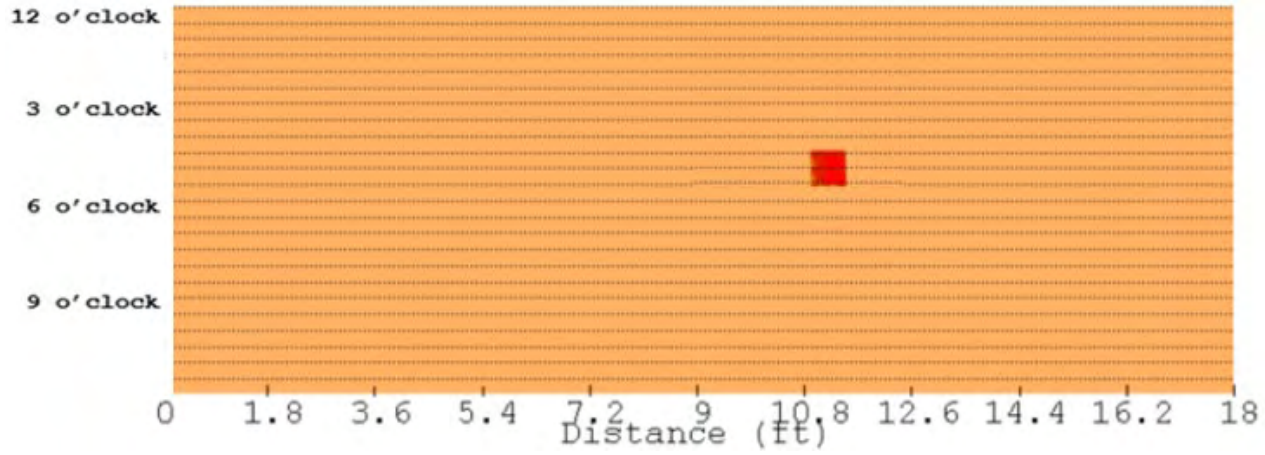
Pure Reference Number 11025

Pipe rollout graph:



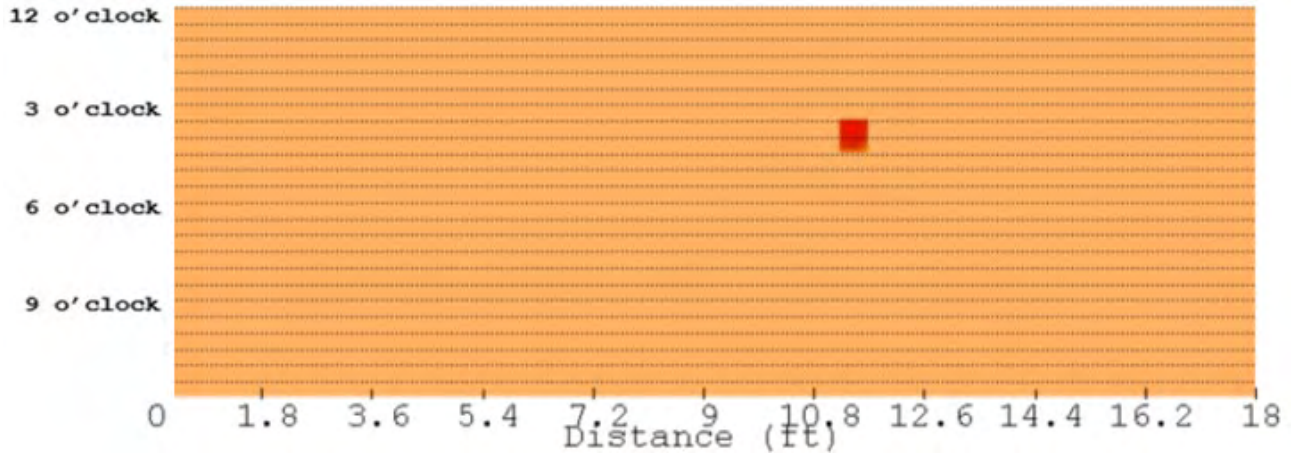
Pure Reference Number 11026

Pipe rollout graph:



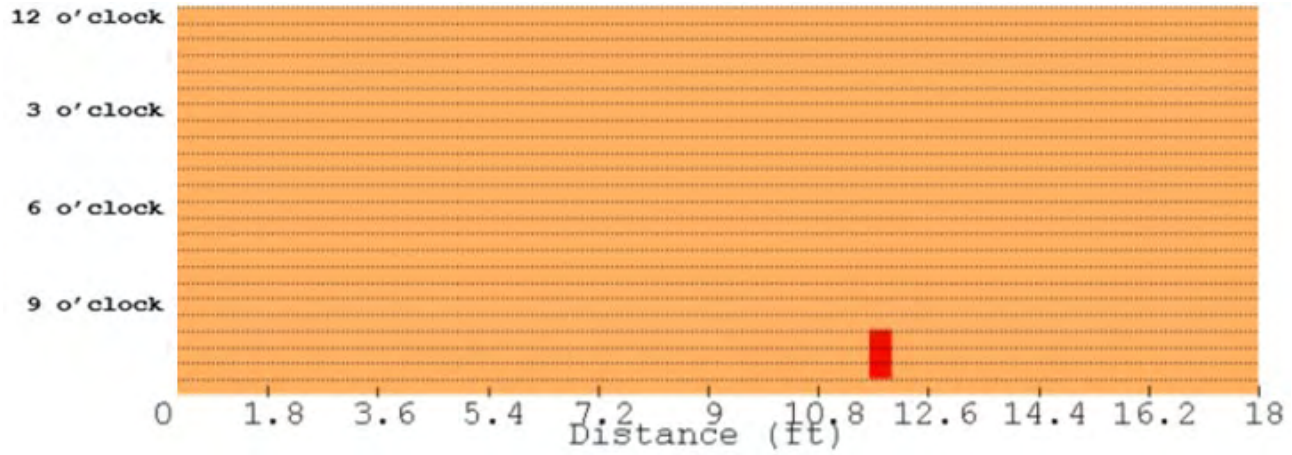
Pure Reference Number 11033

Pipe rollout graph:



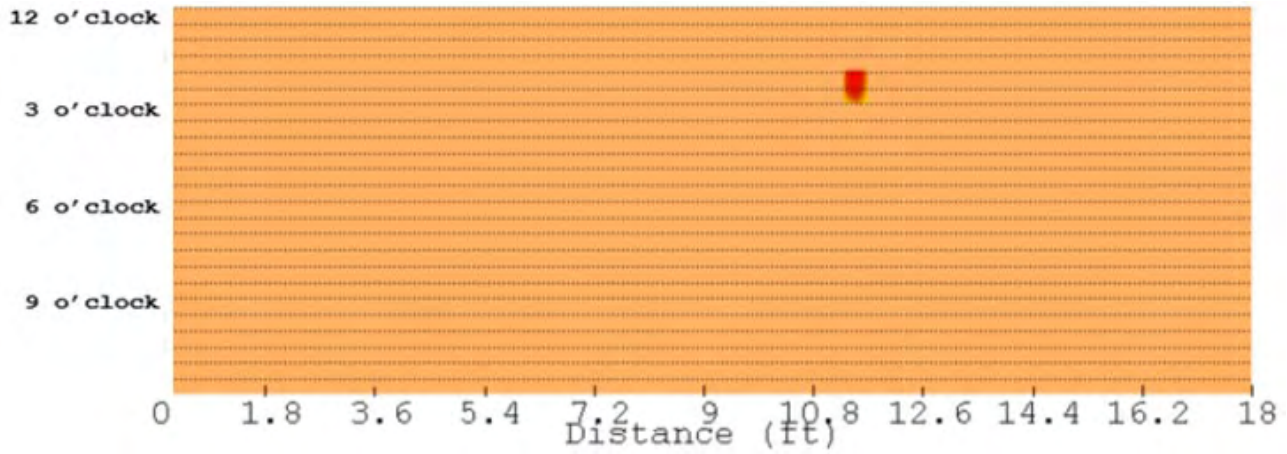
Pure Reference Number 11038

Pipe rollout graph:



Pure Reference Number 11039

Pipe rollout graph:



3.1.3. Repaired Pipes

Gannet Fleming, Inc. and the Lehigh County Authority provided Pure Technologies with the approximate location of three (3) repair sites in the 36-inch DIP Transmission Main, as summarized in Table 3.3. No repairs were provided for the 30-inch DIP Transmission Main.

Table 3.3: Repair Locations in the 36-inch DIP Transmission Main

Pure Reference Number	Diameter (inches)	Low Station	Pipe Length (feet)	Note
10023	36	20+84	5	May 2020 repair near 17th Street and Walnut Street. A section of pipe was replaced. Repair is observed in the electromagnetic data.
10133	36	40+09	14	Suspected location of June 1991 repair near 17th Street and Russell Street. Bell pack sleeve installed. Repair is not observed in the electromagnetic data.
10134	36	40+23	4	February 2020 repair near 17th Street and Russell Street. A section of pipe was replaced. Repair is observed in the electromagnetic data.

3.2. Locating Pipes with Defects

An important part of the data analysis process is correlating the electromagnetic data to the physical pipe in which it was collected. Features that can be identified in the electromagnetic data, such as inline valves, bends or outlets, are used as correlation points. An example of data correlation from another pipeline is illustrated in Figure 3.3. Pipe lengths are derived from a combination of the inspection tool's odometer and the Plan and Profile drawings.

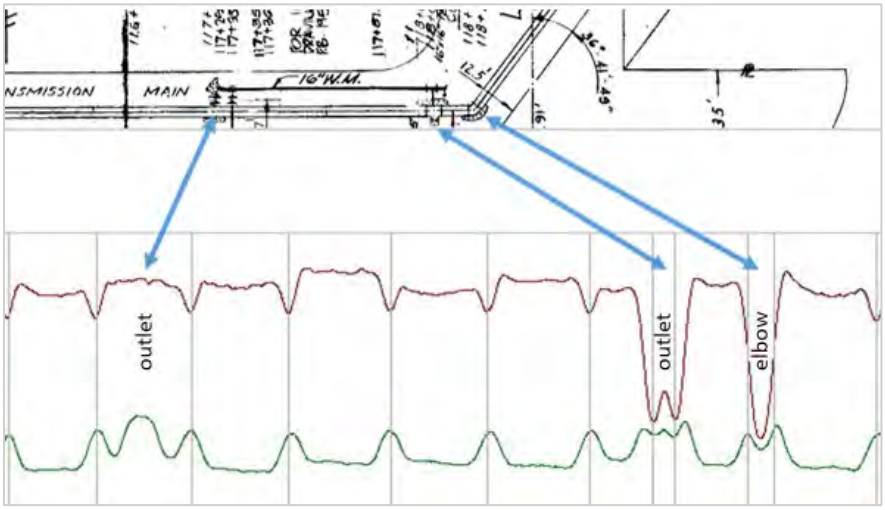


Figure 3.3: Data Correlation Example from Another Pipeline

Once the electromagnetic data has been correlated to the pipeline, a Pipe List is generated for reference. The Pipe List is a record of all the inspected pipes and can be used as a reference when trying to locate any specific pipes. Most pipe joints are visible in the electromagnetic data which makes producing a pipe list possible; however, some joints may be masked by bends, nearby joints, or casings and encasements. The distances provided in the Pipe List table are based on the information provided; Gannet Fleming, Inc. and the Lehigh County Authority provided Pure Technologies with the plan and profile drawings for the inspected portions of the 30-inch and 36-inch DIP Transmission Main. The best way to locate a specific pipe is to measure the distance from the nearest known locatable feature on both sides of the target pipe. Pure Technologies has extensive experience in locating and verifying pipes and is available to assist with any excavations or investigation. Please contact Pure Technologies for assistance. The Pipe List can be found in Appendix B.

Figure 3.4 shows the inspected portions of the 30-inch and 36-inch DIP Transmission Main and the approximate location of pipes that were identified with wall loss anomalies.

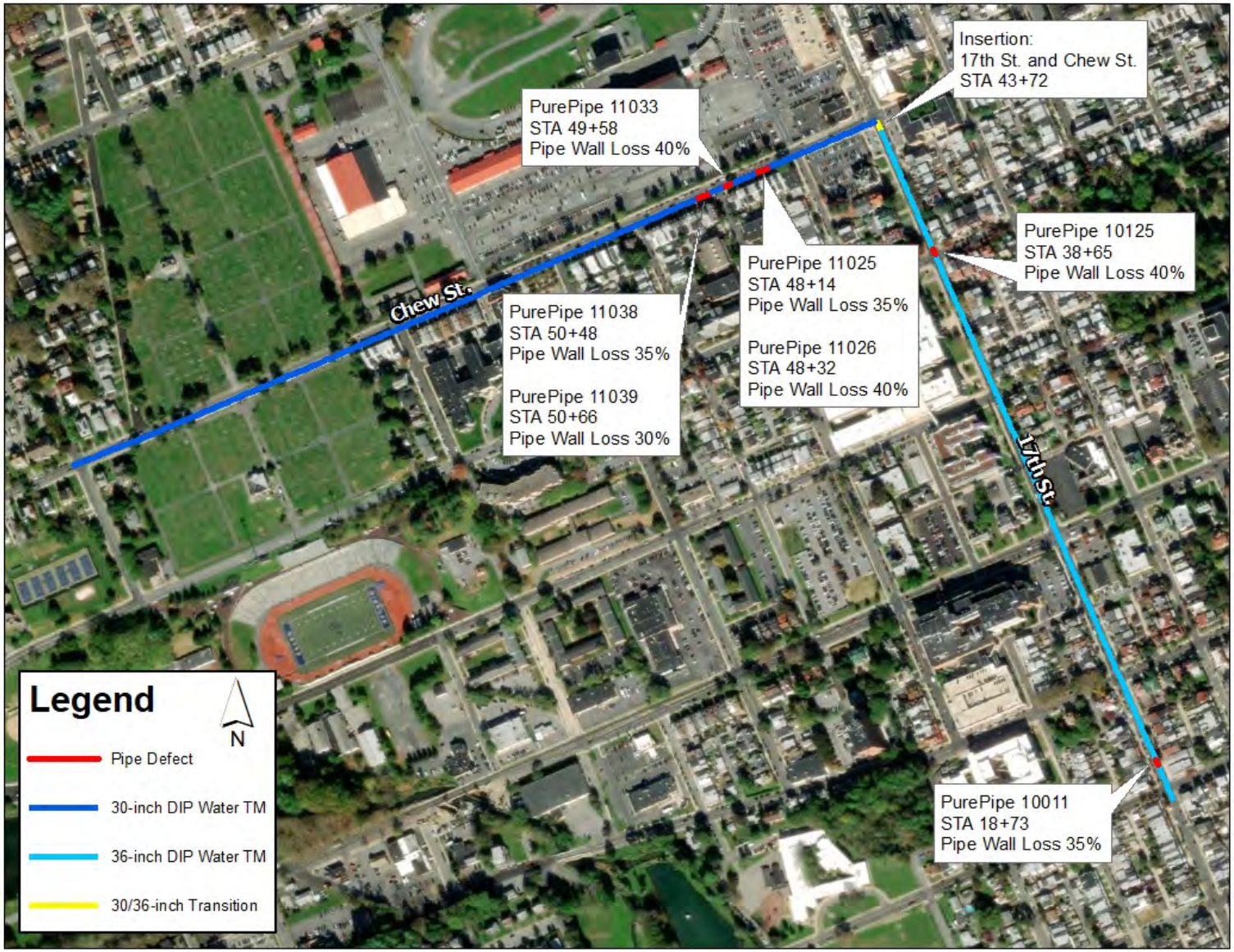


Figure 3.4: 30-inch and 36-inch DIP Transmission Main Anomalies

3.3. Quantification of Defects through Calibration

Effective quantification of defects identified in electromagnetic data requires knowledge of how the electromagnetic signal behaves without pipe damage (baseline condition) and the ability to compare that baseline condition to the data signal received from the pipe when it is damaged. Because the data signal is sensitive to pipeline properties (e.g., pipe wall thickness, material, pipe diameter, etc.), two (2) pipes with the same diameter, but with different classes, will exhibit different baseline signals. Additionally, these pipes will produce signals that respond differently to pipe wall loss.

To understand how the data signal responds in varying conditions, Pure Technologies performs calibration scans on pipes similar to the inspected pipe. The calibration process involves scanning a pipe or set of pipes with properties (i.e., material, diameter, pipe wall thickness, etc.) that are as close as possible to the properties of the in-situ pipe. These representative pipes are initially scanned to establish the baseline signal. Pure Technologies uses this information to assess signal variation due to the pipe properties alone.

Once the baseline signal has been established, additional scans are performed on the pipe while systematically varying the size of the pipe wall loss defects and recording the response. The results from the calibration testing are incorporated into Pure Technologies' analysis software. At this point, an experienced data analyst can measure an anomaly signal and compare it to the calibration information to quantify the size and depth of the pipe wall loss defects.

While the calibration process was not performed on pipes from the 30-inch and 36-inch DIP Transmission Main, the calibration information applied to the 30-inch and 36-inch DIP was based on Pure Technologies' experience at other test sites. Pure Technologies has accumulated a database of calibration information from varying diameters of metallic pipe that can be applied to the inspected pipes. Variations between the specifications of the calibration pipe and the inspected pipes are summarized in Table 3.4.

Table 3.4: Comparison of Calibration and Inspected Pipes

Pipes	Diameter (inches)	Pipe Type	Pipe Class	Pipe Wall Thickness (inches)
Calibration	24	DIP	N/A	0.47
Transmission Main	30	DIP	50	0.39
	36	DIP	50	0.43

The minimum size of a pipe wall loss anomaly detectable by Pure Technologies' electromagnetic tool for the 30-inch and 36-inch DIP Transmission Main is estimated to have 30 percent wall loss and longitudinal length of three (3) inches.

If a wall loss anomaly is smaller than the minimum size stated above, detection may be possible only when the sensor is close to the anomaly (i.e., sensor passes directly under the anomaly).

Furthermore, variations in pipe properties alter the baseline condition of the electromagnetic data. Defects identified on pipes with variations in pipe property are reported with less certainty due to the variation in the electromagnetic data baseline condition.

Additionally, if calibration or validation testing is performed on any pipes from the 30-inch and 36-inch DIP Transmission Main at a future date, the results can be applied to the data from this inspection to refine the estimations of pipe wall loss.

For more details regarding the calibration process, electromagnetics capabilities, limitations, and functions, refer to Appendix A.

3.4. Confidence Codes in Pipe List

The PureRobotics inspection platform's capability to detect and quantify pipe wall loss anomalies is impacted by the amount of tuberculation/debris in the pipeline, the availability of calibration information, and availability of as-built specifications. If inspection conditions are not optimal, then the results may be reported with less certainty.

The analysts' confidence in the identification and quantification of pipe wall loss anomalies is reported on a pipe-by pipe basis using "confidence codes" in the Pipe List in Appendix B.

3.4.1. Confidence Codes for Detection of Pipe Wall Loss

Tuberculation/debris in the pipeline may cause noise to be present during the data collection using the PureRobotics inspection platform and the electromagnetic data quality may be impacted. The minimum size of a pipe wall loss anomaly detectable by Pure Technologies' electromagnetic tool is expected when the data quality is optimal and minimal noise is observed in the data. When noise is present in the data for one (1) or more inspection runs, the minimum size of pipe wall loss anomaly detectable by the Pure Technologies' electromagnetic tool may be larger than expected. A confidence ***color*** code is used in the Pipe List to represent how the observed noise affected data analysis.

3.4.2. Confidence Codes for Quantification of Pipe Wall Loss

The availability of calibration information and pipe specifications of the inspected pipeline affect the analysts' ability to accurately quantify pipe wall loss. A confidence ***number*** code may be assigned to pipes with identified pipe wall loss in the Pipe List based on the availability of calibration information and pipe specifications.

4. Structural Analysis

4.1. Design Specifications

The design properties used in the calculations are summarized in Table 4.1. An important input for the structural evaluation is the actual operating pressure of the pipeline. The client provided Pure Technologies the operating pressure and volumetric flow for the 36-inch DIP Transmission Main, which was utilized within the calculations to determine the resulting minimum wall thickness. In lieu of a measured surge pressure, the value used in the analysis was calculated using the C150 design standard.

Table 4.1: Constants Used for Structural Analysis

Parameters	
Inside Diameter of the Pipe (inch)	36
Assumed Pipe Class	50
Assumed Design Thickness (inch)	0.43
Pipe Effective Length (inch)	36
Yield Strength (psi)	42,000
Volumetric Flow (cfs)	22.3
Design Bending Stress (psi)	48,000
Gamma of the Soil (pcf)	120
Weight of Fluid (pcf)	62.4
Gravity (ft/s^2)	32.2
Young's Modulus (ksi)	24,000
Bulk Modulus (ksi)	290
Max. Allowable Deflection (%)	3
Manning Coeff	0.011
Initial Pressure into the Pipeline (psi)	70
Calculated Surge Pressure (psi)	130
Initial Elevation (ft)	112
Specific weight of liquid (lb/cu in)	0.0361
Depth of water table (ft)	6.5
Impact Factor	1.5
Bedding Moment Coefficient	0.189
Deflection Coefficient	0.103
Modulus of Soil Reaction (psi)	400

4.2. AWWA C150 Design Check

Pure Technologies performed a structural analysis of the 36-inch DIP Transmission Main to determine if the nominal pipe wall thickness was adequate for current loading conditions. Often loading conditions change between the design of the pipe and the current day demands. Pure Technologies utilizes the DIP design standard, AWWA C150 *Thickness Design of Ductile-Iron Pipe* (AWWA C150-08) as well as AWWA C151 *American National Standard for Ductile-Iron, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids* (AWWA C151), the contemporary DIP manufacturing guideline.

Using the equations presented in the current design standard for DIP, Pure Technologies calculated the minimum pipe wall thickness required to withstand both internal pressure and external loading along the length of the pipeline. Since internal pressure and external load act in opposite directions, they are analyzed as separate loading conditions with the higher required thickness governing.

Since the only structural component of a DIP is the ductile iron itself, any loss of cross-sectional area due to corrosion has an immediate impact on the overall strength of the pipe. Calculating the required thickness and comparing that to the measured thicknesses for each pipe can show which pipes have an available factor of safety should corrosion wall loss occur and which pipes are mostly likely to fail should any damage to the ductile iron take place. Checking the minimum required thickness per the design criteria gives a first level of understanding the current conditions and the significance of any damage found.

4.2.1. Design Check Results

The as-built drawing provided for the 36-inch DIP Transmission Main indicates that the pipe is Class 50 and the nominal wall thickness is 0.43 inches. Using the equations in C150, the minimum required thickness, including a +/- 0.07-inch service allowance, for each pipe was calculated. Based on the C150 design and normal operating pressures, the nominal wall thickness exceeds the minimum required wall thickness over the length of the inspected pipeline. The results are graphically shown in Figure 4.1 (next page) where the minimum nominal (installed) thickness is shown in red (dashed line). Using the design check to assess the severity of the defects is a very conservative way to evaluate their significance. The impact of the significance in this case assumes that the wall loss applies to the entire circumference of the pipe. To more accurately determine the impact of a defect, finite element modeling was utilized and can be found in Section 4.3.

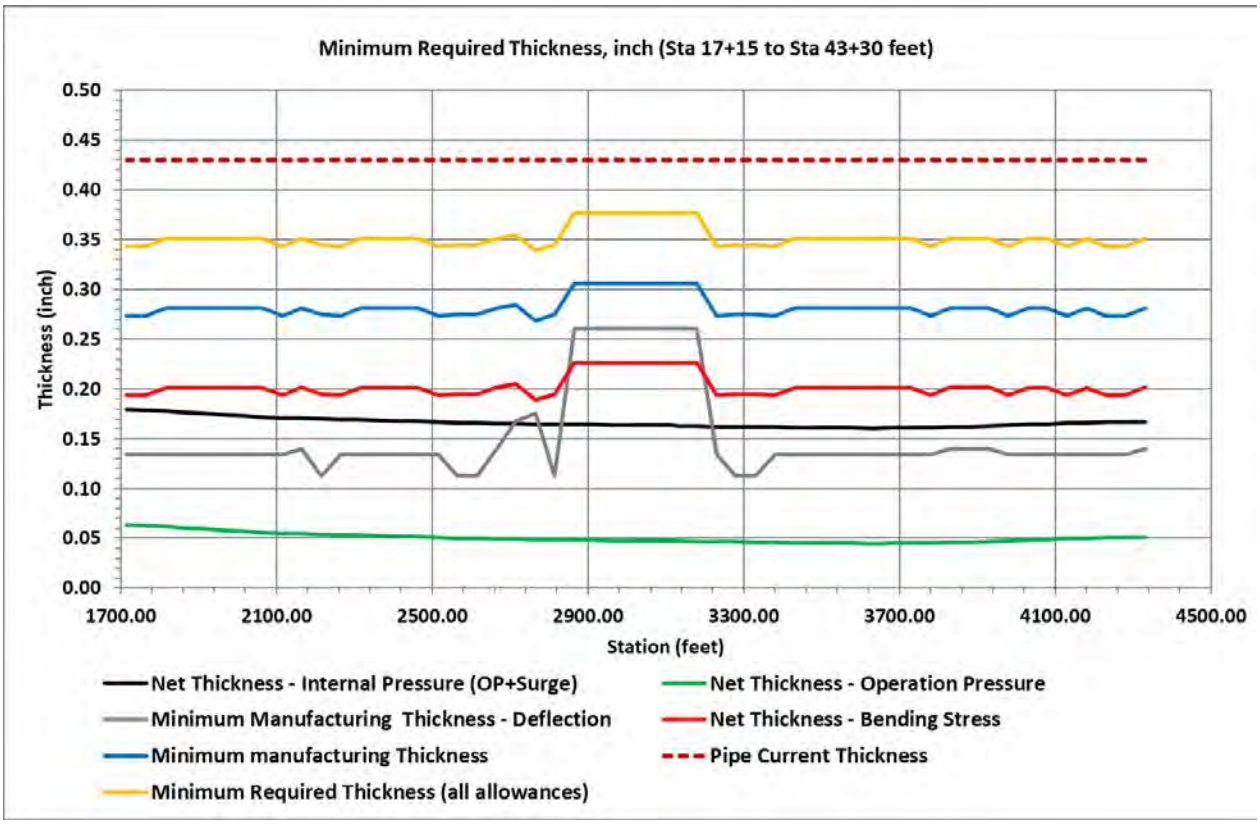


Figure 4.1: AWWA C150 Structural Design Check

4.3. Finite Element Analysis

To develop actionable information from data generated during the non-destructive field testing, Pure Technologies has developed a condition-based pipeline management model based on structural evaluation of DIP. This model incorporates data from the operation of the transmission main, as-built drawings, depth of cover, and industry design specifications. Prior to the implementation of any inspection techniques or technologies, a preliminary structural evaluation of the transmission main was conducted. The results of this model are presented in a pipeline condition curve that allows for both the localized and systemic condition evaluation of the transmission main. This curve represents the Yield Limit of the ductile iron force main along its length, which identifies the specific wall thickness required to remain in the elastic zone.

The establishment of minimum wall thickness of DIP for water and wastewater services is typically performed using ANSI/AWWA C150/A21.50, which provides guidance for the minimum wall thickness based on several operational factors including operating and surge pressure, pipe embedment type, depth of cover, and live load conditions. Prior to 1991, DIP was classified based on thickness class rather than by today's standard of pressure class. Thickness class designations include Classes 50 through 56 and generally as the thickness class increases, so does the minimum wall thickness and associated pressure/loading capacity.

Along with depth of cover, pressure is one of the primary data inputs when conducting a structural evaluation of DIP. While most of the 36-inch DIP Transmission Main operates below the design capacity of a particular material, when pipe wall degradation is combined with the operational pressure or surge pressure, the likelihood of failure can be significantly increased.

4.3.1. FEA Results

A finite element model was created using the design properties found in Table 4.1. This model can subject the distressed pipes to internal and external loading to achieve a similar chart that will determine the pipe design's Yield Limits based on pressure, earth/live loading, and pipe wall defect depth and dimension. The Yield Limit identifies the specific wall thickness required to maintain an un-deformed state, the elastic zone. This parameter is used to determine the safety of the pipeline. Any wall thickness measurements less than this limit should be considered for rehabilitation or replacement. Figure 4.2 presents the results of the FEA on the 36-inch DIP Transmission Main, any pressures and defect lengths can be evaluated on the graph to determine respective Yield. Pure Technologies used a maximum working pressure of 200 psi (70 psi operating plus 130 psi design surge) to evaluate the minimum defect size to Yield, which was determined to be four (4) inches in length at 80 percent corrosion.

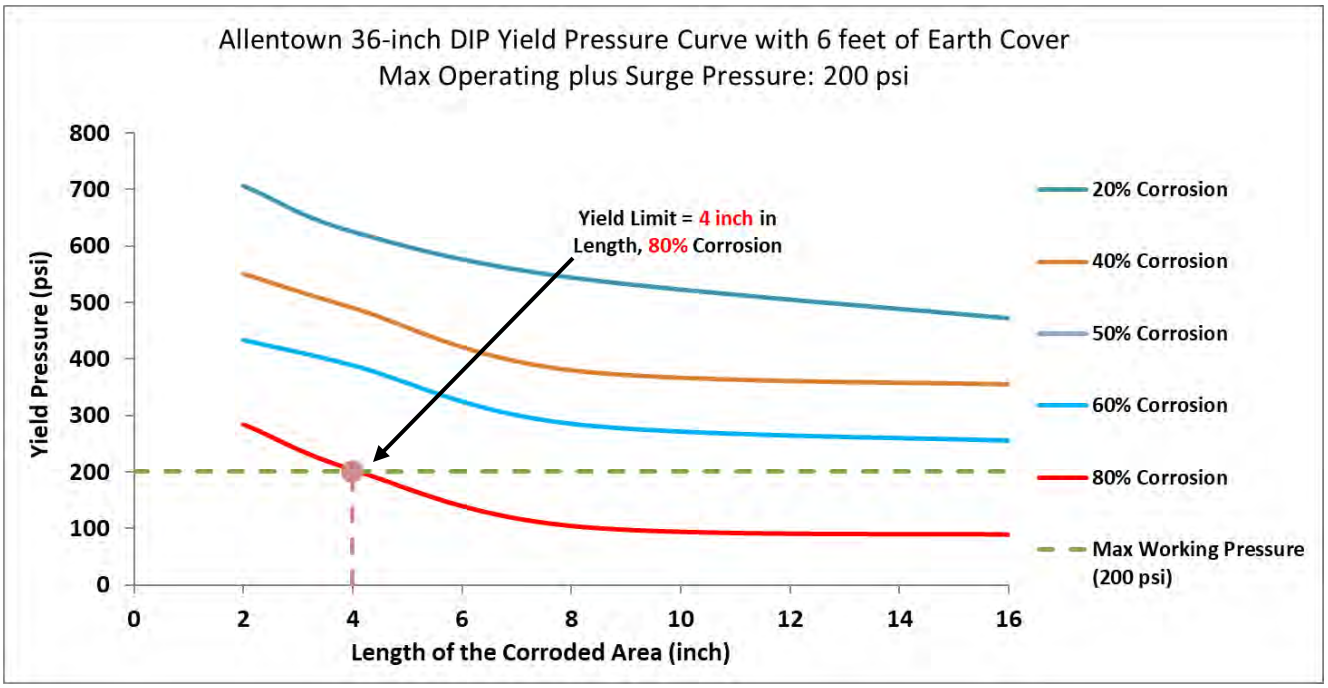


Figure 4.2: Finite Element Analysis Results for 36-inch DIP Transmission Main

5. Conclusions and Recommendations

5.1. Conclusions

Based on the PureRobotics inspection and structural analysis performed on December 14 and 15, 2020, Pure Technologies concluded the following:

- Of the 328 inspected pipes, seven (7) pipes had electromagnetic anomalies consistent with pipe wall loss.
    - 36-inch Section
        - Two (2) pipes were identified with a pipe wall loss anomaly.
        - The area of a pipe wall loss anomaly ranged from 12 to 13 square inches.
        - The pipe wall loss anomalies were quantified with an estimated depth ranging from 35 percent to 40 percent of the nominal pipe wall thickness, based on calibration testing performed at other sites.
    - 30-inch Section
        - Five (5) pipes were identified with a pipe wall loss anomaly.
        - The area of a pipe wall loss anomaly ranged from 11 to 16 square inches.
        - The pipe wall loss anomalies were quantified with an estimated depth ranging from 30 percent to 40 percent of the nominal pipe wall thickness, based on calibration testing performed at other sites.
- As part of the structural analysis of the 36-inch DIP Transmission Main, an AWWA C150 design check was performed to determine if the nominal pipe wall thickness was adequate for current loading conditions. Based on the C150 design and normal operating pressures, the nominal wall thickness of 0.43-inches exceeds the minimum required wall thickness over the length of the inspected pipeline.
- An FEA analysis was performed on the 36-inch DIP Transmission Main and found that the pipe wall loss defect detected in Pipe 10011, which was reported as 12 square inches with 35 percent corrosion across, would reach the yield limit at approximately 425 psi.
- An FEA analysis was performed on the 36-inch DIP Transmission Main and found that the defect detected in Pipe 10125, which was reported as 13 square inches with 40 percent corrosion across, would reach the yield limit at approximately 360 psi.

5.2. Recommendations

Based on the PureRobotics inspection and structural analysis carried out on December 14 and 15, 2020, Pure Technologies recommend the following:

1. Perform a Structural Analysis that includes an FEA to determine the structural significance of the identified distress on the 30-inch DIP Transmission Main.
2. Perform transient pressure monitoring for a minimum of 30 days with hydraulic analysis to evaluate operating pressures and determine if pressure surges are occurring during normal operation of the pipeline. If measured pressures exceed the provided operating and design surge pressures used, then the distressed pipes will need to be re-evaluated in the structural analysis.
3. The electromagnetic data collected by the PureRobotics' tool has an estimated minimum defect detection threshold of three (3) inches by 30 percent wall loss. To evaluate the transmission main for defects below this threshold and the condition of the pipe joints, perform an acoustic survey while the pipeline is in operation to identify potential leaks or pockets of trapped air in the pipeline that could not be detected during the PureRobotics inspection.
4. Pure Technologies recommends investigating the distressed pipes on the 30-inch transmission main due to the close proximity of these distressed pipes to determine the cause.
5. Due to the failure history on the 36-inch DIP Transmission Main, consider excavating distressed pipe on the 30-inch and 36-inch DIP Transmission Mains to perform verification of the pipe wall loss defects identified and collect soil samples for corrosion testing.
    a. If pipe is excavated, Pure Technologies will provide under the current contract field support, including creation of dig sheets, mark out of the locations, and verification of the distress using non-destructive external wall thickness measurements. Additionally, Pure Technologies will provide a revised report incorporating and summarizing the verification findings.
    b. Consider performing calibration on replaced pipe to provide necessary information to quantify pipe wall loss defects.
6. Reinspect the 30-inch and 36-inch DIP Transmission Main electromagnetically in five (5) years to monitor and evaluate deterioration of the identified distress and condition of the transmission main.

APPENDIX A

Electromagnetic Inspection Technology

A1 Electromagnetic Inspection Technology

A1.1 Background and Theory of Electromagnetic Inspection

For years, it has been possible to exploit the concept of eddy currents to measure structural properties in metals. The application of a time-varying magnetic field to metal structures can create internal electric currents as free electrons which are driven by the field along discontinuities in the metal itself. Many applications of this phenomenon have been developed to detect damaged sections in steel and iron pipelines.

Electromagnetics are used to generate an electric current in the pipe wall. A signal generator outputs a low frequency alternating electric current into a coil of wire, known as an exciter coil, positioned at the center or near the surface of the pipe. The magnetic field generated by this coil extends through the liner and into the pipe wall. As the coil travels along the length of the pipe, the field also moves creating a localized magnetic field that generates eddy currents in the pipe wall.

When the pipe wall is uniform, the current will flow uniformly through the pipe wall; however, if a defect exists, a distortion in the current is formed. As the magnetic field passes over the section of pipe wall loss, currents are generated that form opposing magnetic field lines. These disruptions in the uniform magnetic field are recorded by the inspection tool for further analysis. The analysis and interpretation of the response of the magnetic field allows for estimates of the size and depth of the pipe wall loss, as well as its approximate location along the length of the pipe.

With pipe wall loss, the detection capabilities are heavily dependent on the proximity of the detector sensor to the pipe wall and to the defect. When the detector lift-off is greater than 2 inches or 50 millimeters, the signal of the wall loss anomaly is minimized and can potentially be masked by the noise in the data. Therefore, a constant tool speed is required to ensure that the noise is kept at a minimum.

A1.2 Analysis Considerations

Electromagnetic inspections detect electromagnetic anomalies, or differences, in the expected induced field of a metallic pipeline. Anomalies that are consistent with pipe wall loss are important; however, the induced field of interest is small and other sources of interference can mask or distort the size and shape of the electromagnetic signal. The accuracy of pipe wall loss detection depends on several factors including, but not limited to:

1. Accuracy and completeness of the information supplied by the client
2. Type and configuration of pipe being inspected
3. Availability of relevant calibration information

4. Type, complexity, location, and number of pipe wall loss anomalies in a given pipe
5. Inspection conditions observed in the pipe during the data collection period

Accuracy and completeness of the information supplied by the client. The inspection system is sensitive to all magnetic properties of a pipe, including pipe wall thickness and composition. Pure Technologies uses the information provided by the client to perform the analysis. Drawings that indicate the exact location of pipe features and varying pressure classes are used to correlate the inspection data. Drawings that indicate how each class of pipe is constructed are used to identify and quantify regions with pipe wall loss. Discrepancies between the drawings and the data may affect the accuracy of the analysis.

Unknown or sealed appurtenances along the pipeline. Although most appurtenances exhibit a signal that is different and distinguishable from pipe wall loss, in some cases, the signals are similar and an appurtenance could be misinterpreted as pipe wall loss if it is not listed on the drawings and not visible during the inspection.

Existence of ferromagnetic (steel) materials near the pipeline. When extra steel is in close proximity to the pipeline, it can cause a signal distortion that may mask an area with pipe wall loss and could also cause anomalies that may be misinterpreted as pipe wall loss.

Discontinuities or variations such as abnormal welding in liner construction. These discontinuities can mask actual damage or mimic damage where none exists.

Proximity to power lines. In some cases, power lines can cause distortion in the signal due to the stray magnetic fields. This can limit the effectiveness of the analysis if the distortion is too severe; however, this interference is rare.

Motion. Turbulence, excessive debris/build up, and passing through bends or valves all produce distortion which can affect the quantification of pipe wall loss or may mask actual damage in those areas. The inspection tool is designed to move as smoothly as possible to ensure optimum data quality, however, contact with the pipe wall is inevitable in some situations. Areas where noise are present and may reduce the confidence in defect detection are noted in the Pipe List.

Thickness of Pipe Wall. For the current electromagnetic system, if the thickness of pipe wall is greater than 0.5 inches or 13 millimeters, or the diameter of pipe is greater than 36 inches or 914 millimeters, accuracy of detection will decrease. Even within the optimal pipe size and configuration, the resolution and precision of measurement is affected by pipe material's permeability. This factor can be obtained through proper calibration. Pure Technologies maintains a database for steel, ductile iron, and cast-iron pipes that aids the estimation. However, if no calibration is applicable for a given inspected pipeline, the detected anomalies can only be ranked to show comparative severity level.

Feature Pipes. The electromagnetic technology can detect pipe wall loss in some feature pipes; however, due to the impact of the feature on the electromagnetic signal, results are presented with less certainty for regions of the pipe near fittings, manholes, blowoff valves, or other features.

Longitudinal Anomaly Position. The signal of a pipe wall loss anomaly varies along the length of a given pipe. Pipe wall loss anomalies close to the middle of a pipe are easier to detect and measure than anomalies near the joint. The increased presence of metal at the joint causes a distinct signal response which may affect the signal of the anomalies. The minimum size of anomalies required for the signal to be detectable and quantifiable near the joint depends on the pipe type, joint configuration, proximity of anomaly to the joint. As a result, pipe wall loss estimates located close to the middle of a pipe will be provided with greater confidence than near the joints.

Circumferential Anomaly Position. The position of an individual anomaly can be accurately determined in data within 0.5 feet or 0.1 meters longitudinally, and within 15 degrees circumferentially. However, sometimes due to vehicle tilting or rotation, circumferential positioning could be off by one (1) or two (2) detectors. If there are multiple anomalies too close together that they begin to merge into a single signal, only the center of signal will be used for estimating the position. This estimation could cause a discrepancy in the determination of the anomaly position of up to 30 degrees.

Effects of Joints. End effects refer to changes in the data signal near the end of a pipe (bell or spigot, if applicable) that are due to a variety of installation methods of the pipe joint itself. End effects do not refer to anomalies at the joint. Beveled spigots, pulled joints, mitered joints, butt straps, closure pieces, steel fittings, etc., will all affect the data signal at the end of a pipe in some way. Research in this specific area has provided methods for analysts to determine if the signal is due to an end effect, or true anomaly. The differences are subtle, and examination of client records can provide the additional information necessary to conclude whether a particular data signal represents end effects or anomalies. In the case where both end effects and anomalies exist, quantification is more challenging.

Background Signal Variations. The electromagnetic data signal is sensitive not only to physical differences in pipe properties, but it is also sensitive to any magnetic differences in the metallic components of the pipe. Pipe manufacturers may use different material suppliers for the various components of the pipes within a pipeline. Even though two (2) pipes are manufactured exactly the same physically, if the steel for the pipe wall comes from different suppliers, they will likely have slightly different magnetic properties, which will result in variations in the background signals. Much like the fingerprint, every pipe in a pipeline, no matter how alike they are supposed to be, will exhibit a slightly different background signal. Since anomalies are quantified by measuring the anomaly signal relative to a background signal, any variations between background signals can affect the accuracy of the measurement and ultimately the estimates of the pipe wall loss anomaly. For instance, according to American Water Works Association's

(AWWA) C150 Design Standard, ductile iron pipe may be manufactured with a certain wall thickness tolerance, varying from 0.05 to 0.09 inches depending on diameter, which may vary from pipe to pipe or along the length of one individual pipe. All these factors will result in variations in the background signals.

Number of Pipe Wall Loss Anomalies. Results are predicted with greater accuracy for pipes containing single anomaly regions than for pipes containing multiple anomaly regions. As the number of anomaly regions per pipe increases, or as these regions become closer together, the complexity of the interpretation increases. In some cases, anomaly regions can interact with each other from an electromagnetic standpoint to create signals of varying complexity.

Other Factors. There are often overlaps amongst the key issues listed above and there may or may not be other factors related to these issues that decrease the level of confidence in the results presented in the report. Wide variations in manufacturing processes may not impact the structural performance of the pipe but can significantly affect the electromagnetic properties. The list of factors includes ones that are known, unknown, controllable, and uncontrollable. Some can be confirmed during excavation or inspection and some can be eliminated by studying construction records, although errors in these records are common. In all cases, every effort is made to consider the various factors during analysis; however, it should be noted that the results provide an estimate of pipe wall loss in a pipe section based on all the information available and assuming that the signal changes are caused by discontinuity in pipe wall material.

Calibration of Pipe Wall. The calibration of pipe wall involves forming pipe wall defects of various sizes and arrangements while using a variety of instrument configurations to conduct the scans. Detection and quantification of pipe wall loss can then be determined based on calibration results. Depending on the clarity of data, small defects could be masked due to excessive noise. The diagram shown in Figure A1.1 depicts the various simulated defects that would be created on site during a typical calibration.

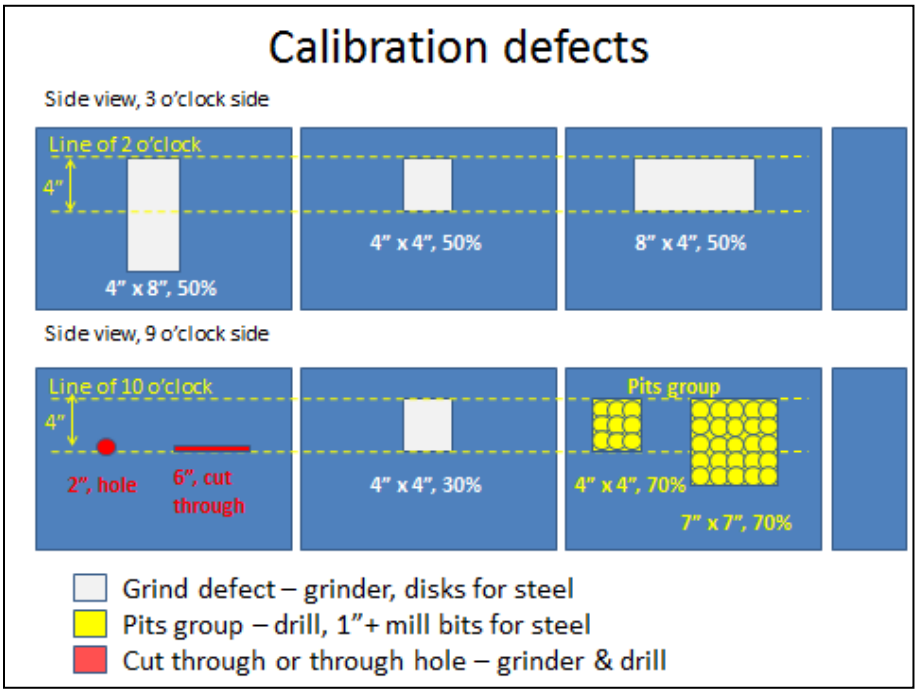


Figure A1.1: Sample of Defects Performed in a Pipe Wall Calibration