NASTT SOUTH CENTRAL CHAPTER

TEXAS & OKLAHOMA

TRENCHLESS REPORT 2023

OFFICIAL PUBLICATION OF THE NASTT SOUTH CENTRAL CHAPTER (NASTT-SC)

2023

- Pipe Bursting Secures Water Supply
- City of Sherman Expansion
- Game Plan: Norman OK
- Fort Worth Two Step

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The NASTT 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.

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NETWORKING EVENTS | EXHIBIT HALL | TECHNICAL SESSIONS

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The No-Dig Show is owned by the North American Society for Trenchless Technology (NASTT), a not-for-profit educational and technical society established in 1990 to promote trenchless technology for the public benefit. For more information about NASTT, visit our website at nastt.org.

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Communities across Texas and Oklahoma are seeing rapid economic and population growth, increasing demand for greater water supply and distribution capacity. The predominantly Cast Iron (CI) and asbestos cement (AC) water main networks are aging out and lack sufficient capacity to meet projected future demand, along with meeting minimum standards for fire protection. Pipe bursting can upsize a water main from a four inch up to a six or eight-inch main while still allowing traffic to flow, with minimal community impact from construction. There is simply no other better method to increase waterline capacity along the same pipe path.

Features:

Replacing a Critical Waterline using Trenchless: Sherman TX

With new and exciting investments, the less exciting, but necessary programs cannot be forgotten, such as the continued maintenance of the City's existing infrastructure. It was clear that replacing this existing infrastructure would not come without challenges. Ultimately, the option with the lowest price tag was selected, best able overcome all of the challenges of this project. A minimally invasive, cost effective solution.

Pipe Ramming & HDD, A Texas Two Step!

Horizontal directional drilling and pneumatic pipe ramming are two trenchless methods that complement each other on small and large projects alike. HDD is the ultra-capable installation method that has allowed projects that were once unthinkable to become realty. And pipe ramming is the ultimate muscle method, there to help, assist and even salvage HDD projects that run into problems. The two methods recently teamed up on a project in Fort Worth, TX.

Microtunneling in the Houston Area

Details on two gravity sewer microtunneling projects at depth in the Houston area. Since the late 80s Houston has adopted microtunneling and guided boring as its primary new trenchless installation method for the deep portions of its sewer project needs. Wih challenging geotechnical conditions and Houston's population and traffic, these microtunnel projects demonstrate how trenchless methods make sense for new installations.

Designing and Installing a Temporary Lift Station

Bypassing a 78-inch sanitary sewer line can pose its fair share of challenges, especially when it is 65 feet deep in the ground. Due to the massive scale and challenging depth of this project a shaft with a diameter of 22 feet was built that would normally be used to insert a tunnel boring machine. This was used to form the deep temporary wet well. During the multi-month project, the bypass pumping system successfully endured several high wet weather events.

Also:

Departments:

Front cover photo courtesy of Huxted Trenchless

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Printed 09/23 in Canada.

MESSAGE FROM THE NASTT SOUTH CENTRAL CHAIR

Justin Taylor, NASTT South Central Chair

Welcome to the 6th publication of the ***Texas and Oklahoma Trenchless Report***. Established in 2017, the South-Central Chapter of the North American Society for Trenchless Technology (NASTT) is proud to present this journal documenting trenchless projects and technology which are the result of the growth and impressive level of support from professionals within our industry.

The South-Central regional chapter of NASTT represents Texas and Oklahoma, two states comprising a geographic area experiencing significant growth in population. As the population grows, so does the need to expand, upgrade and replace existing infrastructure. Now more than ever, the benefits of trenchless technologies are critical to addressing our infrastructure challenges. The ***Texas & Oklahoma Trenchless Report*** is focused on providing a better understanding of trenchless methods and best practices on a regional level.

The South-Central chapter (SCNASTT) was formed in January of 2016, and has since hosted six chapter events, including in 2016, 2017, 2019, and 2022 at The University of Texas at Arlington, and at Oklahoma State University in 2018. After taking a break in 2020 due to Covid-19, we followed up in 2021 with a conference in Sugar Land, Texas for the first time, and we are now looking forward to our chapter's first event in the city of San Antonio, with our annual conference taking place there on September 26th of this year at the University of Texas San Antonio (UTSA) campus. These events are averaging roughly 125-150 attendees and include utility owners, engineering firms, municipalities, and contractors. At these events, attendees learn about the trenchless projects that are taking place in their local areas as well as the new technologies that may be able to assist them in their projects, and enjoy the professional networking opportunities to learn from their peers.

> *"The South Central Chapter has seen exceptional growth over the past several years, and we hope to continue that growth in order to better serve the industry and our communities."*

The South-Central Chapter is committed to supporting education through scholarships for our members. A total of 8 student scholarships at $1000 each will be awarded at the 7th Annual Chapter Conference on September 26th in San Antonio, Texas for the 2023-2024 school year. The South Central Chapter is excited to continue to support eligible students and members through scholarships, education, and future employment within our industry.

I would like to take this opportunity to thank the members of the South Central Chapter Board, which we recently expanded to include more members and better diversify our team. The chapter now has a strong core of 12 dedicated members. This publication, the educational conferences we produce, and the scholarships and support we are able to supply would not be possible without the hard work and support of the board members who work to make this chapter what it is. Thank you for your continued service.

The South Central Chapter has seen exceptional growth over the past several years, and we hope to continue that growth in order to better serve the industry and our communities, and be a resource for the personal and professional growth of our members. I challenge each of you reading this publication to consider joining the South-Central Chapter of NASTT and get involved with our organization. We hope you find this publication to be a valuable resource for all things trenchless and we truly appreciate your continued support.

Sincerely,

Justin Taylor
NASTT South Central Chair

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MESSAGE FROM THE NASTT CHAIR

Matthew Wallin, PE, NASTT Chair

Annual South Central Trenchless Conference Heads to San Antonio!

Hello South Central Chapter Members and Associates! Earlier this year we held the NASTT 2023 No-Dig Show in Portland, Oregon, which was a great success and a wonderful opportunity to see our industry friends and colleagues while we celebrated all things trenchless. And now we are excited to switch gears and look forward to the many upcoming Regional Chapter conferences this fall, including the annual South Central Trenchless Conference! The conference will be held on September 26 at the University of Texas in San Antonio. The event will include presentations by industry experts discussing trenchless installation and rehabilitation methodologies as well as networking with breakfast, lunch, and refreshment breaks.

In the coming months we have many additional events planned to bring the underground infrastructure community together. Our ever-popular NASTT Good Practices Courses are being held both virtually and in-person throughout the year.
Visit **www.nastt.org/training/events** to find a course that fits your schedule.

We are also already planning for the 2024 No-Dig Show which meets in Providence, Rhode Island next April. Providence is a great central location within the heavily populated northeast corridor, just a short drive from Boston, and within reasonable drive from Philadelphia, New York City, Hartford, and many other cities in between. Our Show motto is *Green Above, Green Below* and it is important that our industry is a steward of our precious natural resources, so we welcome the opportunity to provide a forum for learning about the latest in innovative trenchless products and services that help us all accomplish that lofty goal. Learn more about all the No-Dig Show has to offer at **www.nodigshow.com**.

> *"It is important that our industry is a steward of our precious natural resources!"*

If you have attended an NASTT event (national or regional) you probably left feeling excited and eager to get more involved. I ask that you consider getting engaged in one of the many NASTT committees that focus on a wide variety of topics. Some of our committees that are always looking for fresh ideas and new members are the Training and Publications Committee, the individual topic Good Practices Course Sub-Committees, the Educational Fund Auction Committee, the No-Dig Show and No-Dig North Planning Committees and Technical Program Committees. There are many opportunities for you to consider where your professional expertise can be put to use through networking with other motivated volunteers. With education as our goal and a strong drive to provide valuable, accessible learning tools to our community, we are proud of our continued growth as both an organization and as an industry. Our volunteers and committee members are what keep us moving in the right direction.

For more information on our organization, committees, and member benefits, visit our website at nastt.org and please feel free to contact us at **info@nastt.org**.

We look forward to seeing you at a regional or national conference or training event soon! And we hope you are planning to join us in San Antonio for the South Central Trenchless Conference, September 26.

Matthew Wallin, PE

NASTT Chair

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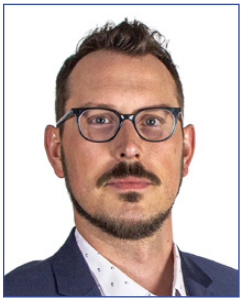


JUSTIN TAYLOR – CHAIR

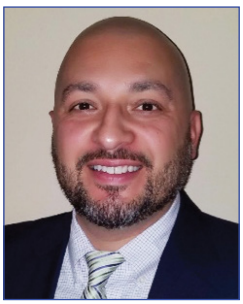
justin.taylor@cciandassociates.com

Justin Taylor, P.E. is the VP of Engineering and General Manager for CCI & Associates Inc., an engineering, design, and inspection firm specializing in trenchless technology. Justin holds a B.Sc. in Mechanical Engineering from the University of Alberta. After almost 10 years of various engineering and management roles in the Western Canadian CCI offices, Justin moved to Houston, Texas to head the engineering team in CCI's first stateside offices. Justin is a licensed P.E. in over 20 states including Texas, Oklahoma, and Louisiana. In his time with CCI, Justin has worked on trenchless crossings for various high profile projects such as Keystone/ Keystone XL, Enbridge Line 3, Plains Wink to Webster, and Kinder Morgan TMEP Pipelines, and has been involved in the development of tools for real-time measurement of strain and stress on steel pipe during Horizontal Directional Drill installations. Justin is an active member of NASTT, having authored and co-authored several papers for the organization, and being a member of the NASTT Program Committee.

ALAN SWARTZ – TREASURER

aswartz@plummer.com

Alan Swartz is a Principal and Oklahoma Design Team Leader with Plummer Associates, Inc and currently serves as the Treasurer of the Board for the NASTT South Central Chapter. He is responsible for the day-to-day operations of Plummer's Oklahoma City Office which serves clients across the states of Oklahoma and Texas. Alan graduated from Texas Tech University with a bachelor's in mechanical engineering and has over 23 years of experience in the design and rehabilitation of water and wastewater pipelines, lift stations and pump stations and is a licensed Professional Engineer in Oklahoma and Texas.
Alan has extensive experience in the design and construction of small and large diameter water transmission and distribution mains utilizing both open cut and trenchless methods including auger boring, tunneling and horizontal directional drilling. Pipeline rehabilitation experience includes sliplining of large diameter sanitary sewer interceptors; pipe bursting and cured-in-place pipe lining for small to medium diameter sanitary sewer lines; and pipe bursting and compressed fit HDPE liners for small to medium diameter water transmission and distribution mains.



SHAWN GARCIA – VICE CHAIR

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Shawn Garcia is a licensed Professional Engineer in the state of Texas and currently serves as Regional Manager for Underground Solutions, Inc. (an Aegion Company) for the North Texas, Oklahoma, and Arkansas areas, where he manages and oversees all business development, operations, and activities in the region. Shawn has worked in the General Contracting, Public, and Private sectors and has over 20 years of engineering development, engineering design, and construction experience specific to the Water/Wastewater Utility Infrastructure Rehabilitation and New Construction industry. He received a Bachelor of Science in Engineering from Texas Tech University. Aside from the SC Chapter of NASTT, he is an active member of AWWA, UCTA North Texas Chapter, and ASCE/UESI.

PAUL BEARDEN – SECRETARY

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Paul is HDR's Trenchless Services Program Leader and has nearly 30 years of experience in the design, project management, and construction of oil, gas, water and utility pipelines utilizing trenchless technologies, specifically horizontal directional drilling (HDD), conventional boring methods, and Direct Pipe®. Paul has special expertise in the construction of complex, large-diameter HDD pipeline installations and extensive on-site experience with major projects around the world. Paul has demonstrable management skills and works effectively with multi-skilled, international teams to complete pipeline projects from front-end engineering design through construction. Paul possesses excellent communication, negotiation, and writing skills and the ability to develop positive working relationships.

BOARD OF DIRECTORS 2023-2024

JIM WILLIAMS – PAST CHAIR

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Jim Williams is a Senior Associate with Brierley Associates, located in Austin, Texas where he works exclusively on trenchless projects. He has 29 years of experience in a wide range of projects primarily in horizontal directional drilling and other trenchless methods. His experience includes design, planning, construction, and construction management of trenchless projects throughout North America.

Jim received his bachelor's degree in engineering from the University of Florida and is a licensed civil engineer in 6 states. He began his career working for several engineering firms in Jacksonville, Florida before founding a trenchless engineering firm in 2006 that focused on contractor support services. In 2010 he joined Mears Group as HDD Engineering Manager until late 2017 when he joined Brierley. He has also authored numerous technical papers and taught many HDD training classes in North America, Europe, and Australia.

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7TH ANNUAL NASTT-SC TEXAS/OKLAHOMA

TRENCHLESS TECHNOLOGY CONFERENCE

September 25 - 26, 2023

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501 W Cesar E Chavez Blvd, San Antonio, TX 78207

Join us in beautiful downtown San Antonio, Texas for trenchless presentations and networking with reception, continental breakfast, lunch and refreshment breaks!

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Monday, September 25th , 2023 (4 pm – 7 pm) Evening Reception

Tuesday, September 26th, 2023 (8 am – 5 pm) Technical Program

A great opportunity

to network, build relationships, and develop business opportunities with attendees and exhibitors from all aspects of underground infrastructure including public works officials, utility company personnel, oil and gas companies, engineers, underground contractors, industry suppliers and students. Registration includes complimentary USB of the Conference proceedings.

Limited space available! Act Now!

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The 7th Trenchless Technology and Pipe Conference (TTP 2023)
Monday & Tuesday, September 25 - 26, 2023

Monday, September 25, 2023

4:00 – 7:00 pm	***Exhibitor Setup, Conference Opening Social (Mi Tierra)***

Tuesday, September 26, 2023

8:00 am – 9:00 am	***Registration with Refreshments***
9:00 am – 9:20 am	**Welcome / Board Introduction / NASTT Introduction** Mr. Alan Goodman-Immediate Past Chair – NASTT National, Mr. Justin Taylor-Chair of South-Central Chapter of NASTT
9:20 am – 9:30 am	**CUIRE Intro / Scholarships** Dr. Mo Najafi-Professor and Director of CUIRE, Mr. Justin Taylor-Chair of South-Central Chapter of NASTT, Scholarship Awards
9:30 am – 9:45 am	**UT San Antonio Introduction & Welcome** Dr. Eric Brey – Dean Klesse College of Engineering & Integrated Design
9:45 am – 10:15 am	**Keynote Address** Cristina Brantley, PE – Director – Pipelines Engineering, San Antonio Water System (SAWS)
10:15 am – 10:30 am	***Exhibitor Session / Coffee Break***

Start of Technical Sessions 10:30 am – 12:00 pm

Time/Tracks	Track A -- -- New Installations *Moderator: TBA*	Track B -- -- Rehabilitation *Moderator: TBA*	*Track C* -–- Projects of Interest *Moderator: TBA*
10:30 am	**One Gulf Coast Town's New Vision for Its WWTP After Ike's Devastation** Craig Fisher, P.E, Texas Regional Engineer **Westlake Pipe & Fittings**	**Bexar County Spray Applied Linings (ASPL) Lessons Learned** Ted Jones P.E, Regional Manager, **Geo Tree Solutions**	**DWU Utilizes an Alternative Delivery Approach to Save Money and Maximize Construction** Rishi Bhattrai, P.E, Rakesh Chaubey, PE, Tracey Long, PE **Hazen and Sawyer**
11:00 am	**NBU Guadalupe River Crossing – Vertical Curved Microtunnel** Robert Weinert, PE, Jesse Guerra, PE, **Plummer Associates, Inc.** Michael Perry, PE, **New Braunfels Utilities**	**Big Approach to Small Diameter Sewer Rehabilitation** Travis Aaron Grohman, P.E., Travis Terrell Ramos, P.E., Mary Carr Portillo, P.E., P.M.P., **Plummer Associates Inc.**	**SAWS Partner Projects – Tunneling to Achieve Project Objectives** Gerardo Gomez, P.E, Michael Persyn, P.E, Jeff Farnsworth, P.E **Kimley-Horn**
11:30 am	**Micro tunneling under the Canadian River in Byng, OK to help construct the largest water transmission main project currently being installed in the USA** Carl Pitzer, P.E, **Thompson Pipe Group**	**"Yes, You Can Bust Water!" Waterline Replacement via Trenchless Technology** John Newell **No-DigTec, LLC**	**McNeil Water Transmission Main: Out of Sight, Out of Mind** Gabriel Castano, P.E. **City of Austin** Jason Swartz, P.E., Chris Mason, P.E. **Black & Veatch**
12:00 pm – 1:00 pm	***Buffet Lunch (Provided with the Program)***		
1:00 pm – 4:00 pm	***Technical Sessions***		

Time/Tracks	Track A -- New Installations *Moderator: TBA*	Track B -- Rehabilitation *Moderator: TBA*
1:00 pm	**A Comparison of Polyethylene (PE) Installation Pull Forces** Chelsea Griffiths, P.Eng., PE, Ashkan Faghih, Ph.D., P.Eng., Justin Taylor, P.Eng., PE, **CCI & Associates**	**A Case Study for the Repair by Semi-Trenchless Technology of an existing78-inch and 102-inch PCCP Aqueducts by Sliplining using Fiberglass-Reinforced, Polymer Mortar Pipe (FRPMP)** Victor Rivera, **Hobas Pipe USA, Inc.**
1:30 pm	**Lampasas River Crossing HDD,** Damola Ashaye P.E, **Underground Solutions, Inc.**	**CIPP Curing Monitoring System Technology** Kit Jones, **Vortex Companies**
2:00 pm	**Case study: Lake Sakakawea, Missouri River, ND 15,426' Intersect HDD,** Tom Forconi, **Brownline USA**	**West Texas Fast and Fuse** Kenny Friar, P.E., Chandler Shields, P.E., **Kimley-Horn**
2:30 pm	***Exhibitor Session / Coffee Break***	
3:00 pm	**Mitigating Risk in Large Diameter Tunneling** Yovani Zelaya, PE, Chase Juhl, PE**, DEC**	**City of Sandy, OR tackles I&I with Blue Light LED light-cured CIPP for sewer laterals** Alan Goodman, **Hammerhead Trenchless**
3:30 pm	**SAWS W-6 Upper Segment: Out of Sight, Out of Mind** Henry Leighton, P.E., **CAS,** Jason Swartz, P.E.,**Black & Veatch,** Gerardo Gomez, **P.E. SAWS**	**Trenchless Renewal Methods in Underground Deteriorated Pipes Rehabilitation** Mohammad Najafi, Ph.D., P.E., F. ASCE, Professor and Director, Sanaz Ghalambor, Polymer Engineer, CEM Ph.D. Candidate, Kawalpreet Kaur, Ph.D., Post-Doctoral Researcher, **CUIRE**
4:00 pm	**Internal Joint Seals** Jeremy Kieninger, **Miller Pipeline**	**Retrospective View: CIPP Lining of a 21-inch Clay Pipe "Deep" Sanitary Sewer in Downtown Fort Worth, TX** Chris Brooks, P.E. , **RJN Group, Inc.**

Pipe Bursting Secures Community Water Supply

By: John Newell, NO-DIGTEC

CHALLENGES CLOSE TO HOME

The headline is a wakeup call. According to an August 4 article in the ***Houston Chronicle***, in 2022 the City of Houston lost 30 billion gallons of treated potable water due to failing infrastructure. A further 9 billion gallons leaked out from January to April this year, with the city losing more than 20 percent of its water supply "at least five times since the start of 2022". Over $150 million worth of precious drinking water into the ground. You often hear about how aging water infrastructure is failing across the nation, with approximately 3.3 billion feet of AC pipe alone nearing the end of its expected life cycle. The Houston situation literally hits close to home. We must protect our water, especially in such a drought prone area.

These huge water line losses are happening at the same time communities across Texas and Oklahoma are seeing rapid economic and population growth, increasing demand for greater water supply and distribution capacity. The population of Texas just surpassed 30 million and there are large industrial developments cropping up everywhere like the semiconductor plants going into the City of Sherman. The predominantly Cast Iron (CI) and asbestos cement (AC) water main networks are aging out and lack sufficient capacity to meet projected future demand, and minimum standards for fire protection.

Minimal excavation/restoration. The pipe bursting method reduces digging requirements are reduced as much as 90 percent compared to an open cut "dig and replace" method. The only excavation required is for the pulling machine, insertion pit and accesses to service connections

With over 2,100 towns and cities across both states, there is a need for secure dependable water supply. Immediate action and focused attention on longer-term cost effective solutions, rather than expensive short-term repairs is necessary to avoid a dire future of repeated water shortages. As the ***Houston Chronicle*** reports, Houston replaced only 10 miles of its 7000 miles of aging water pipe inventory in 2022. Just to keep pace with a 50-year replacement cycle would require a minimum 140 miles of pipe replacement annually. It is important to keep in mind that Houston is just one city out of many communities, one example among many.

Unlike failures in sewer lines, clean water leaking into the environment poses little risk itself to public health or safety. Municipalities are highly motivated to prevent and immediately clean up leaks and repair failures in the sewer system, responding as rapidly as possible to mitigate environmental hazards, health risks and negative social impact. By comparison, waterline replacement projects are left aside until they inevitably become urgent, prompting unscheduled repair jobs, which redirects time and money earmarked for other longer-term projects. This reactive "whack-a-mole" approach to fixing leaks only when they become urgent is costly, disrupts planning and public works schedules, while at the same time diverting crucial funding away from proactive long term replacement programs.

We can no longer keep kicking this can down the road. The very definition of a "false economy" is to force ratepayers to keep paying for short-term fixes to leaks and line breaks in these outdated water systems when effective long-term options do exist that can efficiently, and cost effectively fix the entire water distribution system. It is no longer possible to meet current waterline replacement needs by continuing as usual, bidding out piecemeal replacement projects as large-scale "dig-and-extract" jobs. A planned proactive approach involves using appropriate technologies to replace the aging CI and AC waterlines with newer larger diameter water pipes, thereby properly managing this precious resource and accommodating increased demand well into the future.

Using proven well-established trenchless technology methods such as pipe bursting to install new longer lasting pipe materials has the added benefits of dramatically reducing impacts on traffic flow, businesses and residences, decreasing carbon emissions due to a much smaller construction footprint, and greatly reducing the costs associated with excavation and surface restoration. By greatly decreasing these restoration costs, more "bang for the buck" can be achieved so that substantially more AC and CI pipe can be replaced using the same funding already in place.

> *There is great value on the ability of a contractor to increase the water main from a 4-inch to a 6-inch or 8-inch main while allowing traffic to continue, with minimal community impact.*
>
> -John Newell, President, NO-DIGTEC LLC

Joint fusing and pipe staging area. Sticks of PVC are joined to full run length prior to the day of the burst, stored conveniently out of the way near the insertion point

COST EFFECTIVE TRENCHLESS SOLUTION

Pipe bursting technology first originated in Europe in the 70s as a trenchless solution for gas pipeline replacement that involves fracturing the existing host pipe into the surrounding soil while simultaneously pulling in a new pipe. First introduced to North America in the late 80s, the pipe bursting method has since gained wide acceptance as a reliable, long-term, low-cost solution for replacing aging sewer system piping. Despite many advantages, pipe bursting remains grossly underutilized in potable water replacement applications.

In fact, some municipal wastewater collection and water department officials simply do not realize that the technique they already endorse for use in their sewer replacement program is

Machine pit dimensions need to be only big enough to accommodate a 4-foot by 12-foot shore box, at a depth not much deeper than the lay of pipe being replaced

equally viable for potable waterline replacement. Even within the state of Texas, one of the world's largest pipe bursting markets, it is still possible to find city engineers who admit they did not know pipe bursting is also well suited for waterline rehabilitation.

However, increasing efforts to educate infrastructure decision makers on the applicability and benefits of waterline pipe bursting are beginning to yield results, and many municipalities are now looking at pipe bursting technology as the preferred method to replace and upgrade their existing potable water pipe systems. Because of the cost, environmental and social advantages over the traditional open-cut method, municipalities are now much more open to exploring the use of innovative pipe-bursting technology in their water line replacement programs.

With a unique ability to upsize capacity while replacing a water line, pipe bursting is rapidly gaining great acceptance. Experience using the method has also demonstrated conclusively that complaints from local residents and business are reduced enormously when pipe bursting is used. Overall, this accumulated experience demonstrates the advantages of pipe bursting as a cost-effective method for replacement and upsizing of existing water lines and service laterals without any need for open-cut digging.

PIPE BURSTING METHOD

Waterline pipe bursting is like other static (drawn by hydraulic cable or rod pulling machines) pipe bursting applications, in which the existing pipe is opened and forced outward by a bursting tool. The tooling fractures and pushes the existing pipe into the surrounding ground. At the same time, the new pipe is pulled into place as the bursting head assembly progresses. New product pipe follows behind the pipe bursting tools, which usually consist of a pulling rig, pipe bursting head and expander. A powerful hydraulic pulling machine at the far end of the pipe path pulls the bursting head and expander through the existing AC, CI or PVC pipe. As the expansion head is pulled through the existing pipe, it pushes that pipe radially outward into the soil until it breaks apart, creating a space for the new pipe. The bursting device also pulls the new pipeline behind it, immediately filling the void created by the old, burst pipe with the new pipe.

Various types of expander heads can be used on the bursting tooling to expand the existing pipeline. Static heads, which have no moving internal parts, expand the existing pipe through only the pulling action of the bursting tool. The condition of the existing host pipe being replaced does not affect the ability to perform pipe bursting, as long as the rods can be inserted through the existing pipe.

Although the most common replacement scenario is a size-for-size replacement, replacement with a pipe of larger diameter is also achieved with the pipe-bursting method. The amount of up-sizing possible depends largely on soil conditions. Larger upsizing requires more force to pull the expander through because there is more ground being moved while bursting through the existing pipe. These factors must be taken into consideration when determining the feasibility of a large up-sizing of existing pipe.

PIPE BURSTING ADVANTAGES

Because of this ability to upsize diameters along an existing pipe path, pipe-bursting harbors great future promise as a method for cost effectively increasing water distribution capacity. In fact, pipe bursting is the perfect solution for any municipality looking to increase the capacity of its water distribution system pipes, while securing existing supply. Even better, this is accomplished without extensive excavation and the usual costs associated with extensive surface restoration after construction. In fact, pipe bursting is the best method for replacing old water pipes in congested urban

Great value in a contractor being able to upsize a water main while still allowing traffic to flow

> *In some jurisdictions, project restoration costs can exceed two thirds of total project spending. Pipe bursting significantly reduces these costs, meaning more pipe can be replaced.*

areas where disruption to surrounding utilities, local residences, businesses and the environment are important considerations.

Municipal water department directors generally assume that out of any funding they are allotted for their urgent asbestos concrete (AC) pipe and cast iron (CI) pipe replacement plans, at least half must be set aside to pay for restoration costs, patching or replacing pavement and repairing surface construction. In some jurisdictions, project restoration costs can exceed two thirds of total project spending. Pipe bursting significantly reduces these restoration costs by 85 to 90 percent because working from small access pits without trenching eliminates a vast majority of this excavation work while minimizing disruption to adjacent buildings, roadways,

The majority of the insertion pit does not need to be much wider than the pipe itself

Enhanced safety. Some modern pulling machine designs free the operator from the pit, offering a superior view of the operation and of worksite surroundings during an installation

parking lots and landscaping. Overall construction impacts to the community are minimized while achieving the larger diameter pipe replacement sufficient to meet demand. Lateral pipe-bursting rehabilitation offers a portable, quick and cost effective method for replacing 1⁄2 – 6-inch laterals when used in conjunction with an overall replacement program.

For more than 70 years, AC and CI pipes have played an important part in waterline distribution across the US. Decades of construction and additional buried services now often crowd the easement they share with them, some lying parallel to the aging water lines and others crossing over it. Unless the pipeline must be relocated or has greatly offset joints, the pipeline can be fully replaced and even upsized using this technique exactly as it lays in situ, following in the same path as the existing pipe. The method greatly reduces the risk of damage or harm to property, shared utilities and personnel during the pipe replacement process. For this reason, the method is often viable when some other trenchless methods, such as horizontal directional drilling (HDD), are not.

There is great value in the ability of a contractor to increase the water main from a four inch up to a six or eight-inch main while still allowing traffic to flow, with minimal community impact from construction. There is simply no other better method to increase waterline capacity along the same pipe path.

CONSTRUCTION PROCESS

A waterline pipe bursting job reduces excavation requirements significantly compared to open cut replacement. Each bursting run requires only a pulling pit (machine pit) at one end, an insertion pit for the replacement pipe at the other end, and small access pits as necessary at each service connection along the run. The machine pit dimensions generally need to be only big enough to accommodate a 4-foot by 12-foot shore box, at a depth not much deeper than the lay of pipe being replaced. The insertion pit need only be wide enough to accommodate the replacement pipe. Length of the insertion pit depends on the depth of the pit, along with the length and stiffness of the new pipe. The insertion pit needs to be long enough to ensure the new pipe can flex sufficiently without damage during its transition from the surface to point of insertion, as it gets pulled through.

The new water pipe is staged and fused into a pipe string of the necessary length on the surface prior to the bursting run. This can be done in a separate staging area off to the side to limit any disruption to traffic, businesses, and residents before the installation. Installation rates typically average 3 to 7 feet a minute, with a whole run generally not taking more than a few hours depending on length of run, site conditions and the equipment used.

Even though the pipe bursting operation takes place within a short span of time, creating a temporary waterline by-pass ensures customers are not without water during installation. The temporary bypass offers two valuable advantages during construction. First, the contractor has the ease of converting over the newly installed main to the services run to the home or business. Secondly, the bypass affords the operator the ability and time to address any obstacle that may arise during the bursting process, such as unknown repair clamps the crew must stop to access and cut through, encountering a concrete encasement, directional changes, etc. Customers are thereby not inconvenienced in case any unexpected delays arise during the construction process.

Once the line and services are reconnected, restoration consists of simply backfilling the pits and patching any pavement or landscaping removed during the installation. Because the replaced pipe remains in the ground, there are no costs associated with disposal. In the case of AC pipe that is replaced there are similarly no costs associated with hazardous material mitigation as the shards of the burst AC pipe stay safely in the soil. Effectively, the project is complete.

PIPE BURSTING MATERIALS

Pipe bursting is used mostly to replace pipe made of fracturable materials, mainly AC, CI, & PVC waterline pipes, and can be used to replace pipe in diameters ranging from 2 to 24 inches. The method is used not only for size-on-size replacement but to upsize pipe where increased capacity is desired.

Fortunately, pipe- bursting is versatile and can easily accommodate installing various pipe materials. Traditionally, the majority of pipe installed via pipe-bursting is HDPE, but the technology can accommodate other pipe including Fusible PVC (FPVC), restrained-joint PVC, and restrained-joint ductile iron. Since 2004, FPVC has become much more prevalent, for several reasons. While HDPE is readily familiar in other pipe bursting applications, FPVC is a long-established, widely used material in the potable water market. It therefore enables water department crews to use connections and fittings they already have on hand and are familiar with, maintaining uniformity of product type and service technique throughout their delivery system.

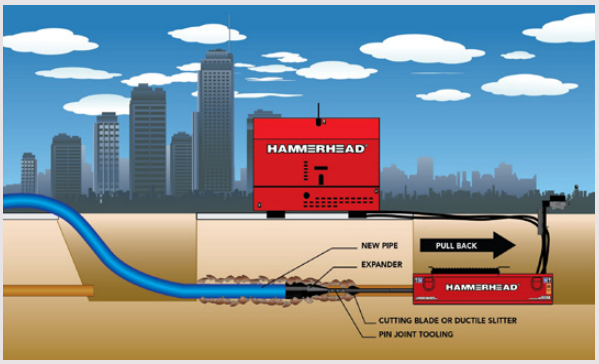
Regardless of what the existing pipe material is, as well as the type of new pipe material being installed, pipe-bursting offers a cost-effective environmentally friendly way of replacing and upsizing aging water mains while minimizing overall impact and disruption to the community.

CONCLUSION

The North American water supply industry urgently needs an effective, fast, environmentally safe and economical means of replacing over 3 billion feet of AC waterline, as well as millions of feet of CI waterline now past its rated useful life. Pipe bursting is a viable, proven yet underutilized replacement method that meets all these requirements.

Pipe bursting narrows the surface footprint, minimizing project work impact on daily traffic, commerce and social routines around the construction zone. Few if any passersby realize a significant project is underway, which in many cases is completed in a few days. The result is a renewed waterline projected to last a century and will likely last much longer.

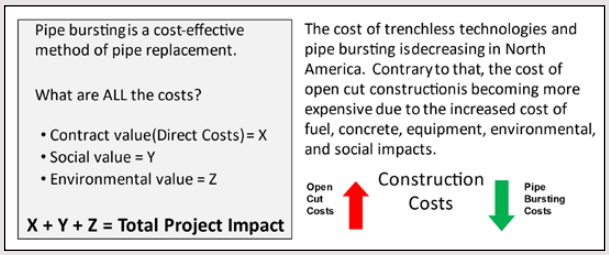
Waterline pipe bursting is a powerful tool whose time has come. As the population continues to grow rapidly and the demand for water increases, public infrastructure decision-makers urgently need to address a looming crisis in waterline delivery/distribution systems in Texas and Oklahoma. Pipe bursting offers a viable cost-effective solution to these challenges, and the best way forward to secure our critical water supply.



The Advantages of Pipe Bursting

Permanently solving the problem by spending less money and time with lower project risk and inconvenience to everyone while providing less disruption.

- Surface restoration costs reduced by 90%
- Funding used for more actual pipe replacement, instead of excavation/restoration
- Reduced project time and costs
- Greatly decreased carbon emissions
- No need for additional easement, ROW
- Zero impact on adjacent utilities
- Minimal traffic disruption
- Minimal impact on businesses/residences
- Minimal impact on environment, trees, landscape
- Safe effective "disposal" of legacy AC pipe
- Ability to upsize and increase waterline capacity



ABOUT THE AUTHOR:

***John Newell** is founder and President of NO-DIGTEC LLC, based in Ferris Texas, the largest Pipe Bursting contractor in North Texas and a pioneer and advocate of this trenchless method over the past 23 years. With nearly 50 years total experience in underground utility construction, John shares his extensive knowledge by serving as guest lecturer on various trenchless pipe replacement techniques at the Center for Underground Infrastructure Research and Education (CUIRE), University of Texas. He is a highly motivated energetic proponent of the pipe bursting method, and a longtime member of NASTT, UCTA, AWWA and NUCA.*

City of Sherman Replaces a Critical Waterline Using Multiple Trenchless Technologies

Project Shows the Merits of Pipe Bursting

By: Shah Rahman, MBA, KCI Technologies Inc.
Kyle Wroblewski, PE, Underground Solutions

SHERMAN – A CROWN JEWEL IN TEXAS' HIGH-TECH ECONOMY

When KCI's Shah Rahman went by to see Wayne Lee, Director of Engineering at the City of Sherman in the Summer of 2020, shortly after Wayne retired from a 30-year career at the City of Irving, he said he was looking forward to some peace and quiet and figured it would be a little while before the growth and development north of McKinney reached Sherman. By late 2021, Wayne was in a mad rush, planning for all the new water and wastewater infrastructure that would be needed to accommodate Texas Instruments' second plant in Sherman that had been announced in November.

This would be a $29 Billion 300mm semiconductor wafer fabrication plant! Together with Tom Pruitt, the City's Utility Engineer, the duo had to quickly plan and assign design work for nearly $530 million of water infrastructure that would involve a raw water pump station upgrade, laying of a new 14-mile, 36-inch transmission main, building of a 2-million-gallon elevated storage tank, upgrade of a wastewater plant and construction of a concentrate lift station. When complete, this infrastructure work along with the new plant will place the City of 45,000, the county seat of Grayson County, in the top echelons of the state's booming high-tech economy.

TAKING CARE OF WHAT LIES BURIED

With new and exciting investments, the less exciting, but necessary programs cannot be forgotten, such as the continued maintenance of the City's existing infrastructure around town. As Wayne would explain during that meeting in Sherman in 2020, "the City needs to focus on the maintenance of all the existing aging buried infrastructure underneath our streets and alleyways, the water and wastewater lifelines that enable our citizens to enjoy a relatively trouble-free life, thankfully without regular busted water pipes or sewer overflows."

In his new role, Wayne wanted a planned effort to remove and replace at least one percent of the City's buried pipes every year. This was to stay ahead of the inevitable aging of buried infrastructures, failures following years of corrosion, movement of clayey gumbo soils in this region, leaking joints and water loss, and a myriad of other causes. To this end, the City quickly put out contracts for both a Water Master Plan and a Wastewater Master Plan.

A PROBLEMATIC WATER MAIN

Where immediate action was required, Wayne Lee explained, was the design and construction of Phase 3 of the rehabilitation

Static Pipe Bursting Head / Cutter

Congested narrow ROW. Pipe bursting reduced impacts to adjacent propeties

Original Cast Iron Pipe

"This was the City's very first pipe bursting project, and it went very well. Utilizing pipe bursting minimized impact to other utilities that we had to work around."

-Wayne Lee PE, Director of Engineering, City of Sherman

and replacement of a waterline built in 1963 that runs along Texoma Parkway. The first two phases, Highway 82 to Gallagher, and Gallagher to Midway Mall, respectively, were designed and replaced seven years prior by the City and its construction crews.

In early 2021, KCI Technologies was contracted by the City of Sherman to provide design for the replacement and /or rehabilitation of 5,100 LF of the cast iron (CIP) 12-inch water main on Texoma Parkway, which is part of HWY 91 that connects the neighboring city of Denison to the north. This line had had many breaks over the years and required immediate fixes to restore water service to numerous businesses and homes along the 1-mile stretch. Texoma Parkway, a major thoroughfare, is a 4-lane, median divided roadway with significant traffic volumes and a posted speed limit of 50mph.

SEARCHING FOR THE BEST SOLUTION

It was clear that replacing this existing infrastructure would not come without challenges. Multiple high traffic establishments were accessed by way of this thoroughfare including numerous businesses and a mobile home community. Keeping their driveway approaches open and mitigating overall impact to local businesses would be important. Sloped drainage ditches, gas lines, overhead power lines and other utilities had also congested the utility corridor within the Right-of-Way, which would make traditional open-cut construction more challenging.

Another major challenge this project posed was the area where the waterline would need to cross under a large drainage channel with steep sides that sloped down approximately 15 feet below.

A third challenge was that the water and wastewater systems of the early 1960s did not meet today's requirements of the TCEQ's (Texas Commission on Environmental Quality) "separation distance from a potable waterline to a wastewater main or lateral manhole or cleanout [of 9 feet]." Whatever solution was ultimately used would have to satisfy TCEQ's concerns of sewage from sewer lines entering through the joints of a water distribution system.

Temporary By-Pass Water Line

Fusible PVC Pipe

Fusible PVC® Pipe Being Fused

5,100 LF of cast iron (CIP) 12-inch water main was replaced along the 4-line Texoma Parkway

In the Preliminary Engineering phase of the project, KCI looked at both a traditional solution of placing a new pipeline by open cut trenches, and either removing or grouting and abandoning the existing line in place, as well as non-traditional trenchless rehabilitation and renewal methods. A less-environmentally-intrusive solution that reduced impacts to adjacent property owners while also providing a quick and cost-effective option for the City, pipe bursting, was explored as the latter option.

Opinion of Probable Construction Costs (OPCC) for traditional construction was approximately $2.5 million, while trenchless renewal using pipe bursting would be in the $1.5 million range. The option with the lowest price tag was selected, which would also be able to overcome all of the challenges of the project.

PIPE BURSTING WITH FUSIBLE PVC®

Pipe bursting is a trenchless method of replacing waterlines that requires less excavation than traditional methods. It is minimally invasive with short installation times that involves pulling a new pipe through the existing pipe, which is burst or broken apart in the process.

The process uses "pull-pits" for the bursting machine and pipe "insertion pits" from where the new pipe will be pulled in.

1. A bursting head is attached to the front of the new pipe.
2. The pulling machine pulls the bursting head through the old pipe, breaking it apart as it goes.
3. The new pipe is pulled along, replacing the existing cast iron pipe.
4. The old pipe fragments are left in place.

Along with the pipe bursting, the ideal pipe material to utilize on the project was deemed to be Fusible PVC® pipe, which when fused together, results in a monolithic piping system that does not have any gasketed joints. Without gasketed joints, TCEQ's precautions to prevent the dangers of potable water contamination through gasketed joints due to the intrusion of raw sewerage from wastewater pipes in close proximity to the water pipe was eliminated. The existing 12-inch cast iron water main would provide the perfect opportunity to have it replaced "size-on-size" with 12-inch DR18 AWWA C900 Fusible PVC® pipe. The pipe allowed for material continuity throughout the City's water distribution system. It also provided the benefit of ease of long-term operation and maintenance as PVC is the City's preferred material for potable waterlines.

HDD: ANOTHER TRENCHLESS SOLUTION

Pipe Bursting, however, would not work when traversing the large drainage channel adjacent to a large mobile home community, due to the existing line having multiple 45-degree vertical bends where the cast iron main was installed to a depth underneath the drainage channel. For this 350-ft segment, KCI decided to utilize Horizontal Directional Drilling (HDD), with Fusible PVC®. This allowed the water main to achieve the required depth and stay inside the easement. It also kept a mobile home community driveway open, which was the only access drive for residents. The same pipe, 12-inch DR18 Fusible PVC® was utilized for the HDD.

TRENCHLESS CONSTRUCTION

KCI required that a temporary bypass line be utilized to give all businesses and property owners access to potable water as usual without unforeseen disruptions. Existing meters/services connections would be swapped over to the temporary bypass line with no issues and little impact to customers. There were existing culverts at each drive approach along the entire route that were utilized for the bypass line to be strung through.

KCI anticipated that the Contractor would strategically locate their excavations for the bursting machine "pull-pits" and pipe "insertion pits" to be located anywhere that an excavation would be required regardless of what type of installation was used (i.e. valves, fittings, connections, and fire hydrants). KCI left the number and location of pits up to the Contractor to determine to allow them to build the project their

"Only one complaint from an owner who wanted his driveway better restored when the construction was complete!"

-Tom Pruitt, PE, Utility Engineer, City of Sherman

"Minimally invasive with short installation times. Quick and cost-effective."

Horizontal Directional Drilling of Fusible PVC® Pipe

own way. Ultimately, the project averaged pull lengths of approximately every 500 feet. The actual pipe bursting installations only took 2 to 4 hours to pull in. Proper setup in the days preceding the pull in and coordination with customers was key. This coordinated operation allowed the contractor to achieve 1 or 2 pulls a week, depending on each location's setup.

Pipe Fusion was able to be contained along the ROW without blocking any drive approaches or parking access to businesses. This avoided impact to businesses other than having to pull the pipe string across driveways for short periods of time.

The project was bid on May 12, 2022. Three bids were received, which came in at a close spread of between $1,649,318 and $1,756,270. Douglas Dailey Construction, the low bid Contractor, had pipe delivered to the jobsite at the beginning of September 2022, with fusion service commencing shortly after. The Notice to Proceed was granted to the Contractor on August 14th, 2022. Construction was completed way ahead of schedule with almost all pipe pulled into place in just under 3 months.

According to Wayne Lee, "We had used Fusible PVC® in the past for horizontal directional drilling at a railroad crossing, but not with pipe bursting. This was the City of Sherman's very first pipe bursting project, and it went very well. There were buried utilities all along the alignment of this project, so utilizing pipe bursting minimized other impact to utilities that we had to work around. There were gas and telecommunications lines along the corridor, a gas line on top of the waterline in one location!" When asked about any complaints from the businesses and homes along the corridor, Tom Pruitt mentioned that there was only one complaint from an owner who wanted his driveway better restored when the construction was complete. Overall, this project showed the merits of pipe bursting, and this trenchless method will likely be utilized in future rehabilitation work.

ABOUT THE AUTHORS:

***Shah Rahman** has 25+ years of experience in the design, installation and rehabilitation of buried water and wastewater pipelines, pipe-soil interaction, and trenchless technology. He was the PM for KCI Technologies on this project. A CE graduate of VMI, he is pursuing a PhD in Structural Engineering at UTA. Since the writing of this article, Shah has taken over as Area Manager for Resilience Water at the Arcadis Houston office.*

***Kyle Wroblewski, PE,** is a Regional Engineer for Underground Solutions/Aegion. Kyle has 10 years of experience in Civil Engineering with an emphasis in Municipal Water/Wastewater Infrastructure Rehabilitation, Trenchless Technology, and New Utility Construction. He has a degree in Civil Engineering from the University of Nebraska-Lincoln.*

Game Plan: How Norman, Oklahoma Fixed Their Aging Sewer System Sooner Rather Than Later

Wastewater System Equipped for the Future

By: Bryan Mitchell, PE and Sean Price, EIT, Parkhill

In the late 1980s, the City of Norman, Oklahoma, faced a serious and messy infiltration and inflow (I&I) problem in its sanitary sewer system. Rainstorms frequently caused the inadequate system to become overloaded with water, leading to unsightly overflows in this respected college town that is home to the University of Oklahoma.

Figure 1: Due to frequent overflows, the city was forced to install signed warning of the dangers

The City of Norman remains one of the only municipalities in Oklahoma to require a public vote to enact utility rate increases. Between 1950 and 1980, the city's population grew from 27,000 to 68,000, and its focus during this time was to expand the utility infrastructure. This left little funding to dedicate to maintenance projects. With limited public funding, Norman opted to install public signage warning residents of the overflow to avoid exposure and other dangers (Figure 1). It wasn't until the problem found its way onto the radar of the United States Environmental Protection Agency (USEPA) that a corrective effort started to take shape.

By the early 1990s, an extensive sanitary sewer evaluation survey (SSES) program was implemented to address immediate needs. By 1998, despite a population growth of 17 percent, these SSES efforts successfully reduced the average daily sewer flow by 38 percent. This was considered a success, but it would only provide a brief relief.

MORE GROWTH LEADS TO MORE CHALLENGES

Although the overflows ceased and warning signage was no longer needed, the aging sewer lines in Norman lacked the capacity to accommodate the booming college town.

While efforts to address I&I had subsided, new growth caused more problems due to the limited sanitary sewer infrastructure capacity. With this new challenge, the concept of the city's Sewer Maintenance Program (SMP) began to form. The need was heightened with the completion of a wastewater

> *"31,000 linear feet of sanitary sewer are candidates for pipe bursting."*

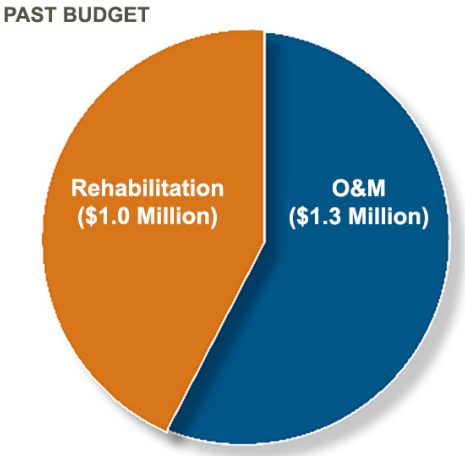


Figure 2: Before 2001, the annual funding for sewer line maintenance was $2.3 million with $1 million designated for rehabilitation projects

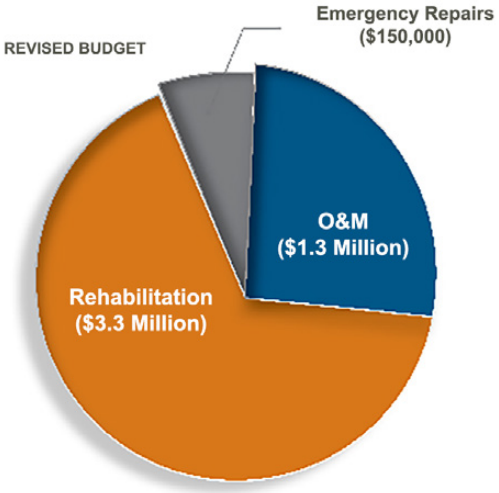


Figure 3: After the vote, an additional $2.3 million for rehabilitation projects bringing the total to $3.3 million with $150,000 for emergency projects

Figure 4: Year one covers more than 31,000 linear feet in the core Norman area that drains into the Imhoff Creek Basin

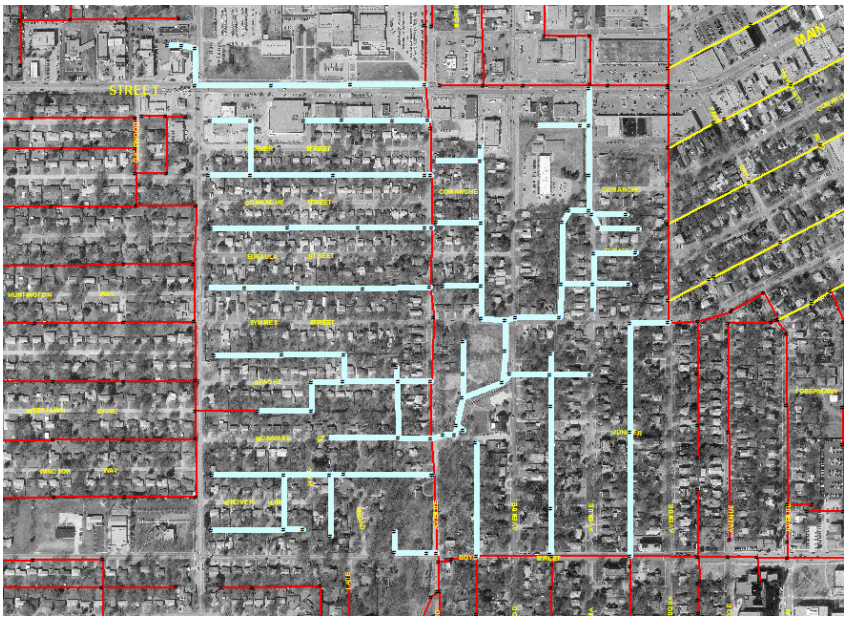


Figure 5: Year two would continue to focus on the older areas totaling more than 22,500 linear feet

master plan (WWMP) in 1999 to identify and prioritize collection system and treatment needs.

Communication efforts on the immediate need to address infrastructure capacity and deteriorating conditions started in 2000 in earnest, and by 2001, a significant public information campaign was in motion. That year, the citizens of Norman voted to provide both short term sales tax funding for immediate sewer interceptor capacity needs as well as permanent funding for a Sewer Maintenance Program for ongoing maintenance.

Prior to the vote, annual funding for sewer line maintenance was $2.3 million with $1.3 million designated for operations and $1 million for rehabilitation projects (Figure 2). After the vote, an additional $2.3 million was approved just for sewer rehabilitation projects for an annual total of $3.3 million with $150,000 available for emergency repairs (Figure 3).

REMEDYING AGING INFRASTRUCTURE - "WORST THINGS FIRST"

The initial public presentation in March of 2002, dubbed "Worst Things First," outlined a systematic plan to obtain a 50-year or younger wastewater system throughout the city. The capital plan started in the oldest region of the city with the most aged infrastructure and advanced throughout the years, mirroring the city's historic growth patterns.

According to the public presentation, the first four years of the maintenance effort would focus on the oldest areas first with all of the lines being replaced in the original Norman town site. The proposed timeline included:

- **Year one** would cover more than 31,000 linear feet in the core Norman area that drains into the Imhoff Creek Basin (Figure 4).
- **Year two** would continue to focus on the older, more aged areas totaling more than 22,500 linear feet just west of the core Norman area that drains into the Imhoff Basin (Figure 5).
- **Year three** would encompass more the 31,500 linear feet with core area draining into the Bishop Creek Basin (Figure 6).

> *Norman continues to proactively address sewer system needs.*

- **Year four** would still address oldest areas first draining into the Bishop Creek Basin, covering more than 30,000 linear feet (Figure 7).

In 2003, the first SMP project was initiated. Over the next twenty years, the SMP would help rehabilitate more than 500,000 linear feet of sanitary sewer lines and achieve the goal of limiting infrastructure age. Today, all sewer lines in Norman are younger than 50 years old. Ever mindful of the past, Norman continues to proactively address sewer system needs with an effective SMP.

Figure 6: Year three would cover more the 31,500 linear feet with core area draining into the Bishop Creek Basin

Figure 7: Year four still addresses oldest areas first draining into the Bishop Creek Basin, covering more than 30,000 linear feet

A SYSTEM EQUIPPED FOR THE FUTURE

Having completed many trenchless rehabilitation projects, Parkhill was hired by the City of Norman to develop the next generation SMP project plans and specifications, beginning with Project SMP 19. The primary objective of the SMP is to rehabilitate existing sanitary sewer lines and manholes by leveraging the latest in trenchless rehabilitation technology to help minimize costs and public impacts.

To maximize the effectiveness of the rehabilitation, Parkhill engineers have taken a more targeted approach to determining which sewer lines and manholes to rehabilitate or replace and have solicited feedback from the people who know this sanitary sewer system better than anyone: the owner.

Trenchless rehabilitation methods will be employed for all 32,000 linear feet of the latest SMP project (Figure 8). Parkhill conducted a constructability review to determine if pipe bursting or if cured-in-place pipe (CIPP) was required for each sanitary sewer line. In total, 31,000 linear feet of 12-inch and 8-inch sanitary sewer lines will be candidates for pipe bursting. In specific areas, however, CIPP will be employed where the sanitary sewer lines are too shallow or a nearby structure is too close and ground upheaval is a concern, or if the existing lines are encased and too much effort is required to pipe burst.

In addition, Parkhill conducted a survey to determine which sanitary sewer manholes could be rehabilitated instead of replaced. In many cases, the engineers found the existing manholes were structurally sound but needed to be internally and externally sealed to prevent I&I. If a broad stroke approach had been used, many sanitary sewer manholes would have been needlessly removed and replaced. Of the 162 sanitary

> *"Worst Things First," outlined a systematic plan to obtain a 50-year or younger wastewater system throughout the city.*

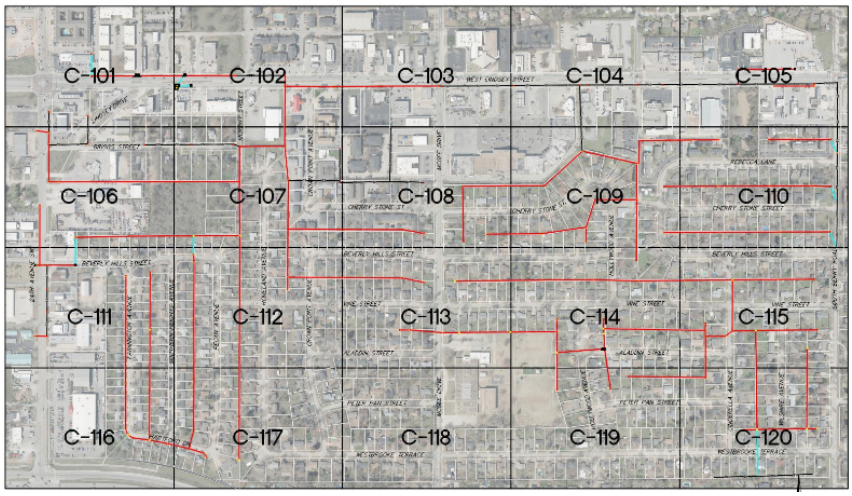


Figure 8: In the latest SMP, Parkhill engineers have taken a more targeted approach to determining which sewer lines and manholes to rehabilitate or replace entirely

sewer manholes included in SMP 19, 133 of them will be rehabilitated. This due diligence saves the client time, money, and resources.

CREATIVE PROBLEM-SOLVING

Throughout the development of the plans and specifications, Parkhill met with the city's Utilities Engineering and Line Maintenance staff to understand the primary issues adversely affecting their sanitary sewer system today. Chief among these was tree root invasion, but not necessarily in locations where tree root invasion most commonly occurs.

City staff told Parkhill engineers that tree roots were getting in through the service tap locations, even in areas that were already rehabilitated less than ten years prior. Even though the city replaced much of its aging clay gravity sewer pipes with cutting-edge trenchless technology, tree roots are still finding their way into the system through the service taps.

With this next generation of SMP project plans and specifications, engineers are mitigating tree root invasion at the service taps by requiring more robust service connections to the sanitary sewer main lines. In areas of the project that will employ pipe bursting, not only will weld-on saddles be required, but the entire service riser will be completely fused up to the fitting at the top, making it essentially one piece from the main to the fitting. In a few areas where cured-in-place pipe (CIPP) will be employed, the service taps will be lined with CIPP to the fitting at the top. In both cases, a connection to the sanitary sewer main is created that is just as strong as the main itself.

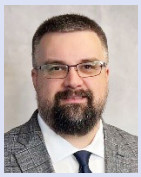
CONCLUSION

Norman's sanitary sewer system has certainly seen its ups and downs throughout the decades, but like any growing city with aging infrastructure, constant attention, maintenance, and adaptability will help things flow more smoothly. This year marks the 20th anniversary of this non-stop effort to maintain an effective sewer system serving a rapidly growing population—which is now the state's third most populous city.

A targeted approach to sanitary sewer rehabilitation and the Sewer Maintenance Program should help the city continue to achieve its goal of providing a robust, future-proofed sanitary sewer system capable of servicing the needs of its ever-growing population.

ABOUT THE AUTHORS:

***Bryan Mitchell, PE**, is a Senior Civil Project Manager with Parkhill and is based in Norman, Oklahoma. His background includes over 28 years of experience in water resource planning, project and program management, and client relations. He is the past state president for the Oklahoma Water Environment Association and a current member of the American Society of Civil Engineers.*



***Sean Price, EIT**, is a Civil Engineer-in-Training with Parkhill and is based in Oklahoma City. His background includes seven years of water and wastewater design and project management experience. Sean has worked in both public and private sectors on several large projects, including the Atoka Pipeline in Oklahoma City and two segments of the Kaw Lake Raw Water Supply Program in Enid. He is a current member of the American Society of Civil Engineers.*

Pipe Ramming & HDD, A Texas Two Step!

Iowa Trenchless Rams Conductor Barrel Casings in Fort Worth

By: TT Technologies

Horizontal directional drilling and pneumatic pipe ramming are two trenchless methods that complement each other on small and large projects alike. HDD is the ultra-capable installation method that has allowed projects that were once unthinkable to become realty. And pipe ramming is the ultimate muscle method, there to help, assist and even salvage HDD projects that run into problems.

The two methods recently teamed up on a project in Fort Worth, TX for the installation of a large diameter force sewer main. The wide-reaching project includes the installation of approximately three miles of 36-inch diameter HDPE force main to service the Fort Worth area. Along with conventional construction methods, several sections of the project were specified as horizontal directional drilling.

While another company was subcontracted for the HDD work, General Contractor SJ. Lewis of Texas subcontracted Iowa Trenchless from Panora IA to install two Conductor Barrel casings to help facilitate the HDD work.

Jason Clark President of Iowa Trenchless said, "There were two 54-inch conductor barrel pipe rams. The first one was 90 feet, and the second one was 180 feet. We did both prior to any of the drilling occurring, but they were consecutive. They were installed on the entry side of separate HDD crossings. One for a crossing parallel to the Trinity River. The other one was for crossing an interstate and multiple frontage roads, and five or six railroad tracks."

Pipe Ramming and HDD Assist Specialist Rick Melvin from trenchless equipment manufacturer TT Technologies, Aurora IL explained the concept behind the casings Iowa Trenchless was contracted to install. He said, "With the Trinity River, the conductor barrel was installed as a way to contain the drilling fluid, protect the start of that bore and ultimately get into a point where drilling can begin. And that's the basic definition of a Conductor Barrel. It's a casing that is rammed into the ground, at a predetermined angle, until desirable soil conditions are met. Drilling happens within the casing that helps the drill head reach desirable soil conditions. It also helps contain the drilling fluids and helps in other ways, but that's the concept of the installation."

To install the two conductor barrel casings, Iowa Trenchless used a 24-inch diameter Grundoram Taurus pneumatic pipe ramming system from TT Technologies.

The project in Fort Worth consisted of the installation if two 54-inch conductor barrel pipe rams. The first one was 90 feet, and the second one was 180 feet

> *"Pipe ramming is the ultimate muscle method."*

IOWA TRENCHLESS QUALITY CONTRACTOR

Iowa Trenchless has performed conductor casings on numerous projects, ranging in diameter from 24 inches to 54 inches. And other than conductor barrel ramming, the contractor has rammed 60-, 72- and 84-inch casings. In addition to

pipe ramming, Iowa Trenchless is a well-rounded utility contractor, experienced in other trenchless methods including auger boring, GBM guided boring, tunneling, pipe jacking and rock boring.

This high level of capability also comes with a high level of attention on safety. Iowa Trenchless has received the NUCA (National Utility Contractors Association) William H. Feathers Safety Award numerous times, including the years 2010-2013, 2015-2016, 2019 and 2022. Clark said, "We care for every employee's safety and well-being and are constantly motivated to make sure every employee has the knowledge and resources to be as safe as possible while on a jobsite. Safety is a topic at every meeting we have, whether it's a company meeting or specifically a safety meeting. Every Iowa Trenchless employee participates in at least OSHA 10-Hour, Excavation Safety and Competent Person, Confined Spaces Entry and CPR/First-Aid training, as well as specialized job training. A number of employees have also been certified in OSHA 30-hour, and have been trained in Hazardous Materials Handling, Waste Remediation and Underground Construction Rescue. I always say that I'm going to end my career without having anybody ever get seriously injured or killed on one of my jobs, because safety is the number one thing."

Iowa Trenchless used a Grundroram Pipe Ramming system from TT Technologies to install the Conductor Barrel Casings. Shown: Pipe rammer with ramming gear attached

According to Clark, with a crew of seasoned professionals including

> *You can feel it in your body when the hammer is hitting!*
>
> -Jason Clark, President, Iowa Trenchless

During the Conductor Barrel process, a casing is rammed in place at a predetermined angle. That casing serves several purposes including helping contain drilling fluid and allowing drilling to begin in optimum soil conditions

Iowa Trenchless crews installed both Conductor Barrel casings successfully, without incident, using the pneumatic pipe rammer

supervisor Brandon Derry, and superintendent Rick Siemers, this was a great opportunity to involve some of the younger crew members on a project that they might not have been on before. He said, "My son Wyatt is 20 years old. Another one on that list, Avere Doles, is 21 years old and from Louisiana Tech Trenchless Technology Center. We had a few more people than we probably needed, but we wanted a bunch of young guys to see what this looks like. Not necessarily a training exercise, but as a way to introduce some of the guys to the installation and equipment that might not get on that type of job as often. If you've ever been on a pipe ramming job, I mean, you can feel it in your body when the hammer is hitting, you can feel it."

ON THE JOB

Crews began work establishing the ramming pad at the angle required of the project. Clark said, "We set up on a dirt berm into the subsurface to get us to where we needed to be rather than build a big, elaborate platform. We needed to ram the conductor barrel in at 16 degrees, 28.1 percent grade. It was about two thirds underground and one third ramped above ground."

Once the angle was established, the ramming platform was shored, and an auger bore track was set in place to drive the casing from. After the first 30-foot section of 54-inch casing was in place, crews used an excavator to lift the 24-inch diameter Grundoram Taurus into position. Prior to positioning the ramming tool, the ram cone was attached to the lead end of the rammer. This piece makes the connection between the 24-inch diameter rammer and the 54-inch diameter casing.

Melvin said, "Standard ramming gear is now available for casings as large as 120 inches in diameter. Having standard ramming gear for all those sizes of pipe makes everything a little easier for the people in the field pushing in casing. It reduces the amount of field fabrication significantly and ensures the most efficient transfer of power

from the pipe rammer to the casing. That's essential to successful ramming projects."

Two 1600 CFM compressors were used to power the ramming tool. Crews proceeded to ram three 30-foot sections of pipe in for the first conductor barrel. Ramming moved as quickly as one foot per minute early in the ramming process. Once the first section of 30-foot casing was installed, the next segment was brought in and placed. That section was welded to the back end of the installed casing. Pipe set and welding took approximately 8 hours to complete per casing segment.

It was determined through discussions with landowners in the area that the soil conditions on the first site left something to be desired. Clark explained, "The first one, which was near the river, was mostly fill and garbage. There was one individual we talked to that knew or was related to the owner of that property and indicated that it had been filled in with garbage years ago. So, we literally went through garbage."

As ramming traveled deeper toward bedrock, speed decreased significantly. Total working time to install all three segments for the first Conductor Barrel was six working days. Then crews moved the ramming gear and set up to the next site, which was a little bit deeper.

According to Clark the site conditions improved on the second installation. He said, "The soil on the second one was better ground. This one was not on the river, but it was crossing railroad tracks and a few other obstacles. It started out as clay, then changed to sand and gravel. On the second one, the advancement rates were faster at the beginning, then we got into sand, gravel, and then eventually cobbles and boulders. It went from moving fast to moving moderately to moving slow to barely moving, which is what you're looking for when you're trying to get into the rock interface. In total that one was 180 feet."

For both sites, Iowa Trenchless crews used bentonite lubrication in combination with the pipe ramming. Melvin said, "Ramming can be successfully completed with or without lubrication. It depends on the type of soil. Mud manufacturers can be a big help for lubrication/mud design for specific soil conditions. You need to decide whether to use mud at beginning of a ramming project because once you've started, it's too late to add lubrication."

Iowa Trenchless crews cleaned out portions of each Conductor Barrel casing with an auger boring machine before turning over the jobsites to the HDD contractor. Melvin said, "Great to work with these guys. Jason has a lot of experience, and his crews are right there too. Good project all around."

ABOUT TT TECHNOLOGIES:

TT TECHNOLOGIES

For more than 45 years, TT Technologies has been the worldwide leader in trenchless technology. Each year, more trenchless sewer, water, gas and electric rehabilitation and replacement projects are successfully completed with trenchless equipment from TT Technologies than any other. TT Technologies is the leader in trenchless!

Microtunneling in the Houston Area

Two Gravity Sewer Projects at Depth

By: Ray Post and Harsha Reddy, Huxted Trenchless

BACKGROUND: HUXTED TRENCHLESS

Huxted's history extends back to the late 1970s when Dwayne Huxted moved from British Columbia, Canada to Palmetto, Florida. Family members owned a company named Kerr Construction, an underground utility and tunneling business and Dwayne joined as a partner. Over time his role evolved, and he became the exclusive owner of the company, bringing his wife and daughter on board to help him lead the way. At that time Dwayne changed the company's name to Huxted Tunneling.

Dwayne had the vision to grow the business to one of the largest microtunneling and jack-and-boring companies on the east coast. In the 1990s the company grew dramatically and shifted its efforts to predominantly microtunneling projects. However, due to health issues with the Huxted family, they were forced to sell the company to JAG Companies in 2010.

JAG Companies maintained the Huxted name and legacy. Huxted Tunneling's headquarters were relocated in 2020 from Palmetto, FL (near Sarasota) to Conroe, Texas (about 40 miles north of Houston, TX) where sister company ECI Drilling was based. The move was initiated by ownership to better align its overall trenchless services with ECI Drilling. Additionally, the relocation allowed Huxted Tunneling to expand its microtunneling footprint.

In 2022, after working in the same location for one year, Huxted Tunneling and ECI consolidated into one company, forming Huxted Trenchless. See *Trenchless Technology's August 2023* issue for a more detailed article on the merger of the two companies.

Huxted has performed microtunneling across the southeast, mid-Atlantic and mid-western portions of the US since the early 1990s. This local, regional, and multi-state experience of actual work performed and its management, allows Huxted to bid and perform across a large portion of the United States. Huxted's Senior Vice President, Ray Post, was involved in some of the projects constructed with microtunneling machines in the Houston area wastewater program during throughout the late 1980s and early 1990s.

The Houston metropolitan area is the fifth largest in the US, slightly behind the Dallas – Ft. Worth area, preceded by Chicago, Los Angeles, and New York. Houston was and is the first and likely the only major metropolitan area in the United States to consistently design, bid, and build projects using the microtunneling and GBM methods of new construction pipe installation. Houston, for all practical purposes, has adopted microtunneling and guided boring as its primary new trenchless installation method for the deep portions of its sewer project needs since the late 1980s. There is still a significant volume of open-cut work, but given the geotechnical conditions combined with Houston's population and traffic, these new installation trenchless methods make sense.

Following its relocation to Conroe, Huxted's tunneling operations shifted their focus towards initiating and closing out work it had bid and won while located in Florida and in other locations that were outside Texas. However, about a year after

Lowering the MTBM into jacking shaft MH-T12 on Talton St.

> *These two projects show the true benefits of direct sewer gravity pipe installation by trenchless methods.*

moving, Huxted started to pursue work in Texas, specifically the Houston area. What follows are summaries of two of our most recent projects in the Houston area:

FWSD #23

In the summer 2021, nearly a year after Huxted's relocation to Conroe, the City of Houston advertised the FWSD #23 Wastewater Treatment Plant and Improvements project. This project consisted of the construction of approximately 692 LF of 60-inch fiberglass reinforced pipe (FRP) gravity sewer by microtunneling, approximately 36 LF of 48-inch FRP gravity sewer connection to an existing lift station; installation of two polymer concrete manholes, construction of stub-outs for connection to future and current projects, one junction structure with associated diversion pipe, and installation of an IPEX vortex unit. The scope also included the abandonment of existing sewers, re-routing of an 8-inch sludge force main, installation of erosion and sediment control devices, and site restoration.

Local contractor Reytec Construction Resources, a heavy civil contractor working in Houston since 1996 was the low bidder and selected Huxted to perform the microtunneling portion of the work based on our experience with these types of terrain.

The subsurface soil conditions along the project alignment generally consist of firm to hard lean/fat clay (CL/CH). Layers of soft to hard silty clay (CL-ML), including dense to very dense silt (ML), and medium-dense clayey sand (SC/SC-SM).

Groundwater in the borings was initially encountered at a depth of 10 to 28 feet below grade during drilling and subsequently rose to a depth between 5.6 and 15.9 feet approximately 15 minutes after the initial encounter. When

Launching the MTBM on the first 30-inch FRP tunnel drive from MH-T12 to MH-T13 on Talton St.

Microtunneling equipment set-up at jacking shaft MH-T12 on Talton St.

encountered, the groundwater could be pressurized.

The microtunnel was approximately 48-feet deep to invert. Thus, the microtunnel was installed with a water head greater than 30 feet.

Reytec opted to install a 36-foot diameter liner plate jacking shaft and a 16-foot liner plate retrieval shaft. Shaft construction started in May of 2023 and Huxted fully mobilized in early June of 2023.

Huxted uses Iseki microtunneling machines and elected to use its Iseki TCC 1350 Unclemole for this project. Perfectly sized for 60-inch RFP, jacking forces never exceeded 225 tons. A conventional laser active targeting system was used, and tunnel line and grade were completed well within the specified tolerances.

The only issue associated with the tunneling occurred with the shaft work. Reytec made the appropriate one-call utility locate and potholed as required, but, after starting excavation of the shaft, an unmarked, unknown 60-inch sewer was found in the jacking shaft location. After a series of discussions with the City and Engineer, it was decided to move the shaft and avoid the existing line.

This FWSD project was a classic single-run microtunnel, no adverse ground conditions were encountered, and the tunnel work was completed without issue and within schedule.

THE GREEN RIVER DRIVE AND CHATWOOD LIFT STATION DIVERSION

Reytec was constructing another project (which actually tied into the FWSD project) that bid in late 2021 with over 10,000 lf of microtunnel or guided boring work. Over multiple planning meetings between Huxted and Reytec on the FWSD project and the strong relationship that was being forged between the two companies, it became apparent Huxted should assist Reytec on this project as well.

The Green River Drive and Chatwood Lift Station Diversion project consists of the demolition of two lift stations, Green River and Chatwood, and construction by trenchless methods of over 10,000 lf of 24-inch and 30-inch gravity sewer line at a depth between 24 and 40 feet that conveys flow under Las Cruces St., Chatwood Dr., and Talton Dr. towards the FWSD#23 Wastewater Treatment Plant.

The subsurface soils consist of cohesive and cohesive intermittent by cohesionless soils. The cohesive soils consist of soft to hard gray, brown, yellowish brown and reddish-brown fat clay, fat clay with sand, sandy fat clay, lean clay, lean clay with sand, sandy lean clay, and sandy silty clay. Cohesionless soils consisting of loose to very dense gray, brown, yellowish brown and gray silty sand, clayey sand, silty clayey sand, poorly graded sand with silt, and sandy silt were encountered between depths ranging from 9 to 28 feet. Fill material consisting of gray fat clay, lean clay, lean clay with sand, and sandy lean clay with sand pockets and grassroots was encountered to depths ranging from 2 to 16 feet below the existing grade.

Groundwater was first encountered at depths ranging from 14 feet to 23 feet in all the borings. The water level measured 15 to 20 minutes after water was first encountered and was at depths ranging from 6.0 feet to 17.5 feet in these borings.

Ultimately, Huxted contracted with Reytec Construction Resources to install over 3,700-lf of 30-inch x 10-foot long FRP gravity sewer in eight tunnel drives. A challenging contract, but one Huxted was quite familiar with from past projects.

Reytec has elected to install 26-foot liner plate jacking shafts and 12-foot liner place retrieval shafts. Huxted could have installed the 10-foot FRP joints in a Shaft as small as 18 feet diameter, but, Reytec has already designed the jacking shafts at 26 feet diameter and procured the liner plate material per the approved submittals.

The microtunnel work on the Green River project was constructed in older subdivisions, with narrow streets and small lots, so Reytec had to work closely with the city and community to manage work locations and traffic control. As part of the project, Huxted was required to set up our

Separation plant set-up at jacking shaft MH-T12 on Talton St.

cleaning plant at a location over 450 feet away from the jacking shaft. Although the microtunnel was just over 550 feet, we had to manage slurry for nearly 1,000 feet.

Huxted mobilized to the site in December 2022. Unfortunately, the first drive ran into a significant delay. Shortly after launching the machine, it began to over torque and slurry flow became difficult to maintain. Keeping a keen eye on the shaker screens, shards of PVC pipe were seen. After lengthy discussions with Reytec and other stakeholders, it was discovered that PVC pipe had been left in the ground by a previous contractor. Huxted and Reytec were unable to confirm the amount of PVC left in place and decided to continue to microtunnel as long as possible hoping to either excavate all the PVC pipe and allow time to prepare and mobilize for the construction of a 911 (rescue) shaft.

After installing 16 joints after hitting the PVC, the machine's slurry chamber became choked with PVC pipe, and it could no longer be advanced and the 911 shaft had to be constructed. A challenge the team was prepared to resolve. Upon rescue shaft construction, the machine was returned to our shop for inspection and repair and then returned to the site.

Instead of re-mining the already constructed tunnel, Huxted assisted Reytec in preparing a base in the rescue shaft to set the machine. The machine was lowered into the shaft, set to the proper line and grade, and reconnected to the tunnel utilities and the already installed pipe. A layer of sand was placed around and over the pipe, then the shaft was backfilled with clay. The sand was placed around the machine to allow lubrication to penetrate the area after tunneling started. The clay layer was an impervious layer to assist with the potential of slurry migration. The relaunch was successful, and the tunnel was completed without issue.

At the time this article was written, Huxted was mobilizing to complete the last two drives. To date, six of the eight tunnel runs have been completed all within specified lines and grade without any major issues.

These two projects as well as other projects the City of Houston has put out for bid both recently and since the late 1980s show the true benefits of direct sewer gravity pipe installation by trenchless methods. Open cut at these depths and locations would be extremely difficult and more importantly, is not practical. In addition, the elimination of pump stations and the management of a gravity flow sanitary system provides a cheaper lifelong cost for the sanitary sewer system, plus it's environmentally friendly.

Huxted appreciates the support that Reytec Construction Resources has provided in helping it complete its first work in the Houston area. We look forward to working in Texas and the Houston area in the future. With eight machines ranging in size from 24 inches to 101.5 inches, we are prepared to support microtunnels of multiple diameters and drive lengths.

Huxted Trenchless has the experience, knowledge, and fleet of equipment to tackle any microtunneling or trenchless project.

ABOUT THE AUTHORS:

***Ray Post** has over 32 years of experience in the microtunneling and tunneling industry. He has worked in all phases of the tunneling industry including executive management, project management, estimating, design and inspection services and sales. Experience in the construction of EPB segmental tunnels, microtunnels, rib and board tunnels, pipe jacking, and jack and bore operations and various shaft construction technics. Ray has worked across the U.S. and Canada in various geotechnical conditions as a general contractor, subcontractor, and joint venture contractor.*

***Harsha Reddy MSCE, MBA** has over 11 years of construction industry experience in various engineering and management roles. His experience includes, but is not limited to, engineering & preconstruction services, estimating, scheduling, safety & procedural planning and execution, site management, and overall project management. He has experience with heavy civil, trenchless, and open-cut projects both as a general contractor, and subcontractor in various geotechnical conditions. He believes that commitment to work is key to producing quality infrastructure that makes the company remarkable.*

Designing and Installing a Temporary Lift Station for an Emergency Trenchless Repair

By: Jake Kress, Sunbelt Rentals

Bypassing a 78-inch sanitary sewer line can pose its fair share of challenges, especially when it is 65 feet deep in the ground. In late 2022, a large sinkhole developed on a 78-inch interceptor sewer in a large municipality in south Texas. This sinkhole threatened to collapse nearby commercial and residential properties, and potentially impact a major interstate. Harper Brothers Construction was awarded the work to complete the repairs on this sinkhole, which required a significantly challenging bypass.Given the urgency of the repair, Sunbelt needed to come up with a temporary solution that could safely divert 54 million gallons per day (MGD) of flow off the 78-inch line to prevent the spread of the sinkhole and allow Harper Brothers a dry environment to design and implement a permanent repair for the pipe.

A 65 foot deep shaft was built to house the temporary wet well

The primary challenge of this bypass design was the depth of the 78-inch sewer. Typically, in the bypass industry, there are two types of pumps: diesel vac-assist pumps or submersible pumps. Each type has its pros and cons, so for the design of the bypass, both were reviewed.

Vac-assisted pumps have a limitation on suction lift, which in this application would require the contractor to excavate to bench the pumps to within about 20 feet of the flow line. This option would have required extensive excavation, but given the proximity of the freeway and the existing structure close to the collapse, a 45-foot-deep excavation was quickly ruled out.

Ruling out the vac-assist pumps made submersible pumps the safest, most viable option. The next challenge was how to install the submersible pumps into the sewer. This project was a trenchless tunneling project so we asked if the contractor could build a structure that would create a wet well over the 78-inch line. They built a shaft that would normally be used to insert a tunnel boring machine with a diameter of 22 feet to form what we would use as our temporary wet well. The shaft was dog-housed on top of the 78-inch pipe with a 10-foot x 4-foot window cut out to provide an opening to access the flow during dry weather and allow for the flow to surcharge into the temporary structure during peak weather events.

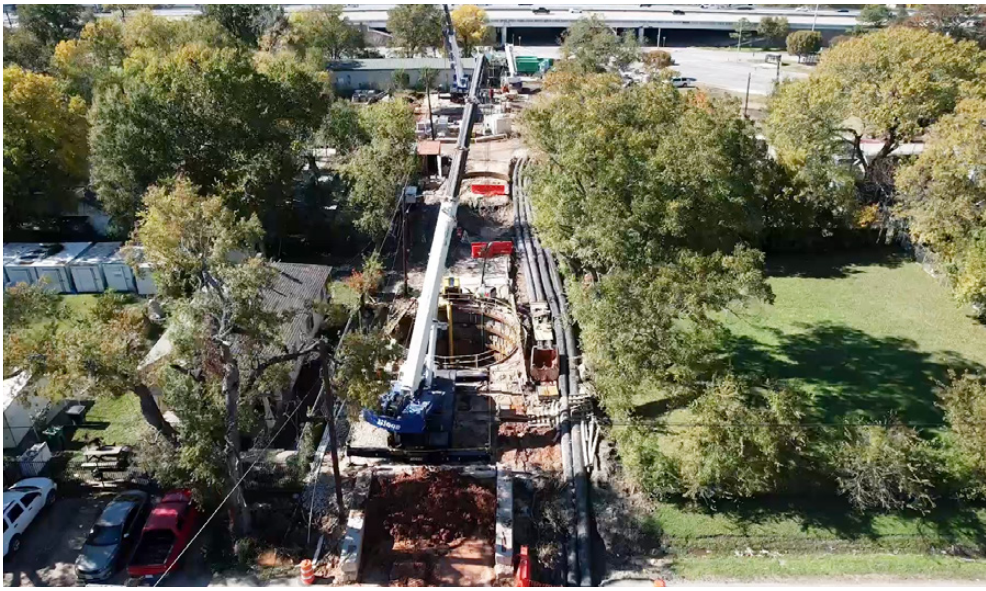
The next hurdle we faced was what type of submersible we would use: electric or hydraulic? This system was going to be run through four 24-inch temporary HDPE pipes approximately 1000 feet downstream of the work environment. With the sparse availability of temporary pumps to be able to handle flows and head pressures for this application, we chose to go electric. We enlisted the experts in Sunbelt Rentals Power and HVAC to determine the temporary power and redundancy requirements to operate the lift station since there was no shore power available. Over 1000KW of temporary diesel generators was sized to power the pumping system.

For the bypass design, four 8-inch "jockey" style pumps were sized to handle the average daily flows keeping the flow

within the pipe. These pumps were placed into the 10-foot x 4-foot window on the 78-inch sewer. Next Sunbelt utilized a manhole upstream of the shaft for two pumps and placed the other two in the invert of the pipe within the shaft. Sunbelt then set six 12-inch electric submersible pumps to handle the peak wet weather flows on the bench around the window on the 78-inch sewer. The massive scale of the wet well and the temporary pumps required everything to be brought in by crane and hard piped.

The discharge portion of the project posed another roadblock. This main line ran through a neighborhood, so blocking the road was out of the question. Every road and driveway needed to be saw cut and excavated. This was not a small feat, since this project required four 24-inch HDPE discharge pipes. Once the roads were cut, plates were installed temporarily until Sunbelt Rentals could fuse the pipe and set them in place. Once everything was in place and tested, more permanent road crossings were put in place, with

"The primary challenge of this bypass design was the depth of the 78-inch sewer."



Massive scale of the wet well and pumps required a crane

Over 1000KW of temporary generators were used to power the pumping system

Manhole upstream of the shaft (lower right) was used for two pumps

adequate barriers to prevent any vehicle from veering off the road and damaging the pipe.

Once the system was finally live, Sunbelt was able to fine-tune the pumping system to run as efficiently as possible.

One primary generator ran the system 24/7 for the duration of the project. Each pump was set on a liquid level transducer allowing for the system to vary RPM to maintain the designated wet well surcharge levels. As the flow increased and more demand came for power, our distribution panel would send signals to the next generator in line to turn on. After some creative load adjustments on each generator to start at a lower load than a typical generator application ensured each pump was ready to start when power was applied. We also had to adjust the parameters on the VFDs to not shut down immediately due to a lack of power.

During the multi-month project, the pumping system endured several high wet weather events that dropped several inches of rain in a matter of hours. The 78-inch line would subsequently be overwhelmed with water, but the pumping system worked as designed even during these events. Additionally, to add further piece of mind to the project stakeholders Sunbelt deployed PumpSentri on this project. With a temporary wet well 65 feet below ground it is almost impossible to accurately gauge the surcharge in the structure. With PumpSentri the surcharge levels of not only the temporary wet well but other structures on the project could be monitored and the data logged remotely, unlike a traditional high-level alarm via a call box, which only sends out an alert when a high-level mark is reached, PumpSentri allowed the team to tell exactly what level was in the wet

Maintaining road access was no small feat for this massive project

Pumping system worked as designed over the six-month project duration even handling several high wet weather events

well in real-time and pull the historical data. Over time the stakeholders were able to see a trend for daily flow and surcharge levels based on wet weather.

The partnership between Harper Brothers Construction and Sunbelt Rentals was the key to success for a project of this magnitude. Thanks to the team approach and careful planning, this highly technical project only took 6 months to complete safely with zero incidents and only a few minor technical challenges came up during the project, which collectively the team overcame. Overall, this represents a highly technical bypass operation carried out in the Southern region of Texas.

ABOUT THE AUTHOR:

***Jake Kress** is a Municipal Sales Representative handling Texas and Louisiana Gulf Coast. In his role he works with municipalities, engineers and general contractors designing turnkey bypass and dewatering solutions.*

Case Study:

Investing in America's Infrastructure

Microtunneling Two Recent Wastewater Projects

By: Jason Holden, Akkerman, Inc.

INTRODUCTION

It is no secret that Texas has become a focal point for required water and sewer investment as its soaring population strains old and deteriorating underground infrastructure. Texas is now home to four of the nation's largest cities, with several suburbs ranking among the fastest growing cities in the country. According to the Census Bureau's release of annual population growth, Texas crossed a new threshold when the total population hit 30,029,572 in 2022, making it only the second state to surpass 30 million people.

> *"It is easy to take water and wastewater infrastructure for granted."*

AGING INFRASTRUCTURE

An effective wastewater infrastructure system is critical to public and environmental health. Efficient sewage systems keep people safe from polluted water that can transmit waterborne diseases such as Cholera, E. coli, and Dysentery.

According to a US Environmental Protection Agency study, an average American produces around 100 gallons of wastewater per day, or 36,500 gallons per year. Much of the water infrastructure in Texas was developed during post-World War II and has yet to be upgraded to meet current demands of the growing population. A 2022 survey conducted by the Texas Rural Water Association (TRWA) found that the average date of installation for water systems was 1966, when the total population of Texas was around 10 million people.

It is easy for both homeowners and politicians to take wastewater infrastructure for granted. When a homeowner flushes the toilet, runs a dishwasher, or drains a tub, the water and waste simply disappear down the drain, to hopefully never be seen again.

Much like homeowners, politicians at state and federal levels often take wastewater infrastructure for granted. Since these underground systems are mostly "out-of-sight", funding for upgrades and renewal are typically "out-of-mind". In 2022, only 9 percent of federal infrastructure budget spending was allocated towards water infrastructure, while highway transportation and mass transit accounted for the largest budgets with 39 and 28 percent respectively.

Earlier this year, Texas Legislature passed Senate Bill 28 and Senate Joint Resolution 75, authored by Lubbock Republican Charles Perry that would create a new water supply fund administered by the Texas Water Development Board (TWDB). If adopted by voters in November, the new Texas Water Fund would prioritize funds to water infrastructure projects in rural municipalities with a population less than 150,000 that often struggle with old infrastructure and fewer resources.

TRENCHLESS SOLUTIONS

Akkerman Inc. is honored to have been part of several notable projects throughout Texas and Oklahoma since our incorporation in 1973. As we celebrate our 50th anniversary in 2023, we would like to highlight two recent successful microtunneling projects in Texas – a new wastewater installation in Beaumont, and a crucial drinking water project in Houston.

ABOUT THE AUTHOR:

***Jason Holden** is the Vice President and Chief Revenue Officer for Akkerman Inc. Using his 25+ years of experience, Jason leads a global team focused on growing premium revenue and enhancing the B2B experience for sales customers, while also driving sales strategy and marketing developments in the trenchless industry.*

Colliers Ferry Pump Station – Beaumont TX

Project Owner: City of Beaumont, TX
Trenchless Contractor: Super Excavators, Inc. (SEI)
Engineer: Freese & Nichols Inc.
Project Location: Beaumont, TX
Trenchless Method: Slurry Microtunneling
Equipment: Akkerman SL60P MTBM System

The Collier's Ferry Pump Station Project in Beaumont, TX included the installation of 2516 lf of 48-inch RCP by slurry microtunneling. The new raw water pump station (Collier's Ferry Pump Station) was designed to replace the old pump station (Lawson Raw Water Pump Station) that was located within the floodplain of the Neches River. To feed the new Collier's Ferry Pump Station located just outside of the Neches River floodplain, a 2516-lf tunnel was required to connect the forebay of the existing structure to the new pump station. Super Excavators, Inc. (SEI) from Menomonee Falls, WI was awarded the trenchless project and utilized an Akkerman SL60P slurry microtunneling system for the installation.

Due to alluvial soils with high groundwater conditions adjacent to the Neches River, the City of Beaumont, TX required the tunnel installation to be completed by slurry microtunneling. The total length was split into two drives of 1,310 and 1,215 feet with an intermediate secant pile shaft and depth of cover ranging from 12 feet to nearly 35 feet along the alignment.

The microtunnel project was successfully completed in the spring of 2023. Even though intermediate jacking stations were installed within the pipe string, the IJS stations were not used as the thrust required to complete the drives were less than 200-tons due to SEI's preparedness.

Project entailed the installation of 2516 lf of 48-inch RCP by slurry microtunneling

Successfully completed in Spring 2023

Sims Bayou Microtunnel Project – Houston TX

Project Owner: City of Houston, TX
Trenchless Contractor: Melcar Group
Engineer: Stiver Engineering
Project Location: Houston, TX
Trenchless Method: Slurry Microtunneling
Equipment: Akkerman SL82P MTBM System

MTBM was remotely controlled and monitored above ground

The City of Houston has a history of using innovative approaches while enhancing their public works infrastructure. As early as the 1940s, the US Army Corps of Engineers and flood control districts worked with the local community to strategize a plan to widen the Sims Bayou for flood and erosion control while maintaining natural ecosystem to encourage habitat diversity. The reconstruction of the Sims Bayou was the first of its kind to incorporate this type of floodway construction and has influenced other professionals to seek similar innovative solutions. Earlier this year, the City of Houston required the use of slurry microtunneling to tunnel underneath the Sims Bayou to provide clean water for their residents while minimizing the social and environmental impacts that other construction methods can impose.

The $18.9 million project was designed to increase the overall capacity of the region's drinking water by making the critical connection of the large diameter water line from one of the city's treatment plants. Since the 524-foot tunnel was the last segment of infrastructure to be installed, project representatives as well as the 285,000 plus residents of the Sims Bayou watershed are pleased to see the project completed.

Awarded in the fall of 2017, the estimated construction schedule was originally 655 calendar days (21 months) to complete, however extremely difficult shaft construction along Houston's Sims Bayou caused delays. A combination of flowing ground and high hydrostatic forces created safety issues during the shaft construction which required project teams to mitigate prior to tunnel operations.

The Melcar Group mobilized their Akkerman SL82P slurry microtunneling system to the Sims Bayou project jobsite in the fall of 2022. The SL82P MTBM included a mixed face cutterhead designed for varying soil conditions including boulders, running sand, and significant ground water. To battle the extreme hydrostatic loads that hindered shaft construction, Akkerman supplied a launch portal and pipe brake that integrated with the MTBM jacking frame to maintain MTBM face pressure, eliminate push-back, and reduce shaft risks. The periphery-drive MTBM was powered by a 400-hp onboard electric power pack that produced over 350,000 ft-lbs. of torque while being remotely controlled and monitored from above ground.

Melcar launched the Akkerman SL82P on December 9 and arrived at the reception shaft on-line and grade after 23 days of operation. Although the installation time for a 20-footsection of 80-inch steel casing averaged just over two hours during the microtunneling process, setting additional sections of pipe in the launch shaft often required the remainder of a shift. Since microtunneling was originally scheduled to begin in 2020, the stored pipe developed inconsistencies that required attention before it could be put together in the launch shaft. This limited the crew to an average 20 lf per shift with a few days installing 40 lf per shift. A sealed intermediate jacking station was installed during the drive; however, it was not required to be activated during tunnel operations. Thrust loads gradually increased along the alignment with a peak break-out thrust of 625-tons nearing the end of the bore, but quickly dropped to 320-tons after pipe advancement and additional pipe lubrication was applied.

Flowing ground and high hydrostatic pressure created challenges during shaft construction

MTBM included a mixed face cutterhead designed for varying ground conditions

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Classification and Certification Requirements for Polymeric Spray Applied Pipe Lining for Gravity and Pressure Pipes

By: Kawalpreet Kaur, CUIRE, UTA
Sanaz Ghalambor, Nukote Coating Systems
Mo Najafi, CUIRE, UTA

INTRODUCTION

Many underground infrastructures are aging and reaching or exceeding their original design life. That is why pipe replacement and rehabilitation has become a major focus over the last several years.

The trenchless technology renewal method of polymeric Spray-Applied-Pipe-Lining (SAPL) is one of the most cost-effective and sustainable methods, with minimum ground disturbance and public inconvenience. Spray Applied Pipe Lining (SAPL), formerly known as Spray-In-Place-Pipe (SIPP) is a trenchless technology pipe renewal method that sprays layers of polymeric liner inside the deteriorated pipe to enhance the structural integrity and extend the design service life. The polymeric SAPL can be applied manually (Figure 1) or with a robotic application

> *"Minimum ground disturbance and public inconvenience."*

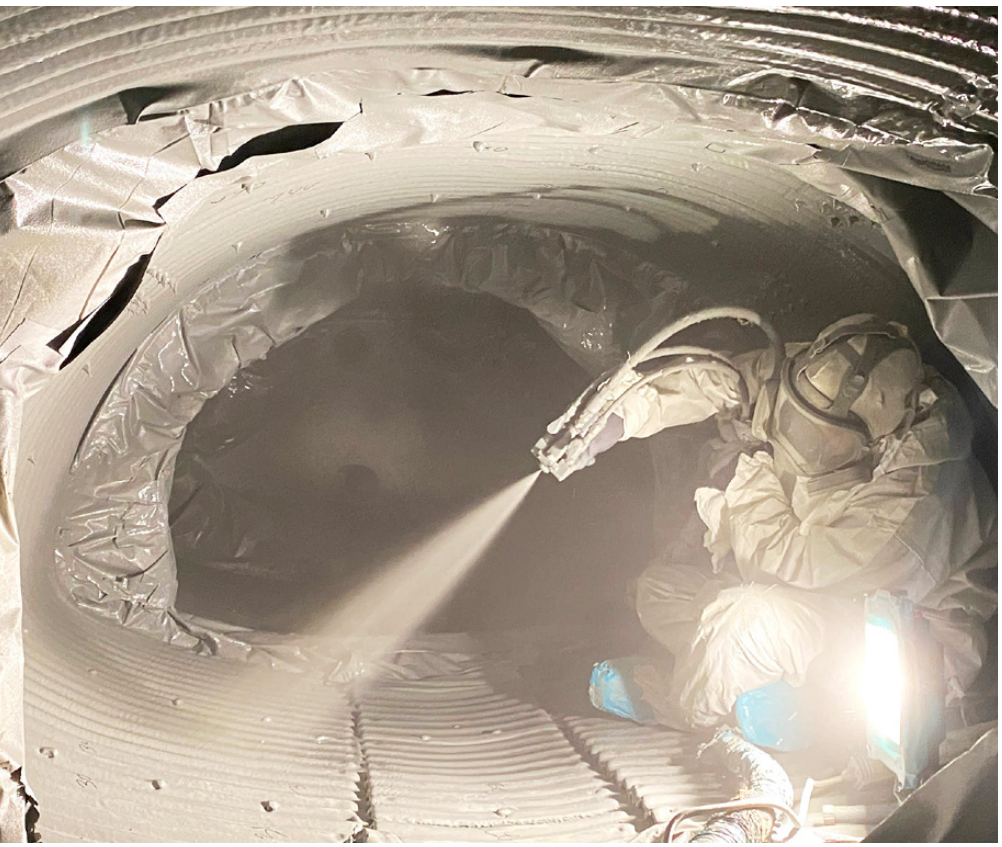


Figure 1: Manual SAPL Application

Figure 2: Robotic SAPL Application

Figure 3: Hole Spanning Test

(Figure 2), depending on the pipe diameter and space constraints.

The lack of comprehensive available standards, design guidelines, testing, and evaluation of polymeric SAPL is limiting its acceptance in the industry.

Due to the need for sufficient information on this technology, the Center for Underground Infrastructure Research and Education (CUIRE) at the University of Texas at Arlington, in collaboration with Nukote Coating Systems, are testing and evaluating the structural properties of the Polymeric SAPL for gravity and pressure pipes. This article will suggest some testing and methodologies for the classification and certification requirements for polymeric SAPL.

TESTING AND CERTIFICATION FOR POLYMERIC SAPL

As per AWWA Structural Classification of Lining Systems (2019), the SAPL lining system is divided into four classes. The tests needed for the evaluation of polymeric SAPL to be used in different classes of pipe rehabilitation can be categorized into 3 groups: Material properties testing, Tests specific for Gravity pipes, Tests specific for Pressure pipes.

MATERIAL PROPERTIES TESTING

Material properties include both short- and long-term material testing. Material testing such as flexural, tensile, and punch shear tests are the common tests performed on polymeric material. These tests show the material's resistance against stretching due to excessive or continuous loading, resistance to deformation, flexural impact resistance due to bending, ground movement, and temperature changes, shear impact due to sudden loading for shallow depth pipes.

In addition, the long-term creep properties of the material, both tensile and flexural, are important to determine the material behavior under long-term loading, which are required for semi-structural and structural design of liner systems.

> *One of the most cost-effective and sustainable methods.*

Figure 4: Hydrostatic Burst Test

GRAVITY PIPES TESTING

Full-scale laboratory test methods include:

Soil Box Testing: Simulates structural capacity of liner to renew the old and deteriorated gravity pipes and culverts in trench conditions using a 330-kip MTS actuator, data loggers, linear variable differential transformers (LVDTs), cable displacement sensors (CDS), uniaxial strain gauges, earth pressure cells, and image processing.

1. Parallel Plate Load (ASTM D2412): Determines liner pipe sample stiffness, which is a function of the liner material's dimensions and physical properties.
2. Ring Stiffness (ASTM D2412): Measure the liner pipe sample's deformation resistance to radial forces and resistance to ring deflection.
3. Creep Ratio (ISO 9967): Provide liner pipe sample deflection over an extrapolated two-year period.

PRESSURE PIPES TESTING

The recommended testing is categorized into two types: Short-term Testing and Long-term Testing. Short-term tests include:

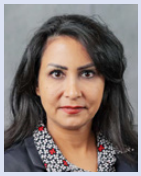
1. Hole Spanning (AWWA): Determines hole spanning capacity of liner in pressure application. Hole-spanning pipe sample showed in Figure 3.
2. External Hydrostatic Buckling Test: Determines liner resistance to external hydrostatic pressure.
3. Hydrostatic Burst Test (ASTM D1599): Determines the burst pressure of liner pipe samples. Useful in calculating the short-term hoop strength of liner material. Burst failure pipe sample showed in Figure 4.
4. Hydraulic Flow Test: Evaluates the hydraulic flow characteristics of the liner material in comparison with the host pipe without liner, considering diameter reduction and surface smoothness under high flow.

Long-term tests include:

1. Fatigue Full-scale Test: Determines if liner can withstand cyclic loads that are 1.5 or 2 times higher than its pressure class for two million or more cycles and to predict design service life.
2. Hole Spanning Internal Hydrostatic Pressure (AWWA) Determine resistance of liner for long-term hole spanning.
3. Pipe Burst- Hydrostatic Design Basis (HDB) (ASTM D2837): Determine effects of temperature and pressure on the life span of liner material and long-term hoop tensile strength.

ABOUT THE AUTHORS:

***Kawalpreet Kaur, Ph.D.**, is a Postdoctoral researcher with a research focus on trenchless technology, pipeline rehabilitation, and asset management. She is working on designing, testing, and evaluating spray applied pipe lining (SAPL) materials by performing various experimental tests for its applications in gravity and pressure pipes.*



***Sanaz Ghalambor** is a CEM PhD candidate at UTA with Polymer Engineering background. She has spent two decades in pipeline integrity, corrosion prevention, and rehabilitation. She's had several presentations at different conferences including UCT, NASTT, IWA and has supported many water and wastewater rehabilitation projects.*

***Dr. Najafi** is a Professor and Direction of the Center for Underground Infrastructure Research and Education (CUIRE) at the University of Texas at Arlington. He has more than 25 years of experience encompassing engineering, education, research, consulting, and management activities. He is the author of four trenchless technology books published by McGraw-Hill (the latest one published in 2022).*

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Emergency Repair of 16-Inch Force Main in North Texas

City of Plano - North Texas Municipal Water District (NTMWD)

By: Tim Peterie & Steve Soldati, P.E., Aegion Corporation

The North Texas Municipal Water District (NTMWD) consists of 10 original member cities: Farmersville, Forney, Garland, McKinney, Mesquite, Plano, Princeton, Rockwall, Royse City, and Wylie. The Texas Legislature created the NTMWD in 1951, and by 1956 this new agency was providing water to the region. By the 1970s, the NTMWD expanded its service to the wastewater system and between 1971 and 2001 added three new member cities: Richardson, Allen, and Frisco. With an ever-expanding region for the NTMWD to operate and maintain, it was paramount for the District's leadership to find innovative methods to maintain its water and wastewater system, keeping up with demand.

By the numbers, the NTMWD serves up to 80 communities covering approximately 2,000 square miles in 10 counties. Two million people live within 80 District communities that make up one of the fastest growing regions in the United States. There are 18 major raw and treated water pump stations, six water treatment plants, over 610 miles of water transmission pipelines, over 226 miles of large-diameter wastewater pipelines, 13 wastewater treatment plants, and a total capacity of over 163 MGD of wastewater treatment.

NTMWD provides high quality and dependable water, wastewater, and solid wastes services in a cost-efficient manner with four main goals: service, stewardship, partnership, and people. These goals drive the day-to-day operations and influence the District's approach to improving and maintaining their extensive system.

Water and wastewater municipalities and agencies develop capital improvement programs to improve or expand their infrastructure systems. This is the more structured method of properly evaluating the system improvement needs and the available funding. However, the infrastructure that municipalities operate and maintain does not wait for a capital improvement program to be developed before it decides to fail. The nation's infrastructure deteriorates at different rates depending on several factors and it is difficult to determine the exact time when a pipeline is going to fail. Responding efficiently with all the proper information and tools at hand is critical to responding most efficiently and effectively.

This was the case with a lift station and sewer force main in the City of Plano, Texas. The Lower White Rock Creek Lift Station collects wastewater from the surrounding area and pumps the raw sewage through approximately 27,000 linear feet (LF) of sewer force main with varying diameters from 16 inches to 27 inches. The force main begins as a 16-inch diameter pipeline at the Lower White Rock Creek Lift Station and upsizes in diameter as it accomodates seven interconnects along its way to the final discharge vault. Approximately 12,700 LF of 16-inch force main was constructed in 1978 and, due to the area's growth over the years, the 24-inch and 27-inch diameter extension was constructed in 1989. The most recent addition was an 18-inch force main pipeline constructed in 2009 to interconnect into the 24-inch pipeline just before the upsize to the 27-inch diameter section.

In August of 2018, a leak was discovered by the City of Plano in a storm drain located under the 16-inch sewer force main. The issue was a fascinating discovery due to the rare circumstances of how

> *This project showcased the versatility and adaptability of trenchless rehabilitation.*

this particular leak was found. In this instance, a leak in one pipe was being captured by an adjacent pipe. This is an important lesson that many times when we inspect portions of our infrastructure, you never know what you will find unrelated to the focus of the intended inspection. In addition, sometimes the location where the leak surfaces is not typically where the leak actually occurs. When a pipeline has a leak, depending on the topography, soil conditions, and other adjacent infrastructure features, the water from the leak can begin to show itself in another location. For a sanitary sewer overflow (SSO) situation, as was the case here, the first priority is to mitigate the leak and provide a temporary repair to stop further leaking. With this repair in place, a team of engineers and operators can then begin the design and implementation of a long-term solution.

Once the leak location was determined and accessed, crews set up a stilling well and pumped the leaking fluid to a nearby manhole. The use of pump trucks and sump pumps facilitated the transfer of this fluid to the manhole to evacuate the leaking sewer effluent.

When addressing an isolated failure location, all focus and resources goes to mitigating the issue. There is one main goal: to stop the leak. However, when looking at a larger, long-term solution, there are several factors that need to be considered such as maintenance of traffic flows, community disruption, temporary flow bypass, and excavation access points. These factors are typically reviewed and evaluated through the planning and design phases to ensure that the proper rehabilitation technique is chosen for the intended application. The owner needed to expedite this review given the design criteria and site layout, Cured-in-Place Pipe was the most cost-effective, best fit solution to fully restore this segment of failing pipeline.

"The NTMWD serves up to 2 million people in 80 communities covering approximately 2,000 square miles across 10 counties."

So, what is Cured-in-Place Pipe? Commonly referred to as CIPP, cured-in-place pipe is engineered and manufactured to project specifications and is designed as an independent solution to meet the pipe rehabilitation goals. This pipe-within-a-pipe method can rehabilitate pipelines between six and 96 inches. It is a fully structural AWWA Class IV solution with no reliance on the existing host pipe for the new service life. CIPP can be installed up to several hundreds of feet at one time and does not hinder the flow capacities of the pipelines. With only two small excavation pits on either end of the pressure-rated CIPP installation, and the ability to

bypass or reroute the flow, the rest of the facility operations above the pipeline will not be disrupted during the rehabilitation process.

For this 16-inch emergency force main repair, Insituform's pressure-rated CIPP, InsituMain®, was installed to fully restore the failing segment of the pipeline. InsituMain® can be manufactured and installed in a wide range of diameters and operating pressures with physical properties exceeding ASTM F1216 and AWWA M28. NTMWD required a 150-psi pressure-rated lining system and, at this pressure rating, the close fitting InsituMain® liner had a thickness of just 8.5 mm. With an overall diameter loss of less than .67 inches and a Hazen-Williams friction coefficient of at least 140, flow capacities were not jeopardized for this project.

With a lining system that met the technical requirements by NTMWD, the team needed to put the solution into action by accelerating the contracting process. The contract between NTMWD and Insituform was executed on October 31, 2018, just two short months from when the leak was first discovered. From the Notice-to-Proceed date in October, the CIPP liner was manufactured, delivered, installed, and pressure tested all by December 14, 2018.

To achieve a fully structural Class IV solution, the CIPP solution needed to be properly designed and manufactured to meet the operating conditions of the pipeline from internal pressures and external loading. However, one key aspect to providing a fully structural Class IV solution is to appropriately terminate the liner.

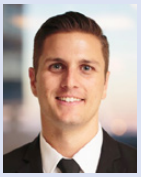
This is achieved by terminating the liner into a new end spool piece where an internal end seal is then installed. Terminating outside the limits of the existing pipe eliminates the reliance on the existing deteriorating host pipe for future service life. When this same termination detail is provided on the other end of the segment to be rehabilitated, standard pipe closure spools and fittings can be installed to reconnect to the existing pipeline prior to backfilling and restoration of the site.

After the CIPP repair was installed, the owner was then able to inspect the remaining force main length to determine the best path forward for future restoration techniques. Using both the PipeDiver and SmartBall by Pure Technologies, the owner was able to collect valuable data on the existing condition of the pipeline to make an informed decision on the best-fit rehabilitation solution. The condition assessment tools provided results that showed several air and gas pockets and areas where there was substantial pipe wall loss.

The results from this inspection step allowed the owner to plan and design for the proper improvements to the system by adding new ARVs in strategic locations and identifying candidates for a rehabilitation. Discovering a leak is never the preferred way of finding out that rehabilitation or repair of a pipeline is necessary. However, the emergency repair and subsequent inspection of this project, showcased the versatility and adaptability of the trenchless rehabilitation industry. The trenchless industry is technology-based and always working to provide better tools and solutions to address the increasing need for innovative, cost-effective tools to address aging infrastructure. With an entire industry dedicated to solving problems that impact every community and a network of owners and engineers matching the available solutions to these problems, we rely on the collaborative approach to find the best fit solution to maintain our critical water and wastewater infrastructure.

ABOUT THE AUTHORS:

Timothy Peterie *is a Manager of Business Development with Insituform Technologies, LLC. With Insituform for more than 23 years, he has over 30 years of experience working in various capacities related to engineering and specializes in helping municipalities find solutions for their pipeline problems. He has a degree in Aerospace Engineering from the University of Tennessee.*



Steve Soldati *serves as the Commercial Manager of Pressure Pipe for Aegion Corporation and delivers innovative, technology-based solutions for the water and wastewater industry across North America. He attended the California State University, Chico, where he earned his Bachelor of Science in Civil Engineering and is a registered civil engineer in Florida and California. He has over 13 years of industry experience working in construction, business development, project & program management for both the private and public sectors.*

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CASE STUDY: Segmental PVC Pipe Supports Solution for More Resilient Wastewater System Reconstruction after Major Hurricane

By: Craig Fisher, P.E., Westlake Pipe & Fittings

Project Type: Sewer Force Main
Application: Horizontal Directional Drilling (HDD)
Owner: City of Seabrook
Product Used: C900 Certa-Lok® RJIB 12" DR18 , C900 Certa-Lok® RJ 14" & 20" DR18
Contractor: TCH Directional Drilling
Engineer: Cobb, Fendley & Associates, Inc.

Photo courtesy of NASA.gov

SEABROOK, TEXAS

Addressing the Seabrook, Texas, Main Street Wastewater Treatment Plant's (MSWWTP) vulnerability to hurricanes became a critical task after Hurricane Ike devastated the Texas coast in 2008. With the potential for major damage to the wastewater system along with service disruptions, the city faced the challenge of finding a solution that would protect the plant, minimize disruptions, maintain the resiliency of the infrastructure, and ensure continuous service to its residents.

CHALLENGE

Seabrook, Texas experienced the impact of Hurricane Ike when the storm made landfall on the Texas coast the morning of September 13, 2008. The powerful category 4 hurricane ranked as the third most destructive in U.S. history and the wind's immense power led to storm surge waves as high as 25 feet within Galveston Bay. The city is located approximately 27 miles north of the city of Galveston on the shores of Galveston Bay and at the mouth of Clear Lake.

One of the critical structures affected by Hurricane Ike's storm surge was Seabrook's MSWWTP. The plant was inundated during the hurricane resulting in approximately $1.5 million in damages. After the storm, thanks to the prompt action of Seabrook's Public Works Department, the sewer service was restored to the MSWWTP and all Lift Stations within just five days. Although the control room and structures of the plant are above ground and elevated above current FEMA flooding and surge elevations, the location today presents a number of challenges: subsidence issues, the proximity to Galveston Bay, and if overtopped, the risk of structural failure of the walls along with the associated overflow leading to the discharge of untreated wastewater into the bay, all which emphasize the need for an improved facility location.

> *"The ability to cartridge feed Certa-Lok during pullback is a major advantage."*
>
> -Samuel Free, Project Manager, TCH Directional Drilling

APPLICATION

In the aftermath of Hurricane Ike, one of the crucial tasks was to address the vulnerability of the MSWWTP to hurricanes of similar magnitude. Along with the low ground elevations, the primary hazard identified at the existing site was the flooding of sensitive components. To provide the plant with longer-lasting protection against flooding and other natural disasters, several alternatives were considered by the city.

HDD offers minimal disruption to surface structures

The preferred alternative was to construct a new wastewater treatment plant at Pine Gulley (PGWWTP). This site is located further inland at a higher elevation. Currently, the top of the MSWWTP tank walls stand only 1 foot above the Base Flood Elevation (BFE), whereas, at PGWWTP, the walls planned are 20 feet above the BFE. Moreover, the new WWTP will be built to current standards and fortified against hurricanes and other natural disasters. Ideally, this alternative would receive funding assistance from FEMA, enabling construction to be completed within 3 years. The city of Seabrook enlisted the services of Cobb, Fendley & Associates, Inc. (CobbFendley) to assist the city's emergency management planners in the application process for federal assistance; with funding approved, the projects moved forward.

The team first looked at the current process where all the wastewater treated by the MSWWTP flowed into the MSWWTP lift station. One option was to leave the system as-is, allowing the entire volume of wastewater to reach the existing MSWWTP lift station and then pump the wastewater to the new PGWWTP. Reviewing this scenario, CobbFendley proposed an alternative option. They suggested intercepting the wastewater from 6 existing lift stations that are closer to the PGWWTP and rerouting the path directly to the new plant instead of following the current process. By implementing the new approach, approximately 50 percent of the service area would no longer rely on a single lift station near the MSWWTP, and this option also provided construction flexibility. The alternative approach was approved, resulting in the installation of 21,500 feet of new sewer force main pipe to redirect the sewage flow to the new treatment plant at Pine Gulley.

SOLUTION

Horizontal Directional Drilling (HDD), a trenchless application, was selected as the installation method. This application offered minimal disruption to surface structures, the ability to cross roads and driveways without closures, and efficient installation in congested, primarily residential, rights-of-way.

Several pipe options were considered for the force main, butt fused HDPE, butt fused PVC, and segmental restrained joint (RJ) PVC. Ultimately, segmental C900 Certa-Lok® RJ PVC pipe from Westlake Pipe & Fittings was chosen as the optimal solution offering the cartridge assembly option; the fused pipe options considered required modifications to the HDD pulls and these solutions were found to be too time consuming and ultimately unable to meet the demands of the project. The green color coding of PVC, whether fused or segmental, was also an advantage for the relatively shallow bury depths as it provided an easy identifier for the wastewater pipe system.

The cartridge style segmental PVC approach involves assembling the pipe string during the pullback operation. Pullback occurs one drill rod at a time and there is a pause every time a drill rod is disconnected and re-racked. The new joint of segmental pipe can be connected to the pipe string during these pauses and the pullback operation can continue at the usual pace. TCH Directional Drilling, the general contractor, was very familiar with

Speed and ease of the coupling system significantly reduces time and manpower

Pipe string is assembled during pullback

HDD is an efficient installation method in congested, primarily residential, rights-of-way

the segmental product and expressed no concerns about pipe-string assembly slowing the pullback operation. Moreover, there were specific HDD project sites where this approach was preferred.

"The ability to cartridge feed Certa-Lok during pullback without risking the integrity of the pipe and or gaskets is a major advantage of Certa-Lok over other pipe products when planning and executing HDDs in congested areas as we encountered in Seabrook where space to string out pipe is limited," said Samuel Free, project manager TCH Directional Drilling. "The speed and ease of using Certa-Lok's coupling system to connect joints significantly reduce the amount of time and manpower required to perform drilling operations over other products that require fusion or welding to join."

Certa-Lok segmental PVC pipe is available in 20-foot or 40-foot lengths. TCH Directional Drilling chose the 40-foot option for increased efficiency and to reduce labor. Opting for 40-foot lengths also resulted in a more cost-effective solution. In addition, Westlake Pipe was available on site to provide support during the project.

Throughout the planning phase, resiliency was a top priority. To better facilitate maintenance, shallower profiles for the HDD bores were specified instead of the typical depth. The shallower depths, however, required additional measures to address potential inadvertent return of drilling fluids leading the design firm to require multiple relief pits along the installation path.

Grade control also received significant attention. An air relief valve is required at every high point in a force main and poor grade control could result in unexpected local high points. Using a walkover system to monitor both the depth and direction of a horizontal drill gives operators real-time feedback and enables constant adjustment of the drilling direction. TCH Directional Drilling used a Digital Control Inc. walkover tracker during the HDD process to ensure grade was maintained within tolerance.

As of the end of January 2023, 10,000 LF of 14-inch C900 Certa-Lok DR18, RJ, PVC; 5,300 LF of 12-inch C900 Certa-Lok DR18, RJIB, PVC; and 5,300 LF of 20-inch C900 Certa-Lok DR18, RJ, PVC or 92% of the total 21,540 LF of force main pipe has been installed. Due to outside constraints with the construction of the PGWWTP, the new force mains will not be placed in service until early 2024. All work by TCH Directional Drilling has progressed on schedule and within budget.

The new WWTP will be built to current standards and fortified against hurricanes and other natural disasters

ABOUT THE AUTHOR:

***Craig Fisher, P.E.**, is a Regional Engineer for Westlake Pipe & Fittings. He shares best practices that he has learned over his 30+ year career with owners, engineers, and contractors during the design and construction phases of water and wastewater projects.*

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Safety, Precision Spur Superior Pipeline Success

Top-tier Fort Worth Contractor has Ability to Adapt

By: Vermeer

Superior Pipeline Services (SPS) has been a successful contractor in Fort Worth and the surrounding area for more than 20 years, and the company is growing because of its willingness and ability to adapt.

Founded in 2001 primarily as a roustabout service operating in the Barnett Shale, the recession of 2008 moved the company's focus away from midstream gas and oil transportation to the distribution of natural gas to residential, commercial and industrial segments.

Since then, major Texas utility companies have looked to Superior for gas line remediation and the installation of new lines in the rapidly growing North Texas region.

But over the past several years, crowded underground utility space and a focus on safety has necessitated another major adaptation — this time to vacuum excavation and more specifically, hydrovac machines.

"The days of utility contractors dropping a bucket in the ground to repair or replace existing lines are over, especially in metro areas of Texas," said Chris Reinmiller, company president.

Superior's customers demand precision digging to avoid both dangerous situations and disruptions in service.

"Vacuum excavation provides that precision," Reinmiller said. "Hydrovac is the new standard in remedial utility work."

Superior has partnered with its primary equipment supplier, Vermeer Texas-Louisiana, to address the three basic tenets of the contractor's business philosophy: Reinmiller and his management team believe that if you give priority to safety, treat your employees well and take care of your customers, it will follow that profits and other goals will be achieved.

Equipment plays a part in all three.

SAFETY MUST ALWAYS BE FIRST

Cory Kelsey, vice president of operations of Superior, said gas lines are the trickiest of all utility work.

"Tolerances are very tight," he said. "There is a lot of stuff in the ground. A four-by-four hole can have six different utilities running through it. It takes a very skilled operator and the right piece of equipment to do this. A mistake can be costly, or worse yet, deadly."

Vermeer Texas-Louisiana Sales Manager Champ Cox explained how vacuum excavation equipment has provided the solution for Superior.

"More and more, utility companies require a 'soft dig' in order to avoid striking existing lines," he said. "It's a way to dig a hole without a bucket or mechanical device. Water digs the hole and the vacuum keeps it clean. Superior utilizes our Vactron [Editor's Note: Vactron equipment is now branded as Vermeer MV Solutions.] units, which are trailer-mounted as well as large vacs mounted on Peterbilt Mack or Kenworth trucks, like our VXT600. The hydrovac exposes the existing lines without disruption, allowing for a clear visual for the work that needs to be done. But Cory

can get very creative with a truck vac… we've seen him dig an entire trench with the truck vac when conditions call for it."

A recent job in a residential neighborhood of Everman, was typical. The job called for approximately 1,000 feet of gas line to be replaced with 4-inch poly.

According to Cory, as he likes to be called, they were looking for five things as they excavated with the Vermeer VXT600 vacuum truck truck vac.

"Existing gas lines, water, sewer, electric and fiber lines are all down there," he said. "We're there to work on gas lines, but we need to identify and avoid all the lines, both main and service lines."

Superior utilizes one of its seven Vermeer horizontal directional drills to bore for the replacement lines once the hydrovacs have done their job. The company's fleet includes two Vermeer D20x22s, two D23x30s, two D23x30DRs and a D7x11. The drill rigs work side by side its 11 Vactron excavation units, and six truck-mounted hydrovac excavators.

> *"Hydrovac is the new standard in remedial utility work."*
>
> -Chris Reinmiller, President, Superior Pipeline Services

Every piece of equipment, according to Cory, helps accomplish their goal to do "whatever it takes to minimize any kind of danger. The last thing we want to do is tear up existing electrical or plumbing."

A QUALITY WORKFORCE

Superior's total fleet currently numbers more than 200, operated by over 60 crews, and Superior prides itself in the quality of that workforce.

Acquisition and retention of those employees is critical to the company's continued growth. Reinmiller said there are a few factors that have contributed to the company's ability to hire and keep the right people.

"First, obviously we must pay our employees well," he said. "But believe it or not, the equipment we provide them with is also key. With the Vermeer drilling and vac excavating machines, we feel we're giving them the best equipment and the best support available at any price. Our people appreciate that."

Cory agreed and said they're fortunate there is no shortage of utility work right now.

"Our major customers keep us busy with work," he said. "If we prepare properly, train our employees and give them the tools, we'll be successful and that's why we're growing."

Superior's customers demand precision drilling

Drill rigs work side-by-side with the vac trucks

Supervisors, Reinmiller said, are empowered to make field decisions and take care of customer demands. That creates an atmosphere where customers' requests (or demands) are handled quickly at the field level.

OWNERS, PARTNERS

Peak Utility Services Group purchased Superior from founder Lynn Ayres a year ago, and that has propelled the company to a new level, according to Cory, who has been with Superior for more than 20 years.

"Peak wants us to grow and are supplying us with the resources to grow," he said. "When I started, we had just 25 employees. Obviously, that's a small fraction of what we have today."

With vacuum excavators truck vacs requiring an investment of around a half-million dollars each, Peak's capital has been instrumental in giving Superior the resources to grow with their customers.

> *"Gas lines are the trickiest of all utility work. Tolerances are very tight."*
>
> -Cory Kelsey, VP Operations, Superior Pipeline Services

Reinmiller noted that Superior's customers were growing rapidly and required their contractor partners to keep pace. "We've worked for two major utilities for years, and they both are growing and expect us to do the same," he said. "And we are trying to outgrow our competition, as well." Having a solid ownership group and a solid equipment partner are both important to our growth, Reinmiller added.

"Our relationship with Vermeer Texas-Louisiana feels like a partnership," he said. "They are committed to keeping us up and running. They do a ton of work training our employees and they are Johnny-on-the-spot when we are down for any reason. With them being local and having branches all over the state, it's easy to get support, but frankly, Vermeer drills are very durable and require less support than other brands we've used. Durability is key. When the drill shuts down, the job shuts down. We run them hard. Downtime can cost $10,000 a day, depending on the size of the crew."

Cory said the right equipment supplier has been a game changer.

"Our relationship now is that when we need something – equipment, parts or service - we can get it. It's hard to grow without the right equipment vendor relationship. It is absolutely vital."

By prioritizing safety, empowering its employees and treating customers with respect by performing work with the utmost professionalism and expertise, Superior Pipeline Services is sure to see even more periods of growth and sustained success.

Supervisors are empowered to make field decisions

A solid equipment partner is important for growth

"We see fly-by-night customers all the time with Texas having so much work," Vermeer's Cox said. "But SPS has uniquely positioned themselves as the go-to contractor for gas line remediation. We're proud of our relationship with them, but they are an absolute top-tier contractor."

ABOUT VERMEER:

Vermeer Corporation *offers one of the most comprehensive product offerings serving the underground construction industry. Products include horizontal directional drills, guided boring systems, trenchers, vibratory plows, rockwheels, piercing tools, vacuum excavators, core saws, and mini skid steers, as well as a range of tooling, accessories, and support equipment.*

The Curveball: How a Compound Curve Horizontal Directional Drill Resulted in Success for City of Frisco

By: James Bryan, P.E., Kimley-Horn and Associates, Inc.

PROJECT BACKGROUND

The City of Frisco, Texas is one of the fastest growing cities in the US over the last decade. Major interstates, fully developed commercial areas, and rapid population growth have driven Frisco's need to minimize the impact of construction while they build new water and sewer infrastructure.

This was no truer than in the northwestern quadrant of the city, known as the Cottonwood Creek Basin. To support future development in the area, the basin needed to be expanded by 1,900 acres with a projected wastewater flow rate of 10 million gallons per day. This would require a new lift station and force main to capture the wastewater flow and convey it to the city's Panther Creek Wastewater Treatment Plant. These improvements collectively were known as the Legacy South Lift Station and Force Main improvements.

The project required an accelerated design and construction schedule to ensure the infrastructure would be in place when needed for the future developments. To minimize the scheduling risk, the city elected to split the project into three segments: Legacy Lift Station, Legacy Force Main South, and Legacy Force Main North. This would allow the projects to be designed and constructed concurrently, which reduced the impact of scheduling delays.

Kimley-Horn was selected to provide design and construction phase services for Legacy Force Main South, which consisted of nearly two miles of 20-inch force main along Legacy Drive and Panther Creek Parkway. This area was already partially developed with single family residential subdivisions, retail shopping centers, and a large middle school. The city wanted to ensure that construction of the force main would not cause excessive disruption to the area, and they wanted to minimize the visibility of the project as much as feasible.

> *Trenchless installations are highly effective at mitigating construction impacts.*

Figure 1 - Project Layout

Kimley-Horn performed an initial alignment study and pipe materials evaluation to determine the best approach for the project. Taking advantage of an ample median along both roadway corridors, most of the line was to be installed using open-cut construction methods. However, trenchless technologies would be employed near the intersection of Legacy Drive and Eldorado Parkway. The intersection experienced significant daily traffic volumes and open cut construction would be highly disruptive. Kimley-Horn elected to use Horizontal Directional Drilling (HDD) for the Eldorado Parkway intersection due to several factors, including length, size, curvature of the alignment, and depth.

HDD DESIGN CONSIDERATIONS

The city predominately uses polyvinyl chloride (PVC) pipe in their water and sewer system. With the city's familiarity and experience with the material and the desire to maintain material continuity across all segments of the project, Kimley-Horn specified AWWA C900 Fusible PVC® pipe for the HDD. The use of a fused, fully restrained, and monolithic gasket-less piping system under this critical area would also mitigate long term risk.

The total length of the HDD was 1,700 linear feet. The design required a compound curvilinear bore path to follow the curvature of the roadway. The challenge with compound curvilinear HDD is the amount of pull force required is substantially increased. The installation also required drilling through hard rock formations. While this would make the initial drilling more challenging, it made the overall design more feasible by reducing the effort required for maintaining the bore hole and pulling in the product pipe.

Kimley-Horn utilized Bore-Aid® software to verify the feasibility of the initial design, and then coordinated with local HDD contractors to further validate the design. This early collaboration was extremely beneficial to the project. The initial design included a reverse horizontal curve at the north end to line up with the open cut portion continuing north. Based on contractor feedback, the alignment was re-worked to remove the reverse curve, thereby reducing pull forces. Instead, a traditional bend fitting was used to align with the open cut section at the HDD exit.

The wide median along Legacy Drive on the south side of the Eldorado Parkway intersection would be utilized for the HDD entry pit and equipment staging area. The contractor was permitted to close the inner-most lanes to facilitate access and ensure safety. This allowed traffic to flow smoothly in both directions and access to all adjacent neighborhoods and businesses to be maintained throughout the project.

Figure 2 - HDD Layout

The HDD exit pit was positioned in the median of Legacy Drive north of the Eldorado Parkway intersection. This area was less developed and allowed for the complete pull length to be strung and fused together, resulting in only one pull-in operation. This was critical to maintaining momentum of the pull through the compound curve sections. This required one median opening to be closed, but it was not heavily used and there were other means of entry and exit into the adjoining neighborhood, so the impact of the closure would be minimal.

Kimley-Horn specified a certain minimum level of contractor qualifications based on size, length, and conditions of the boring operation. A pre-bore plan and profile was required, and minimum installation tolerances were established to provide a target for the bore operator. A wireline guidance system

> *HDD was selected for the Eldorado Parkway intersection due to several factors, including length, size, curvature of the alignment, and depth.*

was also specified to ensure that the force main would be correctly positioned within the right-of-way of Legacy Drive.

CONSTRUCTION CONSIDERATIONS

A maxi-rig was selected by the contractor due to the size, length, and pull forces involved. Prepping of the bore hole required 6 weeks to complete. A 6-inch pilot hole was drilled, and then 16-inch, 24-inch, and 30-inch reamer passes were used to reach the final bore hole diameter. The hard rock formations and heavy spring rains contributed to the overall duration of the bore hole process.

Figure 3 - Fused Pipe String

Figure 4 - HDD Entry Pit and Staging Area

Once the bore hole was prepared, the pipe pull-in only required 8 hours to complete. The pipe was ballasted at approximately 1,300 feet into the pull. Hydrostatic testing was performed at 150 psi for four hours. Connections required another 2 weeks to complete. Overall, the entire HDD process required 8 weeks.

SUMMARY

Installation of buried infrastructure in already developed corridors makes for complex projects with a multitude of challenges. The ability to utilize trenchless installations is a highly effective way to solve this problem and mitigate construction impact. Solid planning and communication between the owner, engineer and contractor allowed for a seamless installation that minimized disturbances to surrounding businesses and residents.

ABOUT THE AUTHOR:

James Bryan, P.E. *leads Kimley-Horn's water and wastewater practice in Oklahoma. A graduate of Texas A&M University, James has over 16 years of experience in municipal water and wastewater engineering, serving a wide range of clients including local municipalities, regional water authorities, and tribal nations. James puts particular emphasis on trenchless technologies and installation, and has employed various trenchless solutions on projects across Texas and Oklahoma.*

A Comparison of Polyethylene (PE) Installation Pull Forces

How Much Can I Pull On This Pipe?

By: Chelsea Griffiths, P.Eng., PE, CCI Inc.
Ashkan Faghih, Ph.D., P.Eng., CCI Inc.
Justin Taylor, P.Eng., PE, CCI & Associates

Polyethylene (PE) pipe and conduit is everywhere around us. It is a versatile product capable of carrying electrical or communications cables, water and sewer, or gas products to consumers. More and more is being put in the ground each year, and with North America's future plans for electrical grid upgrades paired with the push for renewables, these trends will continue and the importance of understanding how to install PE pipe efficiently and safely will be more relevant than ever.

Pull force analysis is regularly completed for horizontal directional drilling (HDD) installations of PE to determine the expected pull force that will be required, assess whether the forces imposed on the pipe will exceed maximum allowable limits, and to determine equipment requirements for the installation.

Several calculation methodologies have been used to estimate the required installation pull forces for medium and high-density polyethylene pipelines (MDPE or HDPE). Two of the most common methods are from ASTM F1962 *Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings* and PRCI PR-277-144507-R01 *Installation of Pipelines by Horizontal Directional Drilling, an Engineering Design Guide*.

ASTM F1962 was specifically developed for polyethylene pipelines and is the most common approach for calculating pull forces. ASTM uses a simplified model of pipeline geometry and primarily estimates installation pull forces based on soil friction. The PRCI method employs a more conservative calculation, developed for steel pipeline installations, but also applicable for polyethylene pipelines. This calculation considers a more detailed pipeline geometry and the effects of the pipe stiffness on installation pull force. It also contains a more significant component of fluidic drag. In the most cases, PRCI will yield a higher estimated pull force.

Although pull force analysis is completed for steel and PE pipes alike, there are several important considerations and differences when installing PE by HDD methodologies.

1. Tensile yield due to high axial forces. PE is susceptible to yield due to its relatively low tensile strength and the time dependent nature of the safe tensile load (continued elongation occurs until the load is released).
2. Bending stress, though considered, is typically not critical when installing PE pipe and manufacturers generally recommend an allowable bending radius of 40 or 50 times the pipe OD to minimize the effect of ovaling.
3. Pipe collapse due to external pressures from the earth loading and drilling fluid (or groundwater table). The depth of PE crossings can be significantly limited by allowable external pressures on the pipe (the deeper you go, the more fluid head pressure the pipe is exposed to).

Installation pull forces can be significantly reduced through use of rollers and for many pipe sizes, buoyancy control (which consists of filling the pipe section with water). Buoyancy control is a common practice in a much wider range of PE pipe sizes when compared to how often it is utilized on steel pipe. Buoyancy control reduces the pulling load by reducing the submerged weight of the pipe and making the pipe more neutrally buoyant. In addition, internal buoyancy water pressure counteracts the external pressures acting on the pipe from the drilling fluid, increasing the collapse strength of the pipe during installation. This is a critical requirement for many PE pipe installations by HDD.

ASTM METHOD

The ASTM method breaks the drill into three basic components below ground, L2 through L3, which consist of the combined exit or entry tangent and arc (horizontal length) and the bottom tangent. An additional length, L1, is the length of pipe required for handling at both ends of the bore including possible thermal contraction. The calculation does not account for the individual geometries of the tangents and curved sections and the calculations are based on the horizontal length of the drill.

When calculating the expected pull force, frictional drag between the pipe and the lubricated borehole and hydrokinetic drag (caused by the drilling fluid being

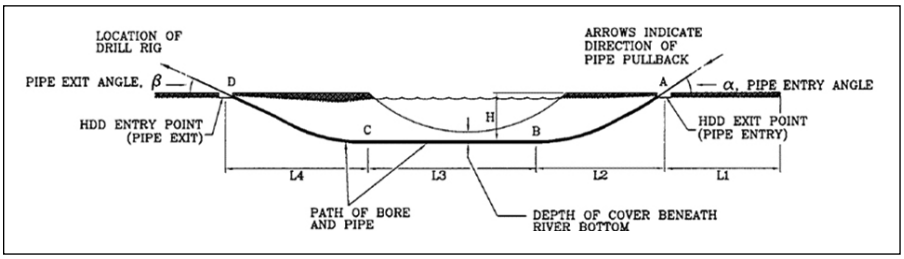

Figure 1. Maxi-HDD for Obstacle Crossing (ASTM F1962-22)

displaced by the pipe) are added. A force amplification factor is also added within the combined entry/exit and curved sections. ASTM excludes the addition of resistance from pipe stiffness along the curves.

The ASTM method and calculations are based on several assumptions that must be validated by the designer.

1. The borehole is open with no collapses.
2. The curvature is gradual and does not contain aggressive steers (dog legs).
3. The cuttings are largely removed from the borehole.
4. Low viscosity drilling fluid (slurry) is present.
5. Circulation of drilling fluid is maintained throughout the bore.

ASTM lays out these assumptions and cautions that the calculated pull force using this method is typically less than the actual experienced during installation. The closer the borehole matches the above conditions, the closer the calculated value will be to the actual pull force.

PRCI METHOD

PRCI provides a method for estimating pull force that may constitute a reasonable conservative alternative to ASTM for PE HDD crossings when some of the ideal pullback assumptions laid out in ASTM are not able to be achieved.

Pull force calculations as recommended by PRCI (2015) are widely used for steel pipeline installation by HDD, but also applicable to PE pipes. PRCI divides the drill path geometry into five potential sections including three straight sections and two curved sections, considering their individual lengths and bending radii. This is a more realistic representation of actual HDD profiles.

When calculating the expected pull force, frictional drag between the pipe and the borehole wall, fluidic drag between the pipe and the drilling fluid (including hydrokinetic drag), and additional normal forces due to bending are added. PRCI treats fluidic drag as a friction force between the drilling fluid and the pipe in addition to friction between the pipe and the borehole. When idealistic borehole conditions are not able to be achieved, additional cuttings will be suspended within the borehole, causing increased friction along the product pipe as it is pulled in. This is an additional factor PRCI considers when estimating pull force as part of a more conservative fluidic drag calculation, which may make it more appropriate for some borehole conditions.

PRCI, like ASTM, highlights that pulling loads are influenced by many site-specific conditions, including the reamed hole diameter, hole stability, removal of cuttings, soil and rock properties, drilling fluid properties, and buoyancy control

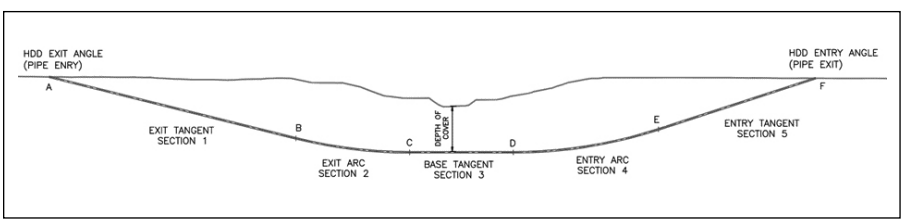

Figure 2. PRCI Method HDD Sections

effectiveness (when utilized). Regardless of the calculation method used, engineering judgment derived from experience with HDD is required.

PULL FORCE COMPARISON

CCI Inc. completed a recent project that included the design and installation of a PE pipeline at over 150 HDD crossing locations. This project provided the unique opportunity to compare calculated pull forces with recorded pull forces on a large number of crossings with varying length and hole conditions. The crossing lengths ranged from 330 to 1650 feet (100 to 500m). Subsurface conditions along the pipeline alignment were characterized primarily as clay and clay (till) with some zones of sand, silt and gravel, and occasional saturated zones. The project consisted of an IPS 9, DR 11, HDPE 4710 pipe.

The pull forces were calculated based on the recommended parameters of each calculation method. PRCI calculations resulted in higher estimated pull forces than ASTM calculations for all crossings. The construction pull forces utilized for the comparison are based on data from a TensiTrak pullback and pressure monitoring system which was utilized in the construction of each crossing to observe whether the maximum allowable pull forces were exceeded.

The measured pull forces in comparison with calculated values using both ASTM and PRCI calculation methods can be seen in Figure 3. The recorded pull forces were greater than the values predicted by the ASTM method in 92 percent of the crossings. PRCI calculations resulted in estimates closer to the actual values, with 36 percent of the HDDs exceeding PRCI pull force estimates.

During the design phase, safety factors are commonly included in pull force calculations to account for project uncertainties and enable proper rig selection and stress analysis to be performed. The safety factor is intended to account for the unknown and variable conditions experienced throughout any HDD installation to ensure that the product pipe can withstand the forces applied. For the calculations completed utilizing both ASTM and PRCI methods, a safety factor of 2 has been applied. The utilized factor of safety

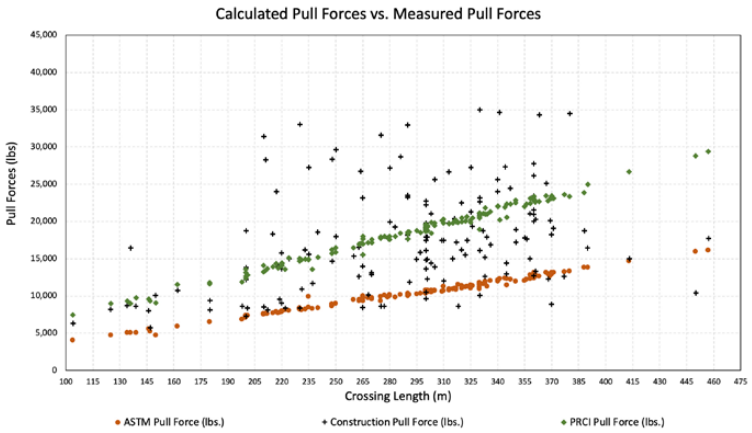

Figure 3. Calculated Pull Forces vs. Measured Pull Forces

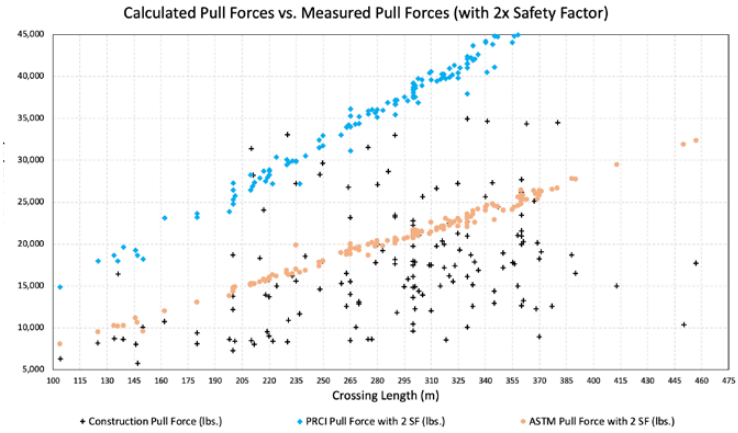

Figure 4. Calculated Pull Forces with Safety Factor vs. Measured Pull Forces

is in line with industry practice and was selected based on the size and length of the crossings (Faghih and Bayat, 2022).

Figure 4 shows the calculated pull forces with an applied safety factor for both the ASTM and PRCI methods. This graph illustrates that PRCI calculations provided more reliable and conservative predictions than the ASTM method. Because of the inherent uncertainties during construction, it is necessary to include conservatism during the engineering assessment of crossings.

The data shows that the construction pull force values recorded in the field were typically greater than values predicted by the ASTM method. The ASTM method is based on the assumption that cuttings removal is mostly complete and fluid circulation is maintained throughout the bore. In addition, the ASTM method does not consider the radii of curvature and the geometry of the curved sections, which in some circumstances, can be a significant contribution during pull back.

The idealistic conditions assumed by the ASTM method for calculating pull force cannot be fully maintained in shallow HDD installations through softer and variable formations because of the change in nature of ground conditions and the risk of hydraulic fracture events which preclude drilling fluid and cuttings circulation out of the borehole.

Pull force under-prediction is common for crossings with potential poor hole cleaning and borehole conditions that are far from ideal. A combination of accumulation of cuttings, borehole instability, and mechanical displacement of soils within the borehole during pull back can result in higher observed pull forces than predictions in these projects. Many of the PE pipeline crossings are categorized within this type of construction practices; therefore, more attention must be given to these crossings during pull force estimations because the ASTM model does not consider the additional resistances to the pipe pull inside the less ideal bores. ASTM F1962 specifies that, "engineering judgment should be applied when bore conditions deviate from" the assumed idealistic conditions. Engineering judgment in this case requires a more comprehensive analysis of anticipated pull force that accounts for additional resistances during line pull.

Overall, the PRCI method appears to provide a more conservative and perhaps more appropriate method to use for calculating pull forces for typical PE HDD crossings. While the majority of the crossings experienced lower actual forces during construction compared to the PRCI estimated values, the inclusion of a safety factor during the planning phases proved to be critical to allow for sufficient HDD designs, as some crossings still experienced pull forces higher than PRCI. Among the safety factors used during design calculations, a SF of 2 for PRCI method looks to provide a sufficient margin for predicting the construction pull forces for the case study discussed.

As this study has shown, modeling installation pull forces on PE pipe can be done in a number of ways, with the outputs varying significantly depending on the approach. What is clear is that care must be taken and engineering judgement applied in order to evaluate site specific expected conditions and ensure the proper models and factors are used, or the risk of overstressing the installed pipes and conduits is very real.

ABOUT THE AUTHORS:

Chelsea Griffiths, P.Eng., PE, *is Trenchless Engineering Manager for CCI's Canadian Division with 9 years of consulting experience within the pipeline and trenchless industry.*

Ashkan Faghih, Ph.D., P.Eng., *is a Senior Project Manager with over 10 years of direct experience in design and construction of trenchless construction projects. Ashkan is based out of Vancouver, Canada, and oversees the west coast division of CCI.*

Justin Taylor, P.Eng., PE *is the VP of Engineering for CCI's US operations, based out of Houston, TX, and has over 15 years of trenchless experience across North America.*

Nine-Mile Pipeline Increases Treatment Efficiency in Shawnee OK

Various Trenchless Methods Used with HDPE Pipe

By: Steve Cooper, SCA Communications

To update the city's sewer system, the Shawnee Municipal Authority (SMA) decided to convert one treatment plant to a lift station, and modernize and expand another. There were several reasons behind the decision. One was the age of the plants and the other was to be able to meet the increasing need. In order to use both, which would be economically beneficial, they would have to be connected. The obstacle was that they were eight miles apart and the pipeline would have to go under the main part of the city, from the south to the north side.

"Initially, our focus was directed solely towards the renovation of the southern treatment plant, primarily due to its age," explained Seth Barkhimer, P.E., director of engineering for the City of Shawnee. "But after analyzing the current and future need, and the impact the project could have onto our annual operating budget, we decided to move forward with a project to reconstruct the south side as a lift station and the north side as a new plant. That, of course, meant, we would need to have a force main that crosses town."

As part of the permitting process, SMA commissioned a full engineering report from Wall Engineering (Durant, OK) that offered eight different detailed options. The decision was made to pump all wastewater from the Southside facility to the new Northside Sequence Batch Reactor (SBR) treatment facility. Started in early 2023, the new force main using high-density polyethylene (HDPE) pipe is being installed with a combination of horizontal bore, directional bore and direct bury. Multiple reference standards were used including AWWA, ASTM International and the Plastics Pipe Institute, Inc.

> *"This pipe provides the integrity and leak-free joints."*
>
> -Camille George Rubeiz, P.E., F. ASCE, Co-chair, HDPE Municipal Advisory Board

The combination of installation techniques is allowing for the line to be installed with minimum disturbance to property owners. By using the bore methods, the Downey Contracting, LLC (Oklahoma City) crew is able to navigate under a major interstate and a railroad line. Being able to fuse several hundred feet in advance of pulling the pipe through the bores allowed for quicker installation times of the line.

The new force main pipeline that connects the south and north plants calls for 47,625 feet of 24-inch HDPE PE 4710 DR11 pipe. The discharge line from the new north plant to the river will use 4,655 feet of 30-inch HDPE PE 4710 DR11 pipe.

"This pipe provides the integrity and leak-free joints," said Camille George Rubeiz, P.E., F. ASCE, co-chair, HDPE Municipal Advisory Board, and senior director of engineering for the Plastics Pipe Institute's (PPI) Municipal & Industrial Division. "It also provides the versatility to be used in multiple installation methods, be it trenchless or cut and cover. The pipe enabled the SMA to go under a railroad crossing and an interstate highway (I-40), plus streets and intersections. HDPE pipe has been proven to perform in a myriad of projects and is known for easy, rapid installation. Also, it has superior resistance to corrosion and abrasion, plus it will not tuberculate." PPI is the major North American trade association representing the plastic pipe industry.

The total City of Shawnee Wastewater Treatment Plant project includes more than $117 million in critical public infrastructure improvements. Scheduled to be completed in 2025, the entire project includes replacing the 41-year-old Northside wastewater treatment plant and converting the 73-year-old, Southside wastewater treatment plant into a lift station. The SWWTP treats an average of 4.5 MGD of wastewater with a peak flow ability of handling up to 12 MGD, and has some 13,000 sewer hookups.

With the population of Shawnee growing at one percent a year, the 32,000 residents share the Designated Market Area (DMA) with Oklahoma City, 40 miles

Combination of installation techniques is allowing the new pipeline to be installed with minimal disturbance

to the northwest, which increases the appeal of living in Shawnee.

"With the reconstruction, we went with a sequence batch reactor plant for the Northside," Barkhimer said. "Since we're taking 100 percent of our treatment there now from both the south and north, we wanted a plant that we could easily expand if we have continued growth in the city. It's a common wall SBR. That way, we could add cell-by-cell as we need given the growth of the city."

In addition to new projects, SMA has an annual program of pipe bursting sewer and "We're going to be doing a lot of pipe bursting of the vitrified clay pipe," he explained. "Part of our replacement cycle is replacing the VCP with HDPE pipe."

PPI's Rubeiz explained the significance of the material used to make the HDPE pipe. "PE 4710 is the highest performance classification of HDPE piping material for water applications. It is tough, durable and flexible, meeting AWWA C906 and ASTM F714 standards and offers an excellent level of performance, recognizing the increased durability and reliability of HDPE pressure pipe used in water systems. This means PE 4710 HDPE pipe can be used with increased flow capacities plus it has increased resistance to surge pressure, fatigue and slow crack growth. The ANSI/AWWA C906-21 standard includes PE 4710 for sizes up to 65 inches and with pressure classes (PCs) ranging from 100 psig to 335 psig operating at temperatures up to 80°F, C906 has always been to provide the gold standard that clearly defines the use and manufacture of high-performance HDPE (i.e. PE 4710) pressure pipes and fittings from four to 65 inches for waterworks."

Additional information can be found at www.plasticpipe.org/mabpubs or www.plasticpipe.org/municipalindustrial

Ability to fuse several hundred feet means quicker installation

ABOUT PPI:

The Plastics Pipe Institute, Inc. (PPI) *is the major North American trade association representing the plastic pipe industry and is dedicated to promoting plastic as the materials of choice for pipe and conduit applications. PPI is the premier technical, engineering and industry knowledge resource publishing data for use in the development and design of plastic pipe and conduit systems. Additionally, PPI collaborates with industry organizations that set standards for manufacturing practices and installation methods.*

The City of Lubbock Uses Sliplining to Rehab Aging Water Line:

Fusible PVC® Pipe Rehabilitates 24-Inch Supply Line under Major Thoroughfare with Minimal Construction Impact

By: Kenny Friar, Kimley-Horn and Associates, Inc.

Pipeline Details & Project Summary	
Project:	**Low Pressure Supply Line Lining**
Location:	**Lubbock, TX**
Length & Pipe Size:	**18,000 LF** **20-inch DR18 Fusible C900® PVC Pipe**
Installation Method:	**Sliplining**
Owner:	**The City of Lubbock**
Engineer:	**Kimley-Horn**
Contractor:	**Horseshoe Construction, Inc.**

Average slipline pull lengths of 1800 to 2000 feet were achieved by the Contractor

The City of Lubbock is a regional hub serving as the economic, educational, and health-care focal point of the area North of the Permian Basin and South of the Texas Panhandle. The area is the largest contiguous cotton-growing region in the world and is heavily dependent on water from the Ogallala Aquifer due to minimal surface water resources. Lubbock is also home to Texas Tech University, one of the largest colleges in the state.

In 2019, the City evaluated several different options for rehabbing one of their critical water supply lines. Over three miles of 24-inch C302 Reinforced Concrete pipe, originally installed in 1953, needed to be either replaced or rehabilitated. The majority of the existing 24-inch pipe alignment was under the concrete of Quaker Avenue, a high-traffic major thoroughfare within the City. This roadway segment consists of 4-lane and 6-lane traffic with a center turn lane. Although the roadway was wide, numerous other utilities had been installed under Quaker Avenue over the years and its utility corridor became overcrowded. Multiple other water lines, sanitary sewer, storm sewer, gas lines, overhead electric, and fiberoptic lines in this congested ROW would make installing another large diameter water main a lengthy and disruptive process.

Additionally, the allowable construction timeframe for this waterline was restricted to a small window. In order to provide sufficient water capacity during irrigation season and meet high demand during warmer months, the pipeline would have to be constructed in late Fall and Winter when demand is lower. Ultimately, the City decided the pipeline could only be shut down and out of service for five months, from October 1 to March 1. Due to the project location, overcrowded utility corridor, and heavy traffic flow, it was established that a trenchless rehabilitation methodology was the best solution to avoid extensive disturbance and meet the aggressive timeline.

Kimley-Horn was contracted to design and oversee the construction administration. Multiple trenchless in-place rehabilitation options were evaluated including pressure cured-in-place-piping (CIPP), a tight-fit high density polyethylene

> *Rehabilitation of over three miles of existing 24-inch water main was deemed a success.*

Due to the congested ROW, a trenchless rehabilitation method was selected

(HDPE) liner, loose-fit sliplining with HDPE piping, and loose-fit sliplining with Fusible PVC piping. Loose-fit sliplining with 20-inch DR18 Fusible C900 piping was ultimately chosen as the best solution for this project since the existing 70-year-old concrete host pipe would serve as the perfect conduit. Of the rehabilitation options evaluated, the Fusible PVC loose-fit sliplining option provided a high pressure rating and a fully structural replacement pipe. These benefits were critical, because the City did not want to rely on the host pipe's structural integrity.

Also, the Fusible PVC pipe's jointless, gasket-less, and fully restrained fused joint provided the benefits of a fused monolithic piping system while meeting the City's traditional preference for Polyvinyl Chloride (PVC) pipe in their water system. In addition, the Fusible PVC pipe had the largest maximum pull force rating of the materials evaluated for the project. The bending radius of the Fusible PVC pipe allowed the pipe to be safely pulled through the vertical curves of the existing concrete pipe, while its uniform cross section allowed it to rest on the invert of the host pipe and be fully supported along its length. The use of standard waterworks appurtenances was an added benefit as well, since connections (to tap, connect, and change direction) to PVC pipe are common to Lubbock.

The Engineer anticipated 16 access pits to facilitate the slipline installation but put the responsibility on the Contractor to determine the number and location of pits. The Contractor would first CCTV the line, then decide where pits would be best. Grouting the annular space between host and carrier pipe was also required to eliminate any chance of soil infiltration in the event the host pipe fully deteriorated over time. Over 99 percent of the line would be installed via standard sliplining with the remaining small section installed via Jack & Bore under the TxDOT Highway 289 frontage road. The project also included installation of several air release/vacuum, blow-off, and butterfly valves.

The project was bid during the Covid pandemic when material lead times were longer due to supply chain issues, however liquidated damages would be enforced if the contractor was unable to meet the aforementioned timeframe. The engineer's project estimate was $6.1M. On May 27, 2021, three bids were received, with two of them coming in under budget.

Horseshoe Construction Inc., the low bid Contractor, had pipe delivered to the jobsite in early October 2021, with pipe fusion services commencing shortly after delivery. The sliplining installation went faster and smoother than expected. The Contractor was able to achieve average slipline pull lengths of around 1,800 to 2,000 feet. They tested each individual segment of the installation and tied-in the line before moving to the next section. The installation of approximately 18,000 linear feet of new 20-inch DR18 Fusible

Over 99 percent of the line was installed via standard sliplining

C900® pipe by sliplining was completed and placed into service several weeks after the New Year.

According to James Holt, President of Horseshoe Construction, "The project went exceptionally well. We had a great project team with UGS, Kimley-Horn, and the City of Lubbock which made the project go very smooth and maintained an excellent line of communication. Our extensive history of utilizing Fusible PVC allowed us to benefit with long installations with the reduced weight of pipe and provide cost savings to the City of Lubbock as would be compared to other methods and materials."

The rehabilitation of over three miles of the City's existing 24-inch transmission water main was deemed a success and was completed substantially ahead of schedule and within budget. The City of Lubbock now has a new, fully functional, monolithic, fully restrained, gasketless, AWWA C900 water supply line, which will provide its residents with reliable water service as required for years to come.

ABOUT THE AUTHOR:

Kimley»Horn

Kenny Friar *is a Project Manager in the Kimley-Horn Water/Wastewater group. His skills include water well design and large diameter water and wastewater pipeline design.*

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