MID ATLANTIC CHAPTER

MID ATLANTIC JOURNAL OF TRENCHLESS TECHNOLOGY 2021

OFFICIAL PUBLICATION OF THE MID ATLANTIC SOCIETY FOR TRENCHLESS TECHNOLOGY

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MESSAGE FROM THE MASTT CHAIR

Richard Thomasson, P.E., MASTT Chair

We are very pleased to produce our seventh publication of the Mid Atlantic Society for Trenchless Technology (MASTT) Journal. The MASTT was founded in 2004 as a Chapter of the North American Society for Trenchless Technology (NASTT) and serves the geographical region of Virginia, West Virginia, District of Columbia, Maryland, Delaware, Pennsylvania, and New Jersey. The region has a huge population and many large municipalities and also, a large industrial base. The infrastructure is very large for water, sewer, stormwater, gas and electric, which in many cases is older and deteriorating. There is an overwhelming need for replacement and rehabilitation of the infrastructure which drives the interest in Trenchless Technology.

There are also a lot of major academic institutions in the Mid Atlantic region which are heavily involved in research on Trenchless Technology. Being close to the nation's Capital, creates a high visibility on infrastructure funding and interest in new technologies which can make tight budgets be used more effectively. There are also major industry leading technology and service companies within the MASTT region. Also, there are major trade associations such as NASSCO, ASCE, NSF, NIST, PPI and others, who are essential in the infrastructure industry. Each has done a tremendous amount of work in asset management being used to manage the replacement and rehabilitation of all infrastructure in the region. Because of the above factors, MASTT is a valuable grassroots resource for education, training, specifications, governance, funding and promotion of the trenchless industry.

Both private and public infrastructure owners across the region have used the new service products and innovation for trenchless work. Educating and introducing new trenchless technologies and services, MASTT has conducted 32 seminars throughout the Mid Atlantic region. These seminars have been very informative and have introduced Trenchless Technology to many people who were not aware of the information over the last 15 years. We are trying to incorporate some of the NASTT short courses into our seminar schedule. This year we had to cancel the two scheduled seminars due to the Covid virus.

We have an overwhelming opportunity and responsibility to bring the deteriorating infrastructure to an acceptable level of service for the huge populace that we serve. The infrastructure assets we are focusing on are generally out of sight and out of mind until a catastrophic failure occurs. A focus on asset management has started to address these assets in a structured and effective way. The major factors in asset management, such as condition assessment, risk management, safety, economic planning, and social factors flow seamlessly into trenchless technology as a major tool for accomplishing the desired outcomes. Environmental, social and economic factors are all addressed and greatly enhanced through the application of trenchless technology. Focus on performance, sustainability, and resiliency of the infrastructure systems to provide a level of service necessary to maintain a healthy nation are primary drivers in our vision for MASTT.

MASTT can be an integral part of the education of providers and users of the infrastructure which is critical to continued viability in the region. We need your participation and collaboration to be able to provide the resources to accomplish this vision. Join in active membership in MASTT and be a part of this critical work to enhance the infrastructure in our region.

> ***"BE A PART OF THIS CRITICAL WORK TO ENHANCE THE INFRASTRUCTURE IN OUR REGION."***

This has been a very tumultuous and challenging year for everyone. The Covid virus has affected everyone in some way. We need to keep everyone in our prayers as we continue to endure the devastation that occurs in everyone's life while trying to be safe and also serve others in any way we can. Although the trenchless work has been affected to some degree, the utility work has been deemed essential and work has continued although affected in various ways. We look forward to 2022 to gain some type of normal operation whatever that looks like. Stay strong, healthy and persevere for the future.

Thank you,

Richard Thomasson
Chair, MASTT

MASTT SITE

GREETINGS FROM THE MASTT EXECUTIVE DIRECTOR

Leonard Ingram, Sr., PWAM Executive Director, MASTT

I am the Executive Director for the Mid Atlantic (MASTT), Midwest (MSTT) and Southeast (SESTT) Society for Trenchless Technology. Covid 19 has caused the postponement of the Baltimore MD seminar and the Atlantic City NJ seminar again until 2022. I, along with MASTT Chapter Officers, investigated the Covid 19 conditions in these seminar areas as well as travel conditions to and from and decided it was too risky to conduct the seminars.

MASTT is planning the FREE TWO HOUR "**MASTT TRENCHLESS TECHNOLOGY 2021 FALL WEBINAR**" for Thursday, November 4, 2021, from 11:00 PM to 1:00 PM with four 30 minute presenters. The Webinar is conducted in conjunction with the NASTT Chapter Webinar Program and it will offer 2 PDHs. Topics and presentations will be chosen by the MASTT Board Executive Officers. Webinar Sponsorships are available for $250. ASAP, please contact Leonard Ingram at (334) 327-7007 or leonard@engconco.com to possibly be a Webinar Presenter and/or to be a Webinar Sponsor. A limited number of Sponsorships are available. Please review the Proposed 2021

"THANKS FOR YOUR SUPPORT"

Schedule below and try to support the Societies with your participation as much as possible.

Leonard E. Ingram, Sr., PWAM
Executive Director, MASTT, MSTT & SESTT

PLEASE REVIEW THE MASTT, MSTT AND SESTT 2021W PROPOSED SEMINAR, WEBINAR AND JOURNAL PUBLICATION SCHEDULE:

SOCIETY	LOCATION/PUBLISH	PROPOSED DATE	STATUS
MSTT SEMINAR	BALTIMORE MD	MAY 19, 2021 - WED	POSTPONED
SESTT SEMINAR	SAVANNAH GA	JUL 21, 2021 - WED	CONDUCTED
MSTT SEMINAR	MILWAUKEE WI	AUG 25, 2021 - WED	CONDUCTED
MASTT SEMINAR	ATLANTIC CITY NJ	SEP 22, 2021 - WED	POSTPONED
MASTT JOURNAL	PUBLISH DATE (DEADLINE 09/03/21)	SEP 24, 2021 - FRI	PUBLISHED
MSTT SEMINAR	CINCINNATI OH	OCT 27, 2021 - WED	PROPOSED
MASTT WEBINAR	NASTT/MASTT VIRTUAL 2 HOUR	NOV 4, 2021 – 11AM 1PM	PROPOSED
MSTT JOURNAL	PUBLISH DATE (DEADLINE 10/22/21)	NOV 12, 2021 - FRI	PROPOSED
SESTT JOURNAL	PUBLISH DATE (DEADLINE 11/12/21)	DEC 3, 2021 - FRI	PROPOSED
SESTT SEMINAR	MIAMI FL	DEC 8, 2021 - WED	PROPOSED

PLEASE CONTACT LEONARD INGRAM, PWAM, EXECUTIVE DIRECTOR, AT LEONARD@ENGCONCO.COM

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MESSAGE FROM NASTT CHAIR

Alan Goodman, NASTT Chair

The Value of Strong Volunteers

Hello Mid Atlantic Chapter Members! This year I began my term as Chair of NASTT's Board of Directors, and I am looking forward to seeing the continued progress and expansion of NASTT, the Mid Atlantic Chapter and the trenchless industry. The past year and a half has been truly unprecedented! We've seen challenges with communication and physical meetings due to the global pandemic, however the perseverance of our membership, sponsors, and trenchless community have enabled this society to rise above the circumstances and set our future for success. Due to unparalleled creativity and sheer effort, we will continue to experience growth and recovery as we work toward our common goals in 2021.

The NASTT 2021 No-Dig Show was recently held in Orlando, Florida at the end of March and was an excellent opportunity to meet together again to learn and network with our industry peers. We were excited to offer an On-Demand option for the folks that were unable to be onsite in Orlando. Virtual attendees accessed all 150+ pre-recorded technical presentations and had the ability to network with each other while learning more about each of our exhibitors through our virtual exhibit showcase. CEUs were given to virtual attendees.

TRAINING AND EDUCATION IS AT THE FOREFRONT OF OUR MISSION AS A SOCIETY

We've also begun planning for the 2022 No-Dig Show being held in Minneapolis, Minnesota in April of next year. Visit www.nastt.org for details.

NASTT exists because of our dedicated volunteers. With training and education at the forefront of our mission as a Society, we look forward to offering many creative options for trenchless training and education throughout the year including our Virtual Good Practices Courses and our virtual or in-person Regional Chapter meetings, conferences and webinars. Stay tuned as we roll out a wide range of opportunities to meet your professional needs.

Our Society is only as strong as our members and volunteers. I have gotten to see first-hand the time and sacrifice that each of you have made. Since our committees align with the strategic plan, I challenge our membership to participate in the NASTT committees. Education and the college curriculum will continue to evolve as we focus on bringing trenchless technology to every corner of North America. I thank you for your dedication and your commitment during what can only be described as one of the most challenging and unusual years of our lifetime!

Alan Goodman

NASTT Chair

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- Request meetings and upload documents associated with a complex project

2021-2022 MASTT BOARD OF DIRECTORS

Richard Thomasson – *Chair*

Richard O. Thomasson has over 51 years of experience working in the water and wastewater field. He has been closely involved with Trenchless Technology for nearly his entire career. While at the Washington Suburban Sanitary Commission he directed many uses of new trenchless technologies, retiring after 31 years as the Director of Construction. He has worked with Parsons Brinckerhoff for 8 years, and Arcadis for the past 12 years, continuing his involvement in numerous trenchless projects. Presently he is working part time with EBA Engineering. Richard has a B.Sc. in Civil Engineering from Virginia Tech, a M.Sc. in Civil Engineering and a MPP in Public Affairs from the University of Maryland. He is a licensed P.E. in Virginia, Georgia and Maryland.

As a Founding Director and the very first Chair of the North American Society for Trenchless Technology (NASTT), Richard believes fully operational water, wastewater systems, gas service, electric service and storm water systems are crucial assets for a healthy growing nation. In 2016 Richard was inducted into the NASTT Hall of Fame.

Camille Rubeiz – *Vice Chair*

Mr. Camille George Rubeiz, P.E., F. ASCE, is the senior director of engineering at the Plastics Pipe Institute, Inc., the major North American trade association representing the plastic pipe industry. He holds a BS in Civil Engineering from the University of Tennessee in Knoxville and MSCE from Rensselaer Polytechnic Institute in Troy, NY. Mr. Rubeiz is a registered professional engineer, is the Secretary of the AWWA 263 [HDPE] Standards Committee, is the Chair of the AWWA C901, C906 and M55 Subcommittees, co-chairs the Municipal Advisory Board with Mr. Luis Aguiar (Hazen & Sawyer; previously with Miami- Dade Water & Sewer) and is a member of the BoD of the Mid-Atlantic Society of Trenchless Technology (MASTT).

Dennis Walsh – *Secretary*

Dennis M. Walsh, P.E. is a Senior Project Manager – Horizontal Directional Drilling for Public Service Electric & Gas in New Jersey. Dennis is a 1972 graduate of the University Of Dayton, Ohio with a B.S. in Civil Engineering and a 2002 graduate of the Polytechnic University of New York with a M.S. in Technology. He retired from KeySpan Energy Company in 2005 after a 28 year career in the gas utility field with a background in engineering, operations, construction, Quality Assurance and HVAC. He led KeySpan's efforts to expand the use of trenchless technology in the early 1990's to decrease its main and service installation costs. Prior to joining PSE&G, he was a consulting engineer for various consultants in the natural gas industry.

Dennis is a past Board member for NASTT, as well as a Board member for the NASTT Mid-Atlantic Chapter and on the Annual No-Dig Committee. He has designed numerous HDD installations for various utilities; including a 1,800 foot HDD for a 30 inch gas main under a tidal basin in Brooklyn, NY; a 2,000 foot 12 inch HDD under an environmental sound in south NJ; a 400 foot long Jack & Bore installation in Newark, NJ; and a 1900 foot HDD of a 30 inch steel pipeline for a 69kV electric system. Dennis is a licensed Professional Engineer in New Jersey. When he is not involved in trenchless projects, he enjoys traveling, and trying to play golf.

Mike Hoffmaster – *Treasurer*

Mike Hoffmaster is a Business Development Manager and Product Technical Advisor for Vortex Companies. He works with their UV CIPP lining and VeriCure Technologies division. He is responsible for educating municipalities and engineering firms on the benefits of a variety of trenchless rehabilitation products and increasing the market share of these products.

Mike has a bachelor of science degree from Shepherd University and has over 33 years of experience in the construction industry. He has over 10 years experience in trenchless construction and spent 25 years, working in a variety of roles, for a major precast concrete company. Mike has played a vital role in obtaining product approvals and specification writing for products he has been associated with. He is an active member of Chesapeake Water Environmental Association (CWEA) where he currently serves as Chair of the Collection Systems Committee, Maryland Rural Water Association (MRWA), Virginia Rural Water Association (VRWA), Pennsylvania Rural Water Association (PRWA) and Water Environment Federation (WEF). Mike enjoys cooking, photography, traveling and volunteering with the Special Olympics - which is something he has been involved with for over 30 years.

MID ATLANTIC SOCIETY FOR TRENCHLESS TECHNOLOGY – BOARD OF DIRECTORS 2021-2022

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NASTT NO-DIG SHOW 2022

The NASTT 2022 NO-DIG SHOW

MUNICIPAL & PUBLIC UTILITY SCHOLARSHIP PROGRAM

The NASTT 2022 No-Dig Show Municipal & Public Utility Scholarship Award has been established to provide education and training for North American municipalities, government agencies and utility owners who have limited or no travel funds due to restricted budgets.

Selected applicants will be awarded complimentary **full conference registration** to the NASTT 2022 No-Dig Show in Minneapolis, Minnesota, April 10-14, 2022. One day conference registrations will also be available. Registration includes full access to all exhibits and technical paper sessions… all you have to do is get yourself to the conference! Selected applicants will also be eligible to receive overnight accommodations. Selection based on responses to the application as well as need.

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FORMIDABLE PIPE GEOMETRY OVERCOME WITH FIRST-EVER BREAKTHROUGH INNOVATIONS

Technical Advancements Expand a Comprehensive CIPL Toolbox for Gas Pipe Repair and Rehabilitation

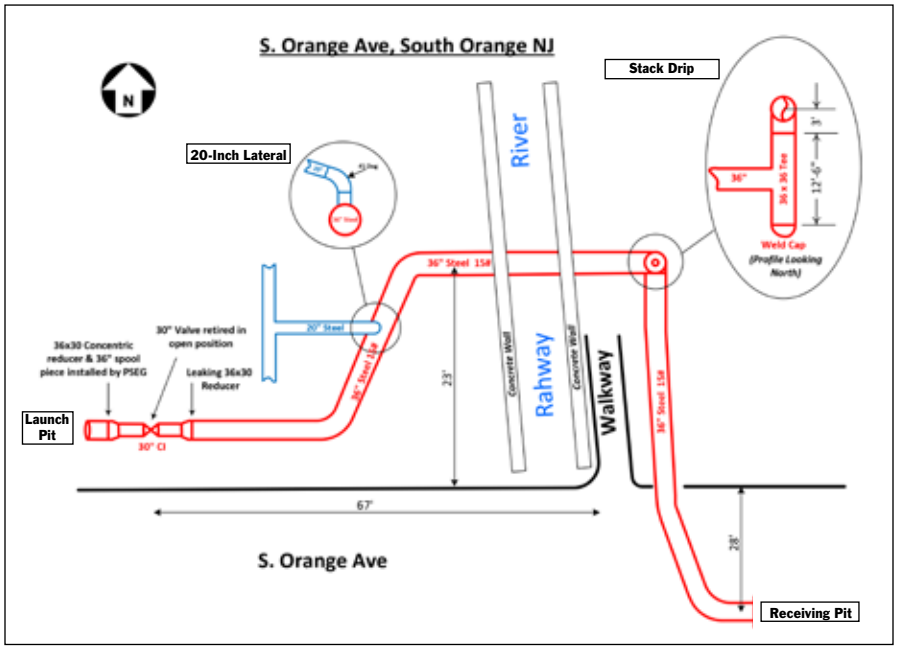
By: George Ragula, RagulaTech LLC

WHAT A MESS!

On our first Zoom-call project meeting, when I described the situation to the contractor, and outlined my game plan for what we needed to do, at first there was complete stunned silence. Not a word uttered by anyone. So silent you could almost hear a surgical mask drop and hit the ground. It was May 2020, in the hot discontented Covid summer, and there was a major problem underground in South Orange NJ where the Rahway River crosses under South Orange Avenue. A big high pressure 15 psig leaking problem!

A 36x30-inch steel reducer connecting a 30-inch cast iron main to a short 165 LF segment of 36-inch steel pipe was leaking significantly at 15 psig. Buried over 10 feet deep amidst a dense maze of subsurface facilities, including a six-foot-wide telephone switching bank going to 8 feet deep, several monitoring well shafts arrayed like sentries around a decommissioned underground gasoline storage tank, and surrounded by the usual sewer, water and electrical subsurface nearby, this reducer and stretch of steel pipe were completely inaccessible to repair through ordinary excavation.

In addition, the pipe had extremely challenging geometry with 6 complicated bends, an opening for an active 20-inch steel lateral, and legacy drip riser stack assembly consisting of a steel 36x36-inch tee with one leg looking down. On the east side the pipe plunged from 5 feet quickly down to 15.5 feet in order to cross under the Rahway River, and then ascended sharply to 10 feet depth on the other side of the river to connect with an inaccessible 30-inch valve, and a run of 30-inch CI pipe stretching westwards. We quickly nicknamed this short but extremely challenging pipe configuration "The Mess".



Challenging complex geometry of "The Mess" was compounded and complicated with the dense inaccessible subsurface

Built in 1971 to cross under the Rahway River, when the river channel was being encased in concrete and the bridge widened, the formidable geometry presented by "The Mess" put everyone on edge. Though a very short run of only 175 LF, the six bends, compounded and complicated by the challenging 3 dimensional stack drip geometry, reducer and gate valve, presented the most compressed and complex set of obstacles any of us had ever encountered.

A temporary concrete cap with 2-inch vent line was placed as an interim repair to vent the leaking gas as a safety measure, however due to the high pressure and diameter, there was urgent need for a

IT TAKES A TALENTED TEAM TO MAKE AN ENGINEER'S DREAM COME TRUE!

36-inch Valve was excavated on the east side of the "The Mess" to form the Receiving Pit for liner inversion

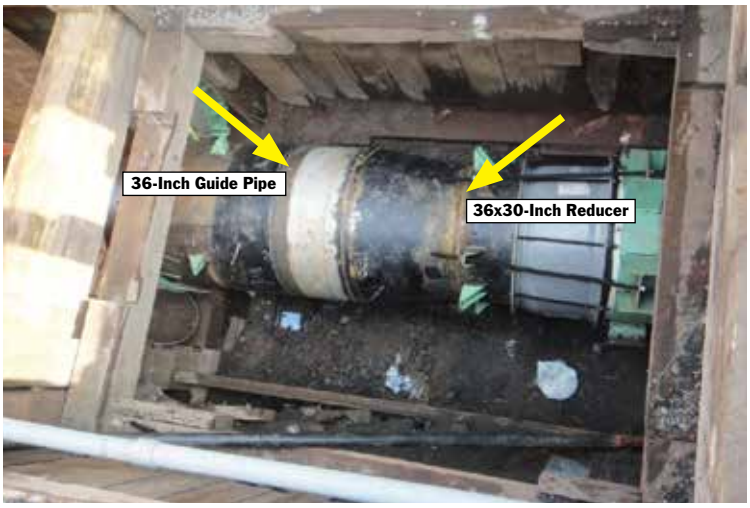
permanent solution. Because the 30-inch valve was impossible to remove by excavation, we had to find a way to push a 36-inch liner through a short section of 30-inch pipe, the 30-inch gate valve itself, and a 36x30 reducer before navigating six bends that included a stack drip and inverting through the remaining 165-foot length of 36-inch steel pipe.

Performing a liner inversion through such a unique and demanding configuration had never been done before anywhere in gas, or any other CIPL application. Finding the best solutions tested our resourcefulness and ingenuity to the maximum. Utilizing trenchless methods requires thinking outside of the box, and "The Mess" took this notion to the greatest extreme possible. I always say "Plan, plan again, and over-plan." The time put into design and planning is certainly the tried and true way to cement progress and ensure success.

Surmounting the challenges presented by "The Mess" took a lot of creativity, innovation, and time invested in careful planning, design and preparation. Design engineering unique and very well thought out first-ever innovations and rigorous shop-testing prior to lining were keys to a successful liner inversion, and the foundations of our ultimate victory over the forbidding geometry of "The Mess".

CIPL TECHNICAL ADVANCEMENTS

The "Mess "was my final CIPL rehabilitation project with PSE&G, and the fitting apex to my lengthy career and extensive body of trenchless work performed in the utility world. CIPL rehabilitation of gas distribution pipelines has evolved a tremendously expanded range of capability over time, with the trenchless application now being used more frequently for progressively more



CIPL lining through a 36-inch Guide Pipe, two 36x30-inch reducers, and a 30-inch gate valve has never been accomplished anywhere before

Pipe configuration of "The Mess" was built in 1971 when the Rahway River in South Orange NJ was encased in a concrete channel and the bridge widened

challenging gas industry projects with increasing complexity, larger diameters and greater distances. CIPL has advanced to the point where the most complex and challenging gas projects are where lining technology really stands out, and delivers the greatest benefits and cost savings for a utility and its customers. I am extremely proud to have played a leading role in these many developments and innovations from the ground-floor level advancing to where we are today with the technology.

Project contractors Progressive Pipeline Management (PPM) have developed deep experience and valuable expertise in gas infrastructure construction over the course of many projects. Since 2002 PPM has been the exclusive North American installer of the Starline® liner product, which was developed specifically for renewing high pressure large diameter natural gas mains. The patented Starline® liner system has undergone ten years of rigorous testing with PHMSA, Cornell University, and NYSEARCH, demonstrating the potential for a 100+ year service lifespan after installation. The Starline® liner uses a specially formulated two-part epoxy to bond the liner to the host pipe, which is mixed onsite and applied to the liner just before inversion.

36-inch Guide Pipe was essential to ensure 36-inch liner was aligned correctly as it traveled through the 30-inch segment

Fundamental to the success of this project was the experience and proficiency contractor PPM developed in lining progressively more challenging pipe configurations, including two world-record setting diameters, most recently the milestone 42-inch CI main lined under the Garden State Parkway in East Orange NJ, all of which required innovative planning, design and advancements. This high level of capability and track record of success, was crucial in being able to formulate innovations through design engineering in response to challenging field conditions backed by extensive shop testing at PPM.

David Wickersham, PPM President and CEO, said, ***"The versatility and testing pedigree of the Starline liner, combined with our 19-years of installation experience, were invaluable to the successful rehabilitation of this difficult pipe configuration."***

Advancements from solutions to challenges on previous projects have become regular practice on our CIPL work moving forwards. Innovations created from solutions to previous challenges, some first implemented only a year ago, have now become well established and are incorporated into standard practices on our gas industry CIPL projects. For example, curtain grouting was first used to stop water infiltration and intrusion (I&I) on an abandoned main in 2020 on the world record-setting CIPL of a 42-inch main in East Orange NJ. We did this again on "The Mess".

Unimaginable even a decade ago, what were once first-time innovations are now regular features on every CIPL gas installation. Along with six new breakthrough advancements detailed in this article, these previous technical advances were the basis for our most recent success on the "The Mess":

- automatic pressure monitoring while curing,
- expertise in custom fabricating SRS bridges over legacy gas fittings,
- curtain grouting to stop water inflow after a main is abandoned,
- optimizing vacuum systems while reducing equipment footprint size,
- redesigned liner inversion drum/cone/transport hose,
- self-propelled robotic sandblasting unit,
- dust collectors to recover grit,
- tail and catch-end reinforcement,
- heavy lubrication of retention strap to prevent liner chafing.

Every element of this previously acquired knowledge and expertise was crucially important to our success on "The Mess". Now, faced with the forbidding geometry of "The Mess", with little time left before the October 1 mandated gas-in date, additional new innovations were necessary in order to conquer the challenges presented by this unique and difficult pipe configuration. Design engineering and intensive shop tests were essential in support of six first-ever technical achievements used to overcome geometry on this project.

FIRST-EVER BREAKTHROUGH TECHNICAL ACHIEVEMENTS

Highlights of the major first-ever technical accomplishments that were essential for successfully CIPL lining "The Mess". The following new achievements have never been done on any CIPL project before, anywhere, with any CIPL application. The fact these were done first on a gas distribution installation in the midst of the Covid-19 pandemic only adds to this impressive feat:

- First-ever installation of a 36-inch liner

Transport hose used to convey inverting liner down into 10-foot deep pit. This innovation eliminates chafing during liner entry and is referenced as the "US Method"

Extensive shop testing of the Guide Pipe and Reducer configuration ensured that the liner would traverse the obstacles and invert properly over the entire length of "The Mess"

WE ARE ONLY LIMITED BY OUR IMAGINATION, PROGRESS IS CONTINUOUSLY UNFOLDING.

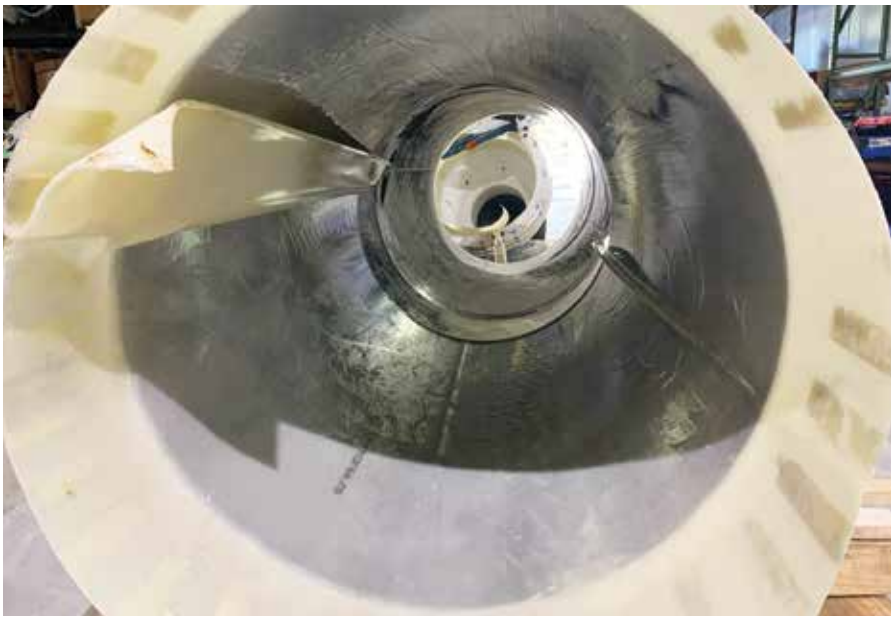
through two 36x30-Inch Reducers and a 30-Inch Gate Valve.

- First-ever use of a 36-Inch Guide Pipe to stabilize the liner before inversion through the first 36x30-inch reducer.
- First-ever design, fabrication, installation and removal of a temporary 20-Inch Metal Restraint Plug to cover a 20-inch lateral and provide a bearing surface for the liner inversion and pressure test
- First-ever use of High Strength Epoxy to fabricate a 90-degree bend from a 36x36-inch Tee that was part of a legacy stack drip fitting
- First-ever use of High Strength Epoxy to span an open 30-inch Valve Gate Well providing a bearing surface for the liner inversion
- First-ever use of High Strength Epoxy Spray to reinforce the leaking 36x30-inch reducer, completely coating the ID of the reducer prior to liner inversion.

1. 36-Inch Lining through Two 36x30 Reducers & 30-Inch Gate Valve

Replacing the 30-inch gate valve and leaking 36x30-inch reducer via excavation was impossible due to heavy subsurface congestion. Because these fitting were connected to the section of 36-inch steel pipe just beyond that traveled under the Rahway River, it was necessary to push the liner through this short 30-inch section first before it could invert eastwards through the remaining 36-inch section of steel pipe.

A second 36x30-inch reducer was installed and connected to the 30-inch pipe upstream of the gate valve so that the 36-inch liner could enter the short 30-inch section. This is the first time ever a liner has been inverted through two reducers, in any CIPL application.



Shop testing demonstrated the wrinkling would be minimal with Guide Pipe and Reducer in place

2. 36-Inch Guide Pipe & Shop Tests

For the first time ever, a 10-foot section of 36-inch guide pipe was attached to the first newly installed 36x30-inch reducer in order to ensure the 36-inch liner was aligned correctly upon entering the two reducers and gate valve, and to stabilize the liner bubble and minimize wrinkling of the liner as it inverted through the smaller diameter short 30-inch section.

Before inversion, extensive shop testing was performed on the guide pipe and reducer configuration before it was installed. The tests confirmed that minimal wrinkles in the liner were structurally sound and did not create any breaches in the liner integrity. Correctly aligned by the guide pipe, the liner was able to invert properly throughout the entire length of 36-inch steel pipe after first traveling through the complicated 30-inch section. First time this has ever been done.

Design engineered prefabricated metal plug installed to cover a 20-inch lateral and provide bearing surface for liner inversion

3. Temporary 20-Inch Restraint Plug

First-ever design and installation of a prefabricated metal temporary restraint plug used to plug-off a 20-inch diameter lateral located at a 13-foot depth that had to be subsequently reopened by cutting the liner back after a successful pressure test. This prefabricated restraint plug played a key role in providing a bearing surface to prevent liner rupture upon liner installation and pressure test. The liner was cut away, and the restraint plug removed entirely once the liner had cured in order to allow gas to flow up into the lateral. Prior to this work, a Miller Pipeline crew had used the opportunity to Weko-Seal the abandoned 20-inch lateral.

4. High Strength Epoxy Elbow

First-ever use of high-strength epoxy to fabricate a 90 –degree bend out of a 36x36-inch tee as part of a stack drip geometry to facilitate liner installation through the fitting. Normally this legacy fitting would have been replaced with a 90-degree elbow, however the fitting was 15.5 feet deep and located in an area containing monitoring wells due to prior gas station tank leaks.

We decided the best approach would be to use high-strength epoxy to fashion a 90-degree elbow from the 36x36-inch tee portion of this fitting. Stone aggregate and leftover sandblast grit were used to backfill the stack drip riser section up to the level of the 36-inch steel pipe, and then a mastic epoxy was manually spread on top of the fill to form a smooth congruent bearing surface for the liner.

Fabricating a new 90-degree elbow for the first time from a legacy stack drip fitting using fill and high-strength epoxy is a first-ever breakthrough technique which will prove invaluable on many future gas industry CIPL projects.

5. Valve Gate Well Epoxy Bridge

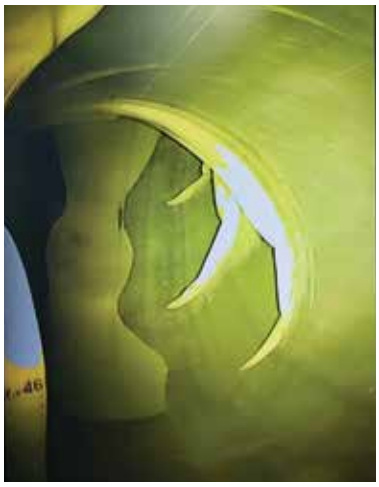
Breakthrough uses of high-strength epoxy technology to support CIPL lining also included the first-ever use of this technology for filling the 6-inch wide 30-inch valve gate well in order to provide a bearing surface for the liner. The well was covered with a smooth surface of mastic epoxy.

6. Leaking Reducer Epoxy Spray

First-ever use of high-strength epoxy spray to reinforce a leaking 36x30-inch reducer by spraying a 0.25-inch layer of epoxy on the entire ID of the fitting prior to lining, to reinforce and add strength to the fitting, which was the final

Liner was cut away, plug removed and 20-inch lateral restored after curing

Application of high-strength heated epoxy spray to reinforce and seal leading 36x30-inch reducer was a breakthrough technical accomplishment



Elbow fabricated from high-strength epoxy was crucial in allowing liner to navigate compound curve with minimal wrinkling

preparation necessary before inversion could begin. This first-ever breakthrough technique will prove invaluable on future gas industry CIPL projects.

DESIGN ENGINEERING INNOVATIONS: CONQUERING FORMIDABLE GEOMETRY

Like attaining a mountain summit, on Friday August 31, 2020 we conquered the forbidding geometry of "The Mess", overcoming daunting obstacles and successfully inverting the 36-inch liner through two 36x30-inch reducers and 30-inch valve, 6 bends, (four 90-degree, one 58-degree, one 22-degree), and two steep grade changes. It was a great deal of bending and shifting to go through for such a short 175-foot length of liner. After months in design, and weeks of preparatory work both in the shop and onsite, the actual liner inversion took less than two hours.

While on the South Orange Ave site, we also opportunistically lined the two segments of pipe that were connected to either side of "The Mess" for a total of three inversions for the project. An 825 LF segment of 30-inch CI pipe was lined

Stack was backfilled, then covered with mastic epoxy to form a 90-degree elbow from the 36x36-inch Tee

Use of aggregate and mastic epoxy to bridge 30-inch valve gate well was done for the first time ever

Injected curtain grouting into the surrounding soil from the interior of the pipe was again used to prevent water entry into the depressurized main

on the west side of the river, and then stretching eastwards from "The Mess", on the other side of the river, an 875 LF length of 36-inch CI. These final two linings were straightforward shots and did not entail any of the extraordinary preparation "The Mess" did.

Given the magnitude of the task, it was a mere two weeks before, on Monday August 17, that PPM moved onto the site and immediately began intensive preparations on a compressed schedule. Preliminary CCTV inspection runs were done the same day, and then curtain grouting to prevent water penetration into the abandoned main began immediately on Tuesday August 18, taking the rest of the week, until Friday August 21, to complete.

Using curtain grouting into the soil surrounding an abandoned main at depth to stop water intrusion was first used successfully in 2019 in preparation for the world record setting CIPL of the 42-inch CI main under the Garden State Parkway in East Orange. Curtain grouting is a great example of a breakthrough innovation becoming a regular important step in the process of preparing the pipe for lining, where there is a chance of water intrusion entering depressurized pipe. Injected curtain grouting guarantees a dry interior for sandblast cleaning the pipe, and ultimately ensures a smooth lining process by eliminating excessive moisture penetration, which is the primary cause of liner disbondment during inversion.

For "The Mess", confined space entry was again required to install the grout from the interior of the pipe. Extensive safety precautions were used including rescue harnesses, fresh air circulation, gas monitoring equipment and a confined space rescue team onsite. A body board and pulley system transported workers down into "The Mess", and then grout was injected into the soil surrounding the pipe by pumping it from the pipe interior through check valves in holes drilled into the pipe. The grout was allowed to cure over the weekend, and on Monday August 24 the excess grout was removed, and the check valves were ground flush with the inner pipe wall and filled flush with epoxy.

Confined space entry with extensive safety precautions was necessary for several preparatory steps prior to lining

Dust collector with three 16-inch hoses was used to recover leftover cleaning grit

Cleaning began immediately on Monday, and, as with the use of curtain grouting, technical advancements first used during the cleaning phase in the world record 42-inch CIPL the previous year were an essential element in getting "The Mess" ready for lining. The dust collectors and 16-inch inlet hose configuration was used again and generated sufficient airflow to remove any grit leftover from the sandblast cleaning.

After the cleaning process was completed, the A&W Maintenance subcontractors moved onsite and completed bridging the gap of the gate valve well with high strength epoxy to provide a bearing surface for the liner, and also sprayed the interior of the leaking 36x30-inch reducer, as detailed above. The most critical part of their work involved the transformation of the stack drip tee to a 90 bend which had to be hand-troweled. The epoxy cured over the weekend, and the necessary lining of "The Mess" was completed on the following Monday, August 31.

Due to the tight complicated geometry within the short 175-foot length of pipe, there was substantial concern that the retention belt would chafe holes in the liner, especially at the furthest end of the alignment, where the liner inverted through the final three bends. This concern was addressed by making the retention belt as narrow as possible, and heavily lubricating it. As a result, there was no abrasion or any damage to the liner from the retention belt throughout the inversion.

Once the post-lining CCTV inspections were completed and pressure tested to 25 psig, and the restraint plug was removed from the 20-inch lateral, the repaired main was gassed-in Tuesday, September 29, just ahead of the October 1 outage deadline.

PPM SITE SERVICES & FIRST CALL PPE

It is important to point out that this extraordinarily difficult project was accomplished during the Covid-19 pandemic – adding to the extreme challenges we already faced with the inaccessible geometry were necessary strict site safety protocols, sanitation practices, and daily Covid-19 screenings for the crew as part of the regular daily site safety meetings.

Fortunately, two companies affiliated with project contractor PPM, PPM Site Services and First Call PPE, specialize in providing environmental cleanup and site sanitation services and supplying clients on industrial sites and gas utilities with high quality masks, PPE, rapid antigen tests and protective antimicrobial defense sprays. This expertise ensured zero Covid-19 cases during the entire difficult and intricate six-week period of construction.

COMPREHENSIVE CIPL TOOLBOX!

With the successful repair of the very inaccessible pipe layout of "The Mess"

Self-propelled robotic sandblast unit nicknamed "The Beast" was again used to clean the pipe interior before lining

nothing can stop us anymore in terms of geometry! Any needed fitting can be now fabricated using metal or high-strength epoxy and gaps over legacy fittings can be bridged using various structural reinforcement sleeves or prefabricated metal restraint plugs for the specific purpose at hand. Tackling and completing challenging projects like "The Mess" creates a dynamic process, driving forwards continuous improvement to equipment, materials, processes and techniques.

The first-ever technical advancements used to solve "The Mess" are crucial elements added to the CIPL toolbox. Through numerous gas rehabilitation CIPL projects tackling increasingly complex and difficult repair work, with ever greater diameters and distance, we have achieved mastery, assembling a significant body of work that now offers a comprehensive toolbox of approaches for repairs on any gas main, no matter the diameter, length, or configuration of the buried pipe. Responding to challenges presented by projects like "The Mess" are what drives creativity and innovation forwards. We are only limited by our imagination, progress is continuously unfolding.

CONCLUSION & REFLECTIONS

"The Mess" was the final CIPL project I did with PSE&G marking the apex of my career with the utility. Like climbing a mountain, it was an uphill battle against imposing geometry, only made possible with the ingenuity and clever technical innovations everyone brought to the table, and our numerous past successes. It takes a talented team to make an engineer's dream come true!

Dave Wickersham summarizes ***"Already having completed several award winning projects with George and PSE&G, we were up to the challenge when he approached us with his engineering design on this project."***

Liner ambient cured with nitrogen supplied as make-up air

Covid-19 safety protocols were a daily routine onsite

It takes a talented team to make an engineer's dream come true

Liner with six tail bolts

Throughout my 43-year gas industry career, I have seen this natural upward progression of technical competence and prowess as various trenchless construction techniques move from theoretical considerations during planning into the realm of practical application in actual construction projects, and then followed by eventual improvement as experience is gained.

The real world experience acquired from completing underground construction projects using trenchless applications then gets filtered back into research and development, which in turn yields fresh innovations, improvements and ingenious new construction techniques. Networking, education, and sharing information are key drivers, providing focus and the foundation for this collective effort.

Inversion of the liner through "The Mess" took less than two hours

More than 33 years involvement in the North American Society for Trenchless Technology (NASTT) has allowed me to maintain an up to date awareness of trenchless technology methods and best practices, along with recent technological advancements. If I don't know the answer, I am confident I can find it through my NASTT peers. By being able to network among numerous industry experts on various underground construction applications/techniques at conferences, seminars and technical sessions, and with access to a rich storehouse of technical peer-reviewed technical papers, I have been exposed to numerous ideas that have enabled me to devise unique and cost-effective solutions to the challenges encountered on various gas construction projects over the years.

By accomplishing the near impossible in solving "The Mess", everything is now possible with CIPL for the repair and rehabilitation of gas distribution systems.

THE MESS = WINNER

"The supreme accomplishment is to blur the line between work and play"

(Arnold Toynbee)

ABOUT THE AUTHOR:

***George Ragula** is CEO and Founder of RagulaTech with over 43 years of experience in gas industry engineering, operations, construction, research/development/deployment and management. George is a noted authority on trenchless applications for the gas industry having spent 33 years specifically focused on trenchless. He received his B.S. in Mechanical Engineering from Polytechnic Institute of Brooklyn in New York. George is a past Chair of NASTT and serves on the NASTT No-Dig Show Program Committee. He also teaches several NASTT courses on various trenchless technology topics, including CIPL for the Gas Industry.*

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BALTIMORE CITY: WATER URGENT NEEDS WORK – WATER MAIN REPAIR USING CARBON FIBER REINFORCED POLYMER (CFRP) WRAP

By: Richard Thomasson, P.E.,
Khalid Qadwai, P.E., PMP, EBA Engineering, Inc.

LEAKING 48-INCH PCCP WATER MAIN

On February 12, 2021, the City of Baltimore DPW received notification of water flowing from the 48-inch prestressed concrete cylinder pipe (PCCP) main under the I-83 bridge southbound (Falls Road) off ramp. This heavily traveled interchange would require proper notification and a great deal of traffic control and detour signage to close the ramp for repair work. The Baltimore City Department of Public Works, Office of Engineering and Construction, notified EBA Engineering, Inc. (EBA), a firm under contract to provide water urgent needs engineering services. In coordinating the response to the leak, EBA provided the repair design concept, obtained permits, and oversaw the emergency contractor. EBA provided recommendations for repair and engineering support to the City of Baltimore to address the problem and complete the repair.

All appropriate City of Baltimore agencies were involved to coordinate and handle safety, traffic, communication, water operations, contract services, and asset management. The team held a field meeting on site and developed a plan to address the leaking water main. Before the work began, the team performed a CCTV inspection of the pipe, which did not show any major faults in the repair area.

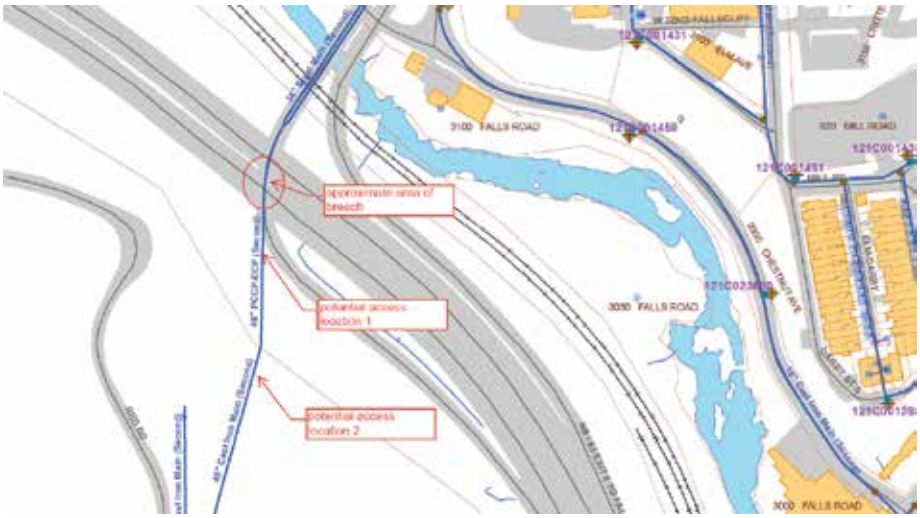

Figure 1. Approximate area of breach, showing location of two access points

REPAIR PLAN – TWO PHASES

EBA met onsite with Wachs Water Services and the Baltimore City Utility Maintenance Department (UMD) to discuss the water main repair options and determined that the work would be performed in two phases:

- **Phase I** – The contractor would excavate the water main break to determine the extent of the damage and to verify the material and outer diameter of the pipe. To perform the work, the contractor would close the southbound ramp and detour the Falls Road traffic from February 16, 2021, at 9:00 am to February 17, 2021, at 5:00 pm. The contractor would install the road plate, move their equipment onto the shoulder of the southbound ramp before the overpass, remove the detour, and reopen the ramp for traffic.
- **Phase II** – The repair would be performed on a date and time to be determined after completing Phase I.

After completing traffic plans, the team issued a public traffic advisory notice, which was necessary before closing the ramp.

RECORDS REVIEW

A review of as-built records for the 48-inch PCCP water main revealed that

THERE WAS GREAT COMMUNICATION AND COOPERATION BY ALL STAKEHOLDERS INVOLVED.

Figure 2. Site meeting to discuss repair options followed Covid safety protocols

the water main was installed as part of I-83 improvements in 1960. The existing 48-inch cast iron water main was relocated across the ramp bridge by connecting the 48-inch PCCP to the 48-inch cast iron water main on both sides and hanging two 34-inch steel pipes under the bridge. The transition of the 48-inch PCCP to the two 34-inch steel pipes included a PCCP 48 x36-inch wye fitting with a 36x34-inch steel reducer on each side of the bridge. The details showed the PCCP pipe encased in concrete on both sides of the bridge.

Matching the record as-built drawings to the surface leak, the drawings showed a single 48-inch PCCP installed on a radius and encased in 8-foot, 8-inch horizontal X 7-foot, 8-inch vertical reinforced concrete encasement. The section showed No. 5 rebar wrapped around the 48-inch PCCP with variable concrete dimensions surrounding the pipe. This concrete encasement restrained the horizontal forces of the pipe radius bend created by deflecting the pipe at the bend points. No entry ports or access tees were at this location. The two 34-inch steel pipes mounted to the understructure of the ramp bridge were not encased in concrete.

WATER MAIN REPAIR – EVALUATION OF ALTERNATIVES

R. E. Harrington, the water urgent needs contractor, started excavation of the water leak site late in the day on February 17. Wachs Water reviewed the necessary valve closures to isolate the leak in the 48-inch water main. One valve at 3500 Elm Avenue would not close properly and needed to be repaired to properly isolate the leak location. During excavation and removal of the concrete encasement, the water flow was too great, and Wachs Water had to drop back further to isolate the water leak area. The City directed that the 36-inch gate valve be replaced with a 36-inch butterfly valve to reduce the shutdown area. R. E. Harrington replaced the valve while the leak was being repaired. EBA inspected the work and designed the restraint of the new 36-inch butterfly valve. As shown in Figure 4, the contractor provided temporary bracing inside the valve vault. EBA later evaluated the pipeline for thrust restraint and designed two thrust blocks on each side of 36-inch valve.

After completing this new shutdown and eliminating the water flow, the contractor continued to remove the encasement and expose the leak on the 48-inch water main. The contractor discovered that the encasement was much thicker than the record drawings indicated, and it took great effort to expose the original pipe without damaging the 48-inch PCCP water main further. The contractor exposed the PCCP leak and discovered a crack in the steel cylinder that was the source of the water leak. The contractor cut a 2-foot hole into the water main and inspected the area for further damage.

Figure 3. Water main breach was flowing onto the South Bound offramp to I-83, creating hazardous conditions

Figure 4. Temporary bracing was used to restrain the new 36-inch butterfly valve while the repair was underway

Figure 5. A two-foot hole was cut into the water main to inspect for further damage

WEKO-SEAL seals had been installed on all joints during previous preventative work.

EBA also recommended CCTV inspection of the pipe near the leak to determine any other defects. AES performed the CCTV and observed no major defects. The City decided to inspect all of the PCCP pipe in the shutdown area following proper confined space entry notifications and using certified personnel. Xylem performed the PCCP inspection, which required installation of entry ports at the two air release valve vaults.


Figure 6. CCTV inspection of pipe in vicinity of the leak required installation of two entry ports

EBA evaluated the alternatives to repair the 2-foot hole in the 48-inch PCCP. The standard method of placing a 36-inch outlet with flange over the hole was not possible due to the encasement around the pipe. Removing the encasement would be too time consuming and could potentially damage the pipe. A second standard option would be to cut out the section of pipe and replace it with a short and closure. Because the leak was under the bridge, the equipment needed to lift the pipe could not be used. Therefore, EBA determined that internal repair was the only option. EBA also evaluated two different access points into the water main and chose a point that already had a sleeved-in portion of 48-inch cast iron pipe with an air release valve in a vault.

Two repair options were deemed feasible and cost-effective. The first option was to use Hydrotite seals in sequence to cover the full section of pipe. A backing plate and additional retaining bands would reinforce the area near the 2-foot hole. These seals were available in 48-inch diameter and could withstand the pressure in the water main. They could also be installed using the access point 300 feet away. The interlocking seals would protect the entire length of pipe. However, this option would not provide any structural strength, which was important since the PCCP wires were broken and the pipe had lost its structural capacity.

The second option was to use carbon fiber (CFR) to repair the total length of the 48-inch PCCP. This option provided the necessary structural integrity and appropriate pressure rating, and it could also be installed using the access point 300 feet away. The City already had the specifications for this CFR option. Therefore, the City selected this option as the best long-term solution.


Figure 7. Surface preparation

CFRP REPAIR

Multiple cost proposals were then evaluated from several CFR contractors including a cost proposal, design and installation procedures, and a schedule. QuakeWrap, Inc., was selected along with their installer, FRP Construction, LLC.


Figure 8. Actual preparation at joint

The QuakeWrap CFR design provided a structural solution that conformed with AWWA standard C305, was NSF-61 certified, and rated with a maximum working pressure of 235 psi.

The manufacturer changed to a new resin and supplied the NSF 61 certification so it could be used on this project. EBA reviewed the QuakeWrap design calculations, drawings for the lap and termination details, and material specifications to verify conformance with Baltimore City standards. Because there were existing joint seals, the contractor revised the procedure and removed the inner core (a ring 8 inches wide, 2.75 inches deep) adjacent to the existing joint seal for termination of the CFR.

The external pipe wall was repaired by welding a steel plate to the PCCP steel cylinder. The external area was cleaned of encasement and PCCP coating to the steel cylinder for 4 inches outside of the 2-foot hole in the pipe. The steel plate was designed to the curvature of the pipe to ensure that it fit to the cylinder. The plate was welded carefully to avoid damaging the cylinder. The rebar was installed as in the original encasement and concrete poured to the existing height of the encasement. Then, the excavated area was backfilled and the roadway replaced.

Figure 9. Completed CFR of the 48-inch pipe

Figure 10. Actual test report on samples

Figure 11. The steel plate was designed to fit the curvature of the pipe to ensure it fit to the cylinder

GREAT TEAMWORK!

All stakeholders communicated and cooperated seamlessly to complete this critical repair. Problems encountered—such as valve defects, permitting for work in park, PCCP inspections, and traffic control— were all handled quickly and effectively. Such a large shutdown of main water system components meant that all work needed to be completed before water demand increased in May 2021. Scheduling was also critical to coordinate many different project team members. Teamwork contributed greatly to successful project completion.

ABOUT THE AUTHORS:

Richard Thomasson. P.E. *has more than 51 years of experience working in the water and wastewater fields. He has been closely involved with trenchless technology for nearly his entire career. While at the Washington Suburban Sanitary Commission, he directed many uses of new trenchless technologies, retiring after 31 years as the Director of Construction. He is currently a Senior Project Manager with EBA Engineering, Inc.*

Khalid Qadwai, P.E., PMP *is an Associate at the EBA Engineering, Inc. He joined EBA Engineering, Inc. in 2008 and has over 20 years of experience in water main design and rehabilitation. He is currently managing several water and sewer projects in the Washington metropolitan area.*

THE "SOONER" THE BETTER

Oklahoma City Pressure Pipe Inspection and Condition Assessment: Witcher Force Main Case Study

By: Jerry Trevino, Mechanical Jobbers Marketing, Inc.

The day after Independence Day, I found myself surrounded and outnumbered at the Atlanta Airport gate by a sea of Oklahoma University (OU) fans while they were waiting for a plane to return them to Oklahoma City. Toddlers to older generations alike, they wore all kinds of red logo OU clothing, back packs, cell phone protectors, face masks and other contraptions and gadgets bearing the red OU logo. I believe I was probably the only one out of several hundred people at the gate with a University of Texas Longhorn emblem on by back pack. I knew for sure I was heading to my alma mater's college football rivalry territory, Oklahoma City - OU Country!

As being the third person to board the plane, I was sure some were questioning my reasoning and logic for going to Sooner Boomer land with a Burnt Orange Longhorn back pack. As soon as I sat on the plane, my thoughts immediately changed to focus on the task at hand. To review the proposed project plan, maps, drawings and known data of the pressure pipes and to rethink all the possible risks involved in the upcoming project the following day. I tried to imagine all the ways possible to prevent and reduce the risks of failure. While I was flying, the crew was taking the long drive from Atlanta to OKC with vital equipment needed to launch/insert, and then capture and retrieve, precious little ball shaped "Pipers" tools needed to perform an air-pocket and leak pressure pipe condition assessment project.

Oklahoma City Water Utility Trust (OCWUT) issued a purchase order to Mechanical Jobbers Marketing a few weeks earlier to perform the insertion and capturing these relatively very small balls when compared to the very large diameter force main sewer transmission lines with a transport capacity of up to 75 million gallons of sewage per day.

I BELIEVE I WAS PROBABLY THE ONLY ONE OUT OF SEVERAL HUNDRED PEOPLE AT THE GATE WITH A UNIVERSITY OF TEXAS LONGHORN EMBLEM!

OKLAHOMA CITY

Oklahoma City, Oklahoma the Capitol of the State has a population of over 638,000 people, covers an area of 620 square miles. It is the 8th largest land base city in the United States.

GENERAL

Infrastructure becomes more critical and more essential when it personally affects you as when it suddenly fails. We really do not pay too much attention to all the roads, bridges as we are driving on them or pay attention to water and sewer lines and other utilities until they are suddenly and without warning shut down. The Texas 2021 freeze in February is a painful reminder of the criticality of infrastructure. Unfortunately, people died in that event. It also affected its surrounding states and Mexico. Therefore, it is essential that municipalities start inspecting and assessing the condition of infrastructure "the sooner the better." The assessments will provide important data to help prioritize maintenance work and design the required upgrades on a planned basis versus an unplanned shutdown. This will save taxpayers funds and, in some cases, save lives.

SITE VISIT

A couple of months before, we had done a site visit to evaluate the insertion/launch site at the Witcher plant, and to evaluate and select the possible extraction manholes and underground chambers that were located a few miles away from the plant. We met with the OKC manager of the Line Maintenance Department, and during lunch when we were inquiring about other potential and future work in OKC, it was made very clear to us with a statement that is etched in my brain to the effect that "there would be no other potential future work if we were not successful in catching these balls." So, in my mind we had to develop a mindset of "Failure Is Not an Option". Although this was not the Apollo 13 mission, which also involved launching and retrieval, it was just as important to me, my field crew, and to the many other personnel and stakeholders involved.

There was a recent history of a similarly funded project where others had very recently failed to catch any of the similar free flowing balls. Therefore, no data was collected, nor any deliverable data was issued to OCWUT after a great expense. So, I had a lot of mental pressure to succeed.

Joe Wells of PICA had previous contact with OKC regarding this project and helped with its conception and coordination. The date and project schedule were established before anyone knew OKC was to experience a 12- to 14-inch rain event just the week before the extraction project. Hurricane Elsa was also moving through Cuba towards Florida and Georgia creating some concern back home. While one carefully creates plans on how to execute a project, these sometimes change due to further evaluation and because of other circumstances, such as weather.

Therefore, we had to quickly make several last-minute changes to the plan. The change in plans involved a change in scope of work. We had previously reached out to CPM, another PICA contractor, for support in this project, in which they had agreed to do, however, the combination of the downpour of rain, and because the change in scope of work, we decided to perform the work ourselves. I had originally planned one permit required for confined space entry and changed that to two entries on two different structures at the same time to reduce the risk of losing the "Pipers", due to higher flows. Also, due to the rain event we could not park large heavy equipment immediately adjacent to the extraction sites as we had planned, such as a vac truck and other support equipment.

There were two possible extraction structures we selected. One was a huge underground piano shaped chamber 30 feet by 20 feet with 8-foot-high ceilings buried 5 to 8 feet underground. This chamber had a flat bottom without any flow channels. It had two force mains feeding it, a 42-inch and a 36-inch with a 72-inch exit pipe. The other was a 16-foot-deep manhole with a 72-inch entry and exit sized pipe. We did not know before the project started the extent of the solids built up in the large chamber. As in most projects, there are many unknowns, and one has to attempt to reduce the unknowns and to reduce the potentials for failure. We were prepared to do some shoveling if we had to since the vac truck would not have access.

CASE STUDY

The OKCWUT took a proactive approach to managing a critical buried asset by requesting a contractor to provide data on the live force mains. The Witcher Force Main is the largest sewer force main in Oklahoma City sewer collection system. It consists of two twin lines; one is 36 inches in diameter and the second one is 42-inch diameter ductile iron pipe. The two twin parallel lines are each over 8000 feet long. The pump station has the capability of pumping 75 MGD.

Based on the location there is a concern with respect to corrosive soils, age, and wear and tear on the twin lines. OCWUT recognized the need to know and understand the internal and external condition in effort to prolong the life of this asset.

Based on its importance, previous repairs, and a need-to-know mindset, OCWUT made the decision to assess the condition of these twin lines using the "Ingu Piper" tools provided by PICA to identify any leaks, gas pockets, and debris build up. After identifying areas of concern, the PICA Bracelet Probe, which utilizes a high-resolution pulse eddy current technology for measuring loss in wall thickness, will likely be used in validation of this condition. The Remaining Useful life (RUL) of the pipe will be calculated based on the operating conditions, surge pressures and other factors. All verified areas of concern will then be scheduled for repairs or replacements of these sections of the sewer lines. This will result in savings to OCWUT and the citizens of Oklahoma City by preventing future pipe breaks and failures.

TEAM WORK TO REACH A COMMON GOAL

To execute this project successfully, it took the planning and collaboration of numerous stakeholders working together to achieve a common goal. The Witcher pump station is operated by the management company Inframark on behalf of OCWUT. Inframark met the City's criteria and expectations, improved performance efficiency including strict adherence to compliance regulations, protection, and preservation of the facility. It helps maximizing operational efficiencies and minimizing energy consumption including odor management, improved public and employee health and safety guidelines along with improved biosolids disposal processes. Inframark managed the sewer pumps flow rates, pressures, volumes, and flow velocity as recommended by Ingu engineers and scientists within the parameters of the Piper ball operational

Figure 1. The INGU "Piper"

Figure 2. The "Bracelet Probe"

conditions to acquire data. OCWUT Line Maintenance and their manager were present to provide assistance as needed. The City's crews are well trained and provided unprecedented level of expertise and provided a "can do" attitude towards this project and were present and available from start to finish. Mechanical Jobbers Marketing / PICA provided the tools, technology, technicians, the operational plan, and the custom-designed extraction mechanism to successfully execute a safe insertion and extraction process.

All was executed by establishing proper communications of the plan via various Zoom phone calls, on site meetings, and constant communications throughout the project. The successful completion of this

Figure 3. Identifies the inspection area of the twin force mains. The area located in the Green had been previously rehabilitated. The acoustic anomalies are identified with pins on each line

Figure4. Zoom of the pipeline section of the 36-inch and 42-inch force mains with the acoustic anomalies. Based on the locations and confirmation of the air-pockets OKCWUT will perform external validations utilizing the PICA Bracelet Probe (Figure 2) to identify the wall loss in these areas and determine the RUL (Remaining Useful Life) of this critical asset

IT IS ESSENTIAL THAT MUNICIPALITIES START INSPECTING AND ASSESSING THE CONDITION OF INFRASTRUCTURE "THE SOONER THE BETTER."

project demonstrates that regardless of your sport team affiliations we all can work together to reach common goals.

PRE-PROJECT PLANNING & EXECUTION

OCWUT Line Maintenance provided 4-inch valves on each of the twin lines to facilitate the insertion process. We first selected to insert the "Pipers" balls in the larger 42-inch diameter force main. OCWUT assisted first by dewatering the rainwater flooded insertion pit OCWUT personnel assisted MJM and Joe Wells of PICA with the insertions. 3 different "PIPERS" balls

were inserted in each of the two twin lines. Each was inserted at 20-minute intervals. Inframark controlled the pumps to achieve 12,000 GPM to provide optimal velocity for the "Pipers." Mechanical Jobbers Marketing crews cleaned and prepared the extraction structures and installed the extraction device to facilitate catching the "Pipers. The balls arrived at the expected times on the 42-inch forced main.

We all took a lunch break and called in a local food truck to bring in Mexican cuisine before starting to work on the second force main line. The second pipe insertion took place. Once again, all crews and interested stakeholders worked together to successfully insert and retrieve all of the inserted "Pipers." All six "Pipers" were recovered after a very long and hot day.

NEXT STEPS

Oklahoma City Water Utilities Trust received the deliverables in approximately 3 weeks from the completion of the field work. This information provided data for OKC managers and engineers needed to mitigate catastrophic pipe bursts and unexpected service interruptions to tens of thousands of taxpayers. As per Dave Russell's (PICA CEO) quote "Good Decisions Start with Good Information." The data provided and interpreted by Ingu will indicate potential pipe sections which may require additional pipe wall thickness validations. PICA has additional high-resolution tools to assess suspect pipe sections that will be used for additional validation. The Bracelet Probe.

THE DELIVERABLES

The deliverables identified several areas of concern. These areas of concern were gas pockets located in (2) 90-degree angles and were in both the 36-inch and 42-inch force main near each other. These multiple gas pockets are areas of potential corrosion/deterioration.

MOVING FORWARD "SOONER" RATHER THAN LATER

Based on the teamwork of all stakeholders, the success of the project and the pro-active approach of OKCWUT, there will be validations, prioritizations and future inspections to help OKCWUT identify and manage these critical assets and minimize any Environmental, Social, or Regulatory impacts.

ABOUT THE AUTHOR:

Jerry Trevino *is President of Protective Liner Systems, Inc. and sister company Mechanical Jobbers Marketing Inc., specializing in infrastructure rehabilitation since 1984. As longtime Chair of the NASTT Southeast Chapter, Jerry strongly believes that trenchless and condition assessment technologies offer numerous methods to maintain and upgrade aging infrastructure.*

SUMMARY:

Survey date:	July 6, 2021
Report date:	August 11, 2021
Line(s) surveyed:	36" Witcher Force Main (35.577854°, -97.426656° to 35.569281°, -97.404524°)
	42" Witcher Force Main (35.577854°, -97.426656° to 35.569281°, -97.404524°)
Service:	Leak detection and air pocket survey

36-Inch Witcher Force Main Results

- Leak Detection Survey: No leaks were detected within the sensitivity of the Pipers®.
- Air Pocket Survey: Two acoustic anomalies were detected that may be caused by the presence of stationary air pockets.

42-Inch Witcher Force Main Results

- Leak Detection Survey: No leaks were detected within the sensitivity of the Pipers®.
- Air Pocket Survey: Three acoustic anomalies were detected that may be caused by the presence of stationary air pockets.

THE USE AND IMPORTANCE OF ENGINEERING PRE-CON SUBMITTALS FOR PIPE JACKING OPERATIONS, PEPCO 48-INCH MICROTUNNEL

By: Karen Armfield, P.E., Todd M. Kilduff, P.E., Kilduff Underground Engineering, Inc. (KUE)

There are multiple trenchless alternatives to traditional cut and cover utility insulation methods. Cut and cover methods are typically the most economical strategy where open site conditions exist and when alignments are dry and not too deep. However, often there are potential disruptions to existing facilities (roads, railroads, and existing utilities) that often creates a situation where a trenchless installation becomes more advantageous. The case study discussed herein, is one example where the advantage of trenchless technology proved beneficial and the pre-construction engineering submittals helped the Contractor to assess how he would implement his proposed trenchless system.

This case involves the installation of an electrical service crossing under CSX railroad tracks using a microtunneling boring machine (MTBM). The project is located in Rockville Maryland and was performed by SECA Underground Corporation. The owner of this utility is Potomac Electric Power Company (PEPCO) of Maryland who required an electrical service to cross beneath the existing railroad bed as part of its White Flint 69kV Underground Transmission Project. KUE was tasked with performing analysis to assist SECA with developing their trenchless workplan strategy for this crossing.

Standard design calculations for the pipe jacking process have permeated into most owner specifications. Axial loading and external loading on the casing/conduit, thrust resistance, settlement estimates and hydraulic fracturing are what is usually required for pre-construction design submittals for pipe jacking applications. Figure 1 shows a free body diagram of the forces acting on a pipe jacking application. If performed skillfully, these checks can offer insight to the Contractor in consideration of the set up and implementation of the proposed trenchless system. Unfortunately, these specifications are often fulfilled without true benefit to the Contractor or project as a whole as a result of the engineers lack of understanding of the pipe jacking process. This paper is focused on how to get the most out of these pre-construction checks and your trenchless designer which is exemplified by the PEPCO project.

The greatest benefit to the Contractor and project by requiring pre-construction engineering submittals is to get another party to review the project conditions and evaluate the feasibility of the means and methods being proposed for the anticipated ground conditions. Although the calculations can help determine the feasibility of the crossing they are often very subjective and require a lot of insight, often relying upon empirical data to arrive at calculated conclusions. Because of uncertainties in ground conditions and limitations of the calculation methods themselves, results should be taken with a "grain-of-salt". Our office typically provides results as probable ranges as opposed to providing single values. The subjectivity in performing the checks results in the quality of the engineering product to be highly dependent upon the individual(s) who are performing the evaluation. It is essential that the engineer understand the pipe jacking process and the influence the proposed equipment and methods of installation can have on variables like axial loading, ground settlement and hydraulic fracturing.

Furthermore, owner's and engineers should be aware of the limitations of axial load predictions for microtunneling applications. Analytical equations and methods for predicting axial loading of pipe jacking operations are primarily for dry applications, when little or no lubrication is added to the pipe string which is often the case with auger boring methods. These load predictions are typically linear with the increasing slope a function of the frictional resistance of the pipe-ground interface and weight of the pipe.

Microtunneling operations are different. Lubrication used in microtunneling is often injected through a tailcan behind the machine and often additionally through ports in the jacking pipe, especially for longer and larger diameter runs. The lubrication has a tremendous impact on minimizing the axial loading that is generated. Often the jacking forces can be held steady even as additional pipes are added to the pipe string. This is because; depending upon the injection rate of the

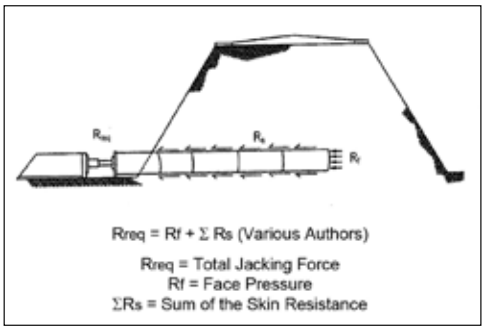

Figure 1: Free Body Diagram of the Forces acting on Pipe Jacking methods

OWNERS AND ENGINEERS SHOULD BE AWARE OF THE LIMITATIONS OF AXIAL LOAD PREDICTIONS FOR MICROTUNNELING APPLICATIONS

lubrication, the additional weight of the casing pipe can be compensated by the pressurization of the annulus. Prior to boring, it is difficult for engineers to assess just how effective the lubrication will be. This is in part a result of uncertainties with the ground conditions. Therefore, axial load predictions for microtunnels are often very conservative. This is demonstrated by Figure 2 where KUE observed a MTBM and Auger Bore method of similar diameter and length that were advanced in similar ground.

Pre-Construction engineering submittals completed for the PEPCO project resulted in adaptation to the contractors means and methods. The project required installation of 48-inch RCP with 5.75-inch (60-inch OD) wall extending 200 feet beneath the CSX tracks. The RCP was utilized as a casing for the power transmission line. The railroad would exert a surcharge load on the RCP during the jacking process which would have to be factored into the jacking and external loading applied to the pipe. In addition, cover was a maximum of 15 feet below the tracks but shallow, less than 6 feet, at the ends requiring careful consideration of hydraulic fracture at launch and reception areas. Additionally, the launch shaft typically requires sufficient cover to mobilize passive pressures to provide a reaction to the jacking forces. The minimal cover at the launch shaft would require a site specific designed thrust block consisting of the addition of H-piles to mobilize passive resistance of the ground.

The ground consisted of about 8 feet of loose sand and silt Fill overlying about 6 feet of medium dense silty sand. The tunnel is anticipated to be bored through a potential mixed face of the silty sand and highly decomposed, to residual, sedimentary bedrock. Groundwater was not encountered in the borings. In the design, the weathered rock was modeled as a granular material with slight cohesion, resulting in the use of a phi-c combination as the soil strength input parameters.

The calculations performed by KUE resulted in the Contractor to understand that the site specific conditions at the launch shaft would require a specially designed thrust block to meet project constraints. The block size was designed to be 8 feet high and 8 feet wide to distribute the force and provide a factor of safety of 1.5. Additionally, it was decided that the operational controls of the MTBM's slurry pressure would have to be performed to minimize hydraulic fracture at launch and reception. This was anticipated to result in higher jacking pressures where the injection of lubrication and slurry at the face would have to be limited to counter balance the minimal earth cover.

In summary, the execution of pre-construction engineering submittals for the pipe jacking applications can be beneficial to the Contractor and project as a whole but the engineer performing these checks must be well versed in the means and methods of the trenchless construction as well as the limitations of the methods that evaluate these installations.

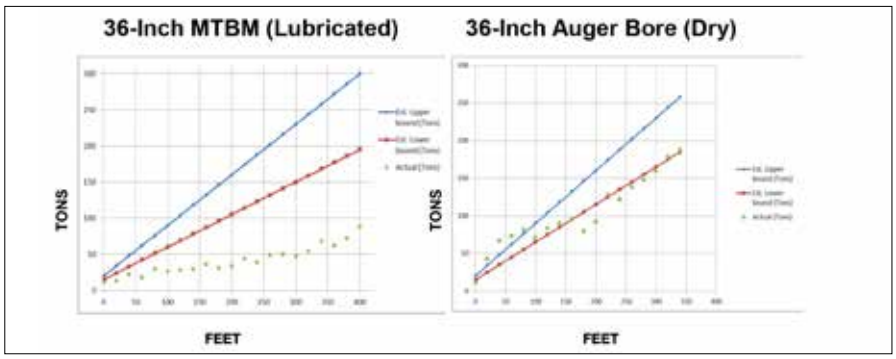

Figure 2: Axial loading development graphs of similar MTBM and Auger Boring installations in similar ground.

ABOUT THE AUTHORS:

Karen Armfield, P.E. *is a Principal Engineer with Kilduff Underground Engineering, Inc. She has 23 years of experience in the geotechnical industry providing analysis and geotechnical solutions for construction. Karen has authored over 15 technical publications in her area of expertise. Ms Armfield also has 18 years of experience as an adjunct professor at CUNY in Brooklyn, NY where she teaches soil mechanics and temporary structures in construction. She is also actively involved in NASTT, ASCE and DFI.*

ABOUT THE AUTHORS:

Todd Kilduff, P.E. *is founder and President of Kilduff Underground Engineering Inc. (KUE), a design and construction management firm specializing in tunneling, underground project design, and construction management services right across North America. Based in Denver CO, KUE has recently opened an office in Red Bank NJ to better serve the growing Mid Atlantic trenchless market. Todd served on the NASTT No-Dig Program Committee in 2020 and was also a Technical Track Session Leader.*

50TH ANNIVERSARY OF CIPP

Keynote Address: July 13 2021
Richard O. Thomasson PE, PWAM
2021 UCT CONFERENCE Nashville, TN

The Washington Suburban Sanitary Commission (WSSC) was formed in 1918 to handle water, sewer and stormwater responsibilities in Montgomery and Prince George's counties in Maryland. When the WSSC was formed and took over several local sewer systems were comprised of single-strength terra cotta pipe. In 1978, the sewer system was over 50 years old and more than 800 miles were 30 years old. A large number of maintenance problems were occurring, and maintenance costs were also increasing. WSSC was always a progressive agency and was on the cutting edge of the technology and seen as being in the forefront of changes in the water and sewer industry. At this time WSSC was the 7th largest water and wastewater utility in the US.

A proactive program was developed to inspect, clean and repair the aging sewer system. The sewer repair program involved grouting for I&I removal and excavation to repair the damaged sewer lines. WSSC was actively investigating alternatives to the excavation and replacement of the sewer lines. Sliplining was the only other alternative to complete replacement of the sewer in 1978, for the rehabilitation of the sewer lines. The backlog of work was constantly building because of the budget constraints and resources on the maintenance work force.

In 1978, WSSC was approached by Insituform East, Inc., concerning a new sewer restoration method which had been used in Europe since 1971. The process was Cured In Place Pipe (CIPP). Insituform was the name for CIPP at that time and was described as the insertion of an impermeable, corrosion-resistant lining inside existing sewer mains. Art Lang was the CEO of Insituform East, Inc. who brought the process to Richard Hocevar, Deputy General Manager for WSSC. A pilot project for EPA was handled by Tom Driver in Illinois. Also, initial introduction to Insituform was on the West Coast in 1977, but the focus was mostly on the manufacturing process and less attention on the technical aspects of installation. After thorough review of all available data on the process, WSSC agreed to use Insituform to reconstruct some of the deteriorated sewers.

A brief summary of the process was the use of a flexible tube with one or more layers of polyester felt bonded to a polyurethane membrane, which retains the resin that saturates the felt prior to installation. The polyurethane membrane becomes the inside wearing surface when the felt tube isn turned inside out during installation. The cure system is a polyester based isothalic resin incorporating a three component peroxide initiator.

Other critical parameters were the exact size of the sewer and the determination of the height of the water column necessary to move the tube through the sewer. Think of all the additional design advancement that has taken place during the years since 1978. There has been so much research on ovality and other

design considerations from the beginning 50 years ago. There was a historic session at NoDig with George McAlpine and Lynn Osborne presenting Insituform's view and an academic's view on ovality and its impact on design strength. As far as I am concerned, this was one of the most anticipated and informative session at NoDig, and I have been involved with all of them.

The installation process was described to customers, officials, and other stakeholders so they would be well informed on the new process. The sewer is thoroughly cleaned to remove all roots, grease and debri. A closed circuit television is used to inspect the sewer for cleanliness and to locate all house connections. The flexible liner is cut for the desired length (manhole to manhole plus height to top of inversion tube) and the felt portion of the liner is saturated with the catalyzed resin. The stretch of sewer to be Insituformed is isolated from the system by plugging the section of pipe and pumping upstream sewage around the project area through a temporary line above ground (by-pass pumping). Water services to houses discharging into the affected stretch of sewer are cut off so no flow can enter while the liner is being installed. Access through existing manholes is used to install the liner. Water pressure from static head of a column of water is used to expand the tube, and move it into proper placement , firmly against the inside surface of the old pipe. After placement, the water in the liner is circulated through a boiler to reach a prescribed cure temperature of 160 degrees and discharged into the the pipe via a layflat tube. When the cure cycle is complete, the liner has become rigid and is, in essence a new pipe. Each end of the rigid tube is cut off flush with the manhole walls to complete the process. In the first 3 years, improvements in the cure system reduced the cure temperature by 20 degrees and and cure time from around 5 hours to 3 hours. These changes resulted in energy savings, plus a reduction in total installation time. Improvement in the Insitucutter, resulted in better service re-instatement and less inconvenience to residents.

Service restoration was the next step to complete the restoration of service to any residents which had been isolated by the installation of the CIPP liner. A closed circuit television unit with a special cutting unit (Insitucutter) is pulled through the newly installed liner. The footage to each house service was previously recorded so the cutter can be positioned. In addition, the water pressure causes the liner to dimple into the house service slightly so visual confirmation of the location of the house service can be made on the TV monitor. The Insitucutter is used to make precision cut in the liner to fit the diameter of the existing service connection. After the opening of the service connection to the newly lined sewer, the water service is turned on, restoring full service to the homeowner. This original method was fraught with problems associated with operator error and proper location of the sewer service.

The initial sewer line chosen to use the Insituform process for reconstruction was one of many lines which could not be replaced by open excavation because of environmental (stream), traffic (State Road) and a railway. The reason for selection of the line was to see if the process could reconstruct the worst situation in the massive backlog of sewer problem

lines. Choosing this line indicates WSSC had ultimate confidence in the process, or we were just a little out of our minds. The sewer line was a 200 foot 15 inch line which travelled under 4 lane Route 1, a 25 foot stream and the AMTRACK and B&O rail lines. The sewer line was reinforced concrete pipe and had a slope of .8. The location was near 11270 Baltimore Boulevard in Beltsville, MD. The work was scheduled for October 31, 1978. Not intentionally, but possible rational for this date was it being a fright night for all involved. If there was not enough pressure on me for success of the process, Richard Hocevar (Deputy General Manager), James Lee (Maintenance Director), Arthur Brigham (Public Affairs Officer) and Douglas Baker (Systems Maintenance Division Head) my immediate boss were on the job checking with me every half hour on what is happening and will everything be alright. The location precluded the use of bypass pumping of the flow through the night. Septic tank pump trucks were used to pump out the manhole above the impacted sewer and hauled to a manhole below the affected stretch. The night was interesting from listening to the septic tank trucks back up alarms. Fit in well with the Halloween night atmosphere. Because of the railroad, there were only remote ways to get to the downstream manhole. An additional critical component was the calculation of flows, tanker truck capacity and travel time from upstream manhole to downstream manhole and time to unload the tank truck. This was just only one aspect of working with Insituform to actually solve installation problems in the field. Another was determining the height of the column needed to move the liner through the sewer main which had a low slope. On this first job, overcompensation was designed as no failure was acceptable and the liner was to be installed without problems. This resulted in requiring the liner to be restrained from too quickly being installed which would push out the resin in a slug in front of the liner and thinner resin in the felt liner. These were not design calculations, but field adjustments that were required to be made in the field with engineering judgement. WSSC construction and maintenance experience allowed us to make adjustments in response to the situation.

A second sewer in the backlog was lined January 1st, 1979. This sewer was in a right-of-way behind Mrs K's Toll House at 9201 Colesville Road. The sewer was 8 inches in diameter and 276 feet long, on a slope of 5.08. There were 4 services including the restaurant and a dentist office. No work could be done with conventional excavation as the right-of way documents only indicated the pipe and taps were within the easement for WSSC. We chose this date for the dentist being closed and started the work after the restaurant closed. In this case, by-pass pumping could be used and no back up alarms of septic tank trucks were heard. Since this was the first sewer connection reinstatement, there were problems with the Insitucutter, which resulted in impacts to the dentist office work on 1/2/1979. Also, because of the small size there were impacts on the installation of the liner. All of these problems were inherent in using something new and Insituform East worked with WSSC to plan for these types of

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situations on future work. In these early installations there were also boiler problems which resulted in longer cure times.

WSSC continued to work with Insituform East on many new projects because of the cost savings, environmental reduced impacts and less customer disruption than conventional open cut construction. A new program for reconstruction of sewers was developed in response to the use of CIPP lining. You may have noticed that I have used the term reconstruction and not rehabilitation throughout this talk. In the WSSC budgeting process, we were advised that we could not use capital budgets for rehabilitation work. The term rehabilitation implied maintenance activity and it must come from operating funding. Most of you know that operating budgets are much less that capital budgets because of the bonding use for capital budgets. Richard Hocevar who was a master of thinking out of the box, asked legal to give an opinion on the use of the term reconstruction. WSSC bylaws, were specific that capital funding was to only be use for construction. Legal gave the opinion that since it had the word construction in it, that it could be budgeted as capital funding. The major reconstruction program commenced using CIPP and budgeted under capital funding. As far as I was able to determine, WSSC was the first to reach a 100 miles of CIPP lining. We also, were for a short time, had the largest size sewer CIPP lined at 72 inches. WSSC also developed a standard methodology for trying new products for use in the reconstruction program.

I developed a comparison of costs for CIPP lining versus conventional construction used at WSSC to support the justification of budgets in the reconstruction program. For 248,00 feet of sewer 6 inches through 30 inches, the cost for CIPP was $13,389,707 versus $26,748,610 for conventional construction. This shows a saving of 50% due to the use of CIPP. These savings do not include monetary savings for disruption, environmental degradation or customer impacts.

I was privileged to meet Eric Wood the inventor of CIPP(Insituform), under very strange circumstances in 1980. I gave a paper on CIPP at the WPCF conference in Las Vegas. James Lee and his wife and Linda my wife and I had to leave our hotel a day early. Art Lang arranged for us to move to Eric Wood's room as he had to fly out and was to come back a day later. We moved to his room and both couples were laying in the beds watching tv. The door opened and Eric walked in and was startled to see two couples in the queen beds. We introduced ourselves and related the circumstances for our being there. He had forgotten something and came back to the room before flying out. He then remembered the arrangement that Art Lang had discussed with him. He was a brilliant individual but in the first moments when he entered the room, he was speechless and confused. I know I will never forget the meeting, he probably wanted to forget the occasion.

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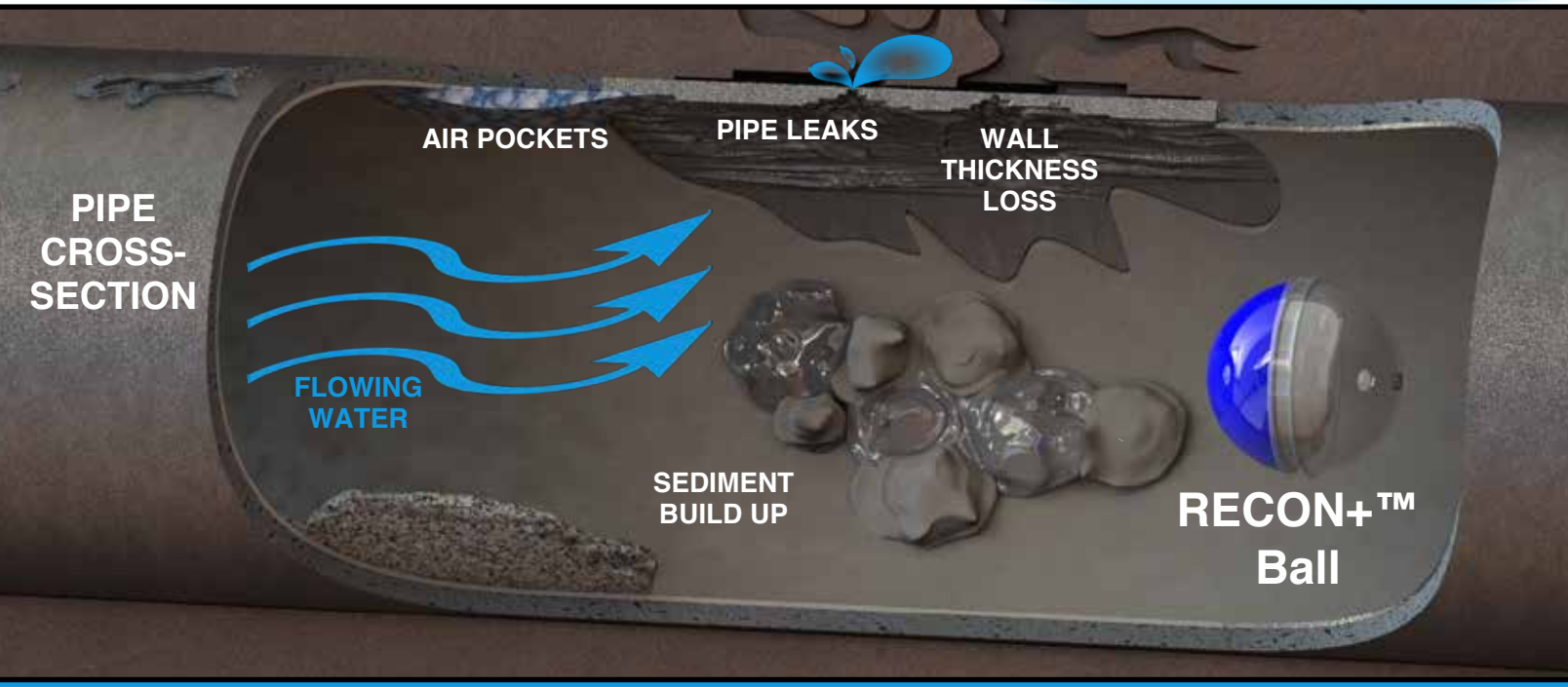

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