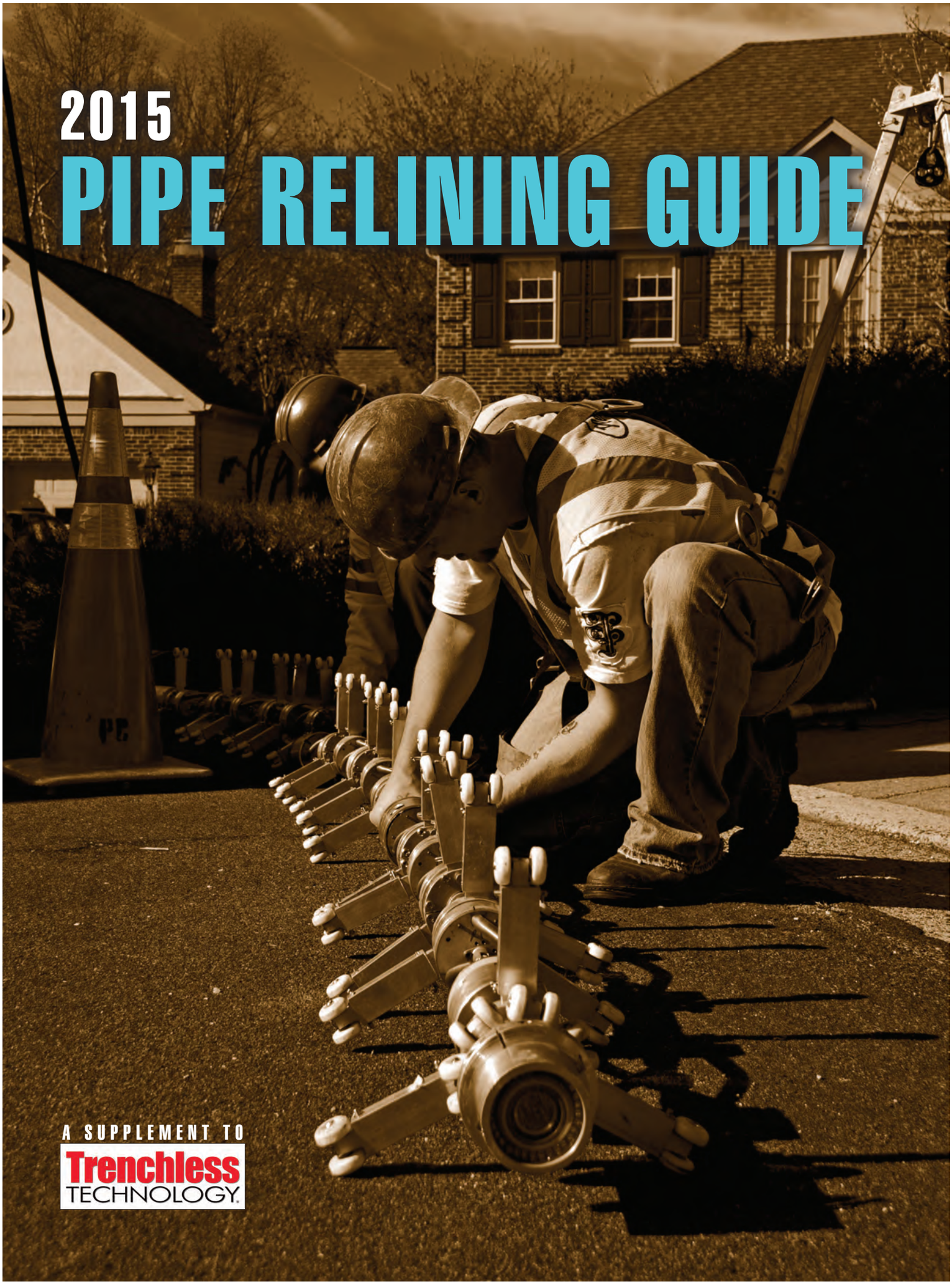

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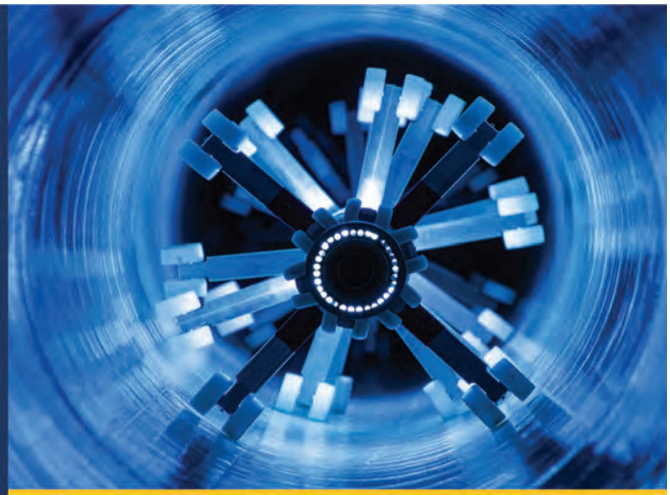

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PIPE RELINING ROLLS ALONG!

You have in your hands the *2015 Pipe Relining Guide*, a special supplement to *Trenchless Technology* and a product of a lot of hard work by the contractors, engineers, manufacturers that make these projects happen. The book contains a diverse and high-quality package of pipe relining case studies and good information that we're sure you will find just as interesting as we did when putting this all together.

The pipe relining segment of the trenchless market continues to get stronger and more expansive with each passing year. As it's been said over and over, North America's underground infrastructure is approaching over 100 years of use at minimum in many places (it's older in others) and its condition remains in dire need attention.

Pipe relining is by far the most popular trenchless method. The growth of pipe relining is a testament to the thousands of trenchless professionals who have tirelessly worked to educate engineers, utility owners and municipalities across North America on the incredible benefits that pipe relining offers our underground infrastructure over what is considered "traditional" methods.

The 2013 ASCE Report Card for America's Infrastructure notes that the capital investment needed to address our country's sewer collection system infrastructure totals about $300 billion over the next 20 years — which is twice the current level of investment by all levels of government — with pipes representing the largest capital need. Chris Daum, with the consulting firm FMI, reports that aged municipal water/sewer infrastructure is chronically underinvested but still sustains at $42 billion to $44 billion each year. In the United States, there are between 700,000 and 800,000 miles of public sewer mains, many post-World War II-installed and approaching the end of their useful life.

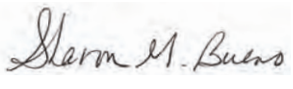
That is A LOT of work to be had for trenchless technology. Pipe relining is no longer the alternate choice for utility owners and municipalities looking to address their underground infrastructure issues — it has become the go-to choice. Music to our ears. But there is still much work to be done in spreading the word. For as much as we tout its benefits, there are some out there who are still tepid in their reception — for them it's the fear of the unknown or a lack of understanding.

Organizations such as NASTT, NASSCO, ASTM, AWWA and ASCE have done a tremendous job over the years in educating public works and utilities on the merits and results of trenchless technology. As our story by assistant editor Mike Kezdi reports, these organizations are at the core of standardization in inspection, design, testing — and education. Our overview of the pipe relining market starts on pg. 8 and discusses the industry's trends — such as the increased use of ultraviolet-cured relining and use of CIPP on pressure pipes. Check out this story — good stuff!

I have read all of the stories in each edition of our *Pipe Relining Guides* the past few years and I've never tired of learning about the different applications and circumstances of the technology's use. The sizes of the projects are getting bigger and the history behind them is fascinating. Check out the storm drain repair in Baltimore (pg. 40) — the drain was constructed during the 1880s using brick and mortar. Very cool stuff. The use of UV-cured CIPP is growing and markets such stormwater, pressure pipe and water mains continue to gain strength.

We cover pipe relining is some form in nearly every issue of *Trenchless Technology* and even that isn't enough. The calls and emails from contractors, engineers and manufacturers keep coming, letting us know about a recent project they've just finished. Even with a special supplement devoted to just pipe relining, we can't use all the stories we hear about — great stories are left out to be told another day. And those stories will be told, so keep letting us know about your work!

The pipe relining market remains a fascinating and exciting segment of the trenchless market. As our infrastructure continues to age and crumble, municipalities and utility owners are looking for ways to solve what ails them. Pipe relining will be there to lead the way to provide the best minimally invasive, least disruptive and most cost-effective answer to addressing these challenges.



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RELINING MARKET OVERVIEW

Storm, Sanitary Systems Still at Top of Relining Heap but Pressure Pipe, Laterals Poised for Growth

BY MIKE KEZDI

When a person visits a doctor for an injury, the MD will likely suggest some form of rehabilitation as the first course of action rather than opting for the more invasive surgery.The same mentality should hold true when looking at underground infrastructure, with pipe relining being the suggested rehab for aging water and sewer networks.

By relining, as opposed to re-laying, the owner is rehabilitating the pipe to like-new condition using any number of methods including sliplining, cured-in-place-pipe (CIPP), fold-and-form and spray-on liners. Sanitary and storm sewers have long been the poster children for the trenchless relining marketplace, especially for the use of CIPP methods, but that way of thinking is changing as technology continues to evolve and the needs of utility owners change.

"Although CIPP is widely accepted, the most common problems that prevent system owners from looking at CIPP relining is a general lack of knowledge of how the product works, the procedures surrounding the installation and cure of the product and unfamiliarity with the cost in today's marketplace," says Mike Marburger, owner of Insight Pipe Contracting L.P.. The full-service sewer maintenance company is headquartered in Harmony, Pa. and counts trenchless rehabilitation among its specialities."There are also some system owners who would rather dig and replace deteriorating infrastructure or use trenchless techniques other than CIPP lining. Although these techniques do have a place in some applications, the system owners may not be aware of the benefits of CIPP lining over other trenchless techniques in certain applications."

EDUCATION A PRIORITY

This is where education is a No. 1 priority and organizations like NASTT, NASSCO, ASTM, AWWA and ASCE come into play. The organizations all work to educate not only those on the contracting side of the industry but utility owners and engineers to the benefits of the various methods available. The professional organizations are also at the core of standardization in inspection, design and testing.

"Many do not understand how CIPP work is a process requiring a blending of field activities and materials coming together to provide a finished product. Materials (resin and tubes) have evolved, but one of the most significant areas of improvement has been the education of specifiers and the construction inspector," says John Jurgens, senior civil engineer for Seattle Public Utilities and a long-time proponent of trenchless technology.

In the early days of trenchless, those construction inspectors were mostly observers, watching a street project one day and something called a "trenchless" project the next. If a project went wrong, it led to a poor experience with trenchless and utility owners were reluctant to return.

"Today however, with better specifications with a thorough submittal review by knowledgeable personnel and alert inspectors, the industry is seeing a lower risk of a poor experience," Jurgens says. "One key will always be to ensure the solution chosen is proper to the problem attempting to be solved. Lining should be considered as 'one of the tools' not the 'only tool.' Capacity and structural issues should always require greater assessment with the potential of excavation, pipe bursting or other activities as a solution."

Jurgens adds that as well known as CIPP is in the marketplace, it can be over-marketed and over-sold. More importantly, when dealing with utilities where the lowest bid wins, quality sometimes suffers and when it does, so does the industry overall. For continued growth of the relining market, Jurgens emphasizes the need for good specifications and good inspections.

CIPP IMPROVEMENTS

Planned and Engineered Construction Inc., of Helena, Mont., specializes in CIPP projects with a service area covering the western United States. Company president Chris Peccia says his company has

seen the most growth in storm drain and culvert lining, with the large volume of sanitary sewer relining continuing to stay relatively constant.

"Since our inception in the early 1990s, the quality and availability of lining materials has drastically improved. There are many quality material manufacturers today, which give contractors many options, and material delivery times have been greatly reduced," Peccia says. "The different material options have made it easier for new contractors to enter the industry, which has resulted in market growth and has also allowed us to operate more efficiently and increase production."

Insight Pipe celebrated its 25th anniversary in 2014 and since the company's inception, Marburger has witnessed firsthand the growth of the CIPP market first on the sanitary side and then on the storm side.

"We are also starting to see a pickup in growth in the force main and water line market," Marburger says. "The offerings have improved through enhancements in the inversion process (through the use of air inversion shooters vs. traditional water inversions), as well as the ability to effectively steam cure a CIPP liner, as opposed to traditional water cure, which, in most cases, improves production. The offerings have also improved through the development of new products such as fiberglass reinforced CIPP liners and UV-cured liners."

In terms of the CIPP market, ultraviolet-cured (UV-cured) lining is seeing growth as more products – Aries Inc. launched its Anaconda UV curing system earlier this year – and contractors – Ted Berry Co. recently added Reline America's UV offerings to its services – enter the marketplace.

"UV is a different way of curing and controlling the process of installing a CIPP liner and this technology application in the United States has helped trenchless rehabilitation continue to grow and be applied in applications of varying complexity," says Matt Timberlake, president of Ted Berry Co. Before adding the UV process, the company's foray into CIPP was via sectional point repairs. The level of control the UV process provides – being able to cure with UV light and have a camera in the liner before and during the cure, as well as no need for steam or water – helped Ted Berry make the decision to offer a full CIPP process.

"We offer a full suite of trenchless services and [we] were looking for what the next generation solution for both sanitary sewer and storm drain rehabilitation would be and based," Timberlake says. "[Based] on how the markets have changed in European markets in the past decade, we felt strongly that applying this technology in the United States would help grow not only the trenchless market but our business, as well."

With a variety of relining options available, it's important for a utility owner to know the condition of their assets and if relining is even an option. It doesn't' make sense to reline an entire sewer segment because of one or two leaks; just as it doesn't make sense to wait for a system to get so bad that the only alternative is new pipe.

MANAGING ASSETS

That's where asset management comes into play and one of the cornerstones of any asset management system is CCTV. This allows a system owner to better focus money where it is needed, and then determine which approach, or

approaches, will get the job done in the most cost-effective manner.

"If you start with an asset management approach – know your inventory, know your condition and know what the value of that system is – then you can make capital improvement plans from there," Timberlake says. "The only way you can do that effectively is with a camera inspection program."

Marburger agrees, "The CCTV industry has helped improved the relining industry through improvements in technology such as pan and tilt cameras and remotely adjustable focus. This has made it significantly easier to determine whether or not a lateral is capped or active. Conventional lateral cutting equipment has also improved; allowing pan and tilt capabilities to better review the quality of lateral reinstatement cuts. Transportable cutters, although still in their nascent stage, have significantly improved production. Also, the NASSCO standard for coding defects has really helped clearly indicate pipes that require repair, which has facilitated increased demand for CIPP lining."

Many in the industry lauded NASSCO's Pipeline Assessment and Certification Program (PACP) standards as one of the drivers for the growth in the trenchless rehabilitation industry by providing common, usable, defect codes. Utility owners can take this information, plug it into GIS or asset management systems, and then have a real-time view of the assets.

"CCTV continues to be the most reliable tool used to evaluate and confirm a pipe's condition. Being a CCTV operator in Seattle is a demanding position as the job includes everything from repairing cameras and cables, dodging traffic, public relations with an interested public and their most important function – accurate coding," Jurgens says. "Coding is critical as the data goes through an algorithm which then alerts the asset management teams which pipes require a next level of review. Seattle Public Utilities has an ongoing weekly, monthly and quarterly QA/QC coding program for its CCTV teams."

A LOOK AHEAD

As utility owners take a deeper look at the assets, where do these industry veterans see a potential for growth? The simple answer is everywhere.

With infrastructure failing daily across the country there does not appear to be an end to sanitary and storm systems' reign as the big dogs on the relining block, but as technologies improve and become more cost-effective, the lateral, pressure pipe and manhole relining sectors are poised to grow, as well.

Both Marburger and Peccia are closely watching the pressure pipe and water pipe lining technologies as potential areas for growth.

"Pressure pipe lining presents a whole different set of challenges than gravity sewers," Peccia says. "When you've been in business as long as we have, new and challenging projects are always appealing."

Timberlake agrees that pressure pipes, including sewer force mains and water mains, have the opportunity to grow as relining technologies continue to emerge, but the one growth area he has his focus on rehabilitating the entire sewer system including the mainline, the lateral and the mainline to lateral connection.

"One of the next big nuts that need to be cracked in the United States is the mainline to the lateral and lateral pipe rehab," Timberlake says. "Although there are many technologies that exist to deal with the mainline to lateral seal or the lateral, most utility owners are hesitant to look at the entire system being from the house to the outfall."

According to Timberlake, the reasons for this hesitancy is due in part to using public dollars on private land, but there are models out there that prove by fixing laterals a utility reduces infiltration, tightens the system and reduces hydraulic capacity at the treatment plants.

The lateral issue also highlights the need for improved and unbiased education.

"We as an industry must, however, look at things from a utility owner's perspective sometimes and often there is so much 'new technology' that owners simply are hesitant to enter what they perceive as a new or emerging technology simply out of fear of the unknown," Timberlake says. "Trenchless education is what I would consider as the most important factor for the market including municipal utility owners and managers, consulting engineers, regulators, and elected officials. I also believe the industry must stop the negative selling tactics that are detrimental to our industry and our credibility."

Mike Kezdi is assistant editor of *Trenchless Technology.*

THE UV-CIPP RELINING PROCESS USES A UV LIGHT TRAIN, SHOWN HERE ON A TED BERRY CO. JOBSITE, TO CURE THE PIPE AS OPPOSED TO STEAM OR WATER. PART OF THE LIGHT TRAIN IS A CAMERA, WHICH GIVES THE CONTRACTOR THE ABILITY TO VIEW THE NEW LINE BEFORE AND AFTER THE CURE.

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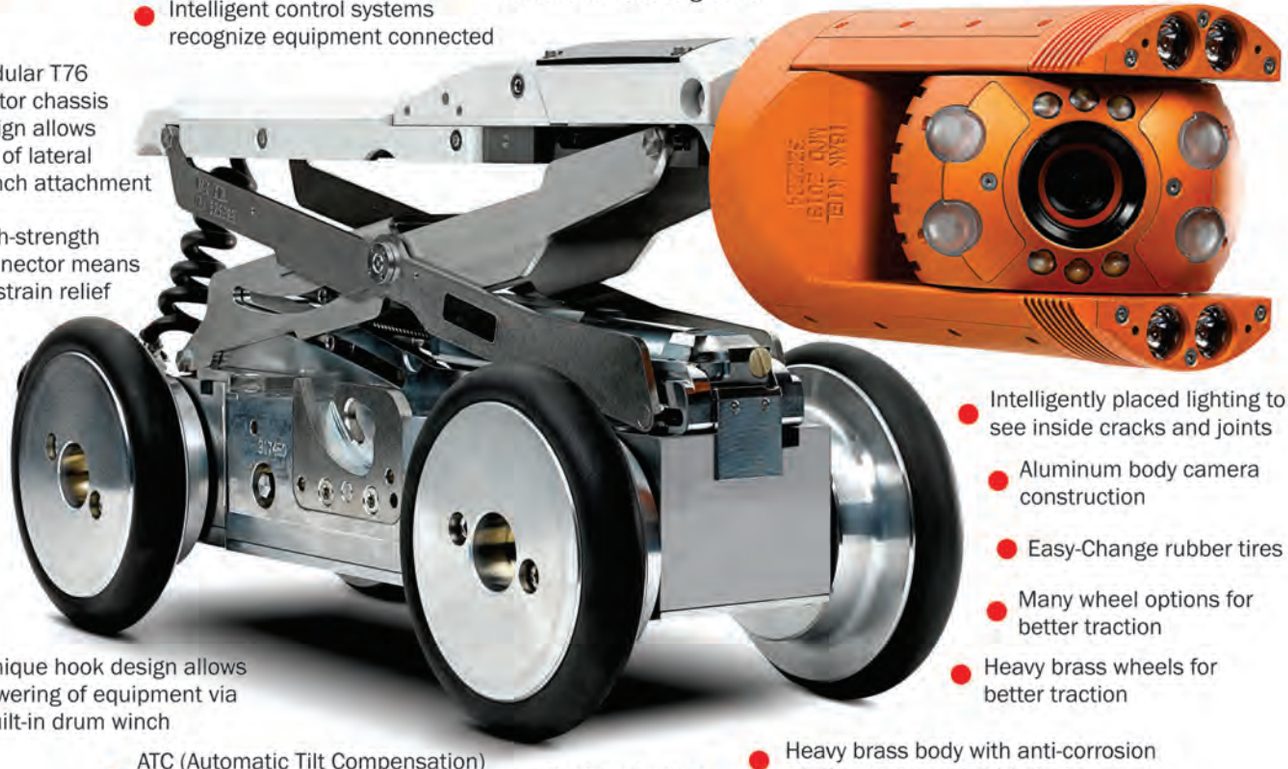

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PREPARE AND IMPLEMENT

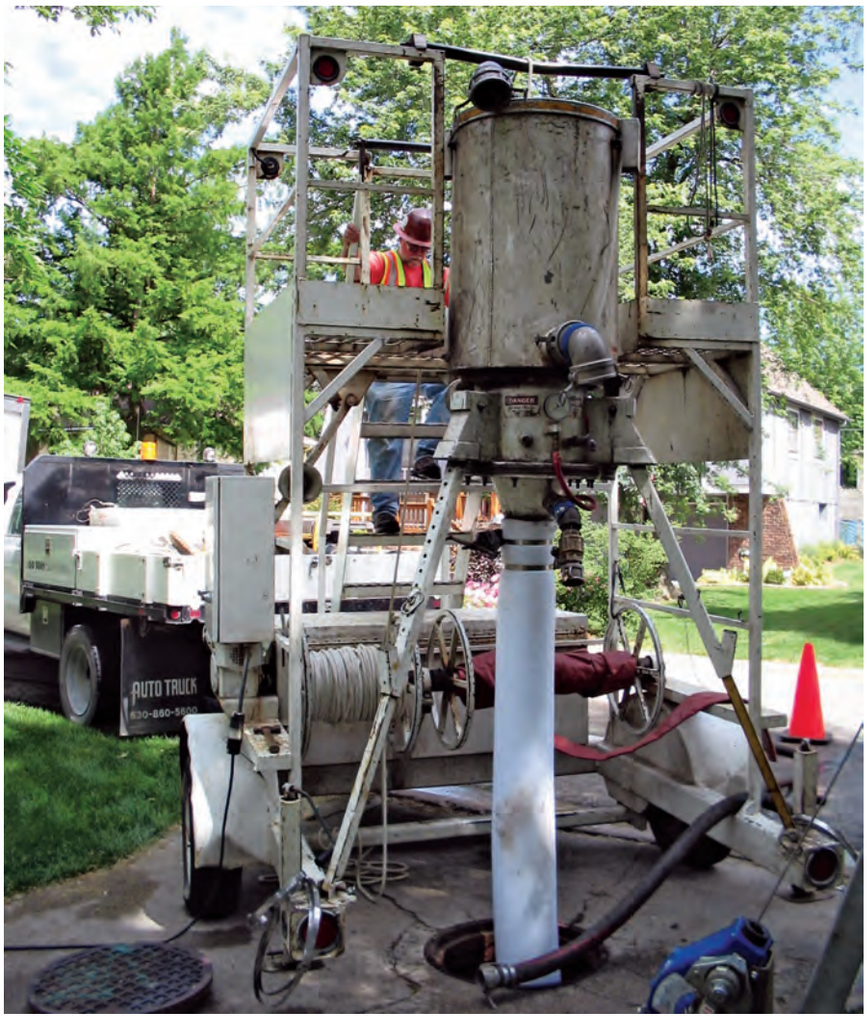
Tips for a Successful Rehab Installation

BY LYNN OSBORN AND GERRY MUENCHMEYER

A successful rehabilitation installation involves, quite simply, preparing and implementing a plan. Although easy to say, it's not quite that simple when dealing with all the moving parts of an actual project. As a result, NASSCO has developed some tips for completing a quality rehabilitation project.

Although these tips focus on cured-in-place pipe (CIPP), many of these principles can be applied to other rehabilitation products. Depending on the nature of the contract, some of the following items can be performed by the owner, some by the engineer and some by the contractor.

1. Determine the rehabilitation requirements. The purpose can be structural rehabilitation, reducing infiltration, addressing corrosion in concrete sewers or a combination of requirements.
2. Select the correct technology. Based on the project requirements and expected results, select the correct technology.This may involve some research of product technical information. The product design, application, location and access should also be considered when selecting a technology.
3. Prepare the design to meet rehabilitation requirements. For CIPP, design often means calculating the minimum wall thickness required based on the physical properties of the technology selected, the design parameters and the purpose of the project. Design also includes selecting the proper materials for the project and the appropriate installation approach. For example, a 72-in. pipeline rehabilitation project may require that the wet-out and installation be performed at the field installation location.The engineer may designate a specific location for access. Because of the distance between manholes, an on-site wet out may need to be accommodated in the design.
4. Prepare detailed technical specifications.The technical specifications of the contract documents are the instructions for the contractor to furnish a specified product or completed project that meets the contract requirements. The technical specifications also instruct the inspector as to what needs to be observed, inspected, measured, tested and documented to ensure that the product meets the contract requirements.



Performance specifications where the contractor defines the means and methods for installation of the work are preferred. Performance specifications allow the contractor to use innovative means which are at his or her disposal to deliver the specified product at a defined level of quality, at the lowest cost for the owner.A well written specification defines:

a. Existing conditions
b.The selected rehabilitation product
c. Work required by the contractor and the inspector
d. Submittal requirements
e.The product quality level required
f. Required quality controls, including specific ASTM requirements
g. Required quality assurance practices during construction
h.The required measurements through inspection and testing
i.The warranty inspection procedure

An example Performance Specification Guideline, for CIPP, is available from NASSCO at *nassco.org* under "Publications & Specifications."

5. Bid and award the project to the best qualified and most responsible bidder with the lowest competitive price. In some cases contractor pre-qualifications are required to bid the work.
6. Performance Work Statement (PWS).As a part of the submittal process, the contractor prepares a detailed PWS outlining the

installation plan including the proposed means and methods to be employed, by the contractor, to complete the project. The PWS provides information that the inspector can reference throughout the project. Examples of what may be included in the PWS include:

a. Statement of product conformance to the contract documents
b. Installation to manufacturer's recommended standards
c. Detailed installation plan
d. Statement of contractor experience and description of lead personnel
e. CIPP wall thickness design
f. Manufacturers' technical data
g. Listing of redundant tools and equipment
h. Proposed public notification program
i. Safety plan
j. Quality plan
k. Odor control plan
l. Recommended CIPP repair and replacement procedures, if required
m. Others

7. **Inspection.** Have a technology-trained inspector onsite to observe, measure, inspect, document and test the materials provided and confirm the quality of the delivered product. This includes all measureable requirements described in the contract documents. The inspector also ensures that the contractor's submitted means and methods are implemented.
8. **Develop a warranty inspection checklist.** The inspector prepares a warranty checklist typically consisting of 10 to 15 percent of the installed product. The checklist represents work quality issues observed and documented during installation.
9. **Perform warranty inspections.** Pipelines on the checklist should be re-inspected at least one month before the end of the warranty period. The inspection should be by the owner or a third-party contractor. If deficiencies are found, the amount of sewers to be re-inspected can be increased, if necessary. Extended warranties may be applied for portions of the project that have not met the requirements of the contract, are defective or have been repaired.
10. **Make repairs if applicable.** Any necessary repairs are made in accordance with the CIPP repair or replacement procedures submitted with the PWS.

A key element of a successful project is to achieve a quality installed product. To help ensure this, have a trained, knowledgeable inspector on the jobsite. In order to define the inspector's role and authority, quality controls and assurances must be outlined in the contract documents and all submittals, specification requirements and referenced standards are available to the inspector. The following are suggested quality checks before, during and after installation.

1. Inspections and quality checks before and during installation:
   a. **Materials, including the tube and resin, as specified.** Manufacturers' technical information and testing data, including shipping, storage and handling recommendations, are reviewed. Safety Data Sheets (SDS) are received and reviewed.
   b. **Amount of resin required for tube wet out as supplied by the tube manufacturer.** Resin quantity, per unit length for each size tube on the project, is determined through information supplied by the manufacturer. Each wet out tube is checked for the proper amount of resin by reviewing the tube wet out sheet and comparing the amount of resin used to the manufacturer's required amount.
   c. **Condition of host pipe just prior to installation.** The host pipe is inspected, typically through CCTV using the Pipeline Assessment and Certification Program (PACP), just prior to installing the liner. The inspector should be knowledgeable on the different conditions that can occur in a sewer and should be able to determine if a sewer can be rehabilitated to specified standards, or if it must first be cleaned and/or repaired.
   d. **CIPP curing schedule.** Since the cured resin forms the body of the CIPP, correct curing is very important. The cure schedule is based on the manufacturer's requirements and contractor performance for different field conditions. Cure is monitored and compared to the submitted manufacturer's recommended schedule.
   e. **Workmanship of lateral connections.** The inspector verifies that the contractor leaves a clean, smooth opening within tolerance, meeting the contract-specified requirements.
2. Inspections and quality checks after CIPP installation:
   a. **Visual inspection.** Inspection of the final product, typically by CCTV, verifies a defect-free and functionally operating system. The CIPP should be continuous over the entire length of the installation run and free of dry spots, lifts, delamination and other defects. Any defects located are repaired in accordance with the contract documents and PWS.
   b. **Physical properties.** The physical properties of the installed CIPP are determined through independent testing by the owner and compared to the values specified or submitted for wall thickness design. The contract documents should define a remedy if the test results are below specified requirements.
   c. **CIPP thickness.** Wall thickness is measured and compared to the approved design for each installed CIPP. The contract documents should define a remedy to be used if the tested thicknesses are below approved thickness.
   d. **Chemical resistance.** Resistance to corrosive agents in the waste stream is typically certified by the resin manufacturer in accordance with ASTM requirements.
   e. **Water tightness.** Leakage is tested as specified in the contract documents. Testing options include an exfiltration test, low pressure air test and a visual inspection for infiltration.

Detailed planning by the engineer and the contractor, followed by execution of the plan, is required for a successful pipe rehabilitation installation. In order to ensure quality product installation, quality control and quality assurance, requirements should be specified in the contract documents. The contractor installs the products in accordance with the contract documents and the submitted PWS and a trained and knowledgeable inspector then observes, inspects, measures, tests and documents before and during product installation and then assures final product quality once the product is installed.

Lynn Osborn is techical director and Gerry Muenchmeyer is past technical director at NASSCO.

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BY MIKE RUSSIN AND RAJ PATIL

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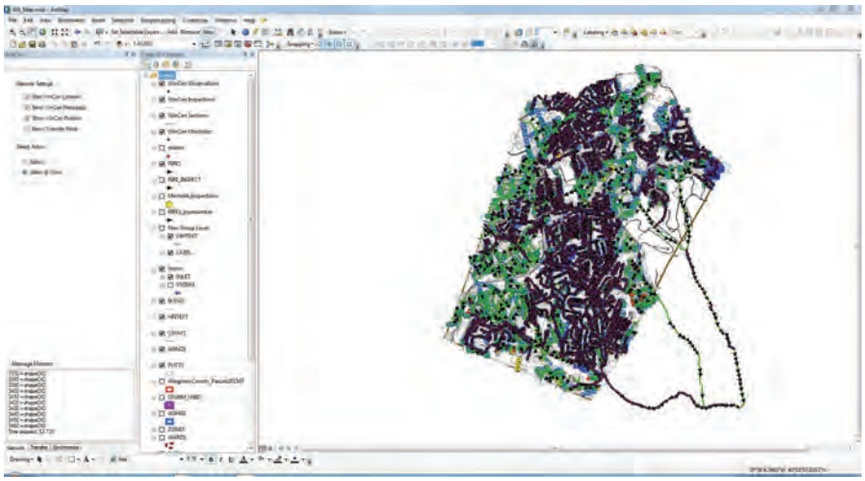
As a result, Bethel Park Municipal Authority acted in a timely manner by developing and putting in place a plan to manage regulatory compliance of sewer infrastructure operations through proper procedure, systems, tools and reporting structures. For more than 15 years, the municipality has been conducting televised inspections on a routine basis using WinCan as part of its CCTV-based asset condition inspection and assessment program. These procedures and processes have been improved upon over this period with corresponding improvements in technology, workflow optimizations, public outreach programs and best management practices (BMPs).



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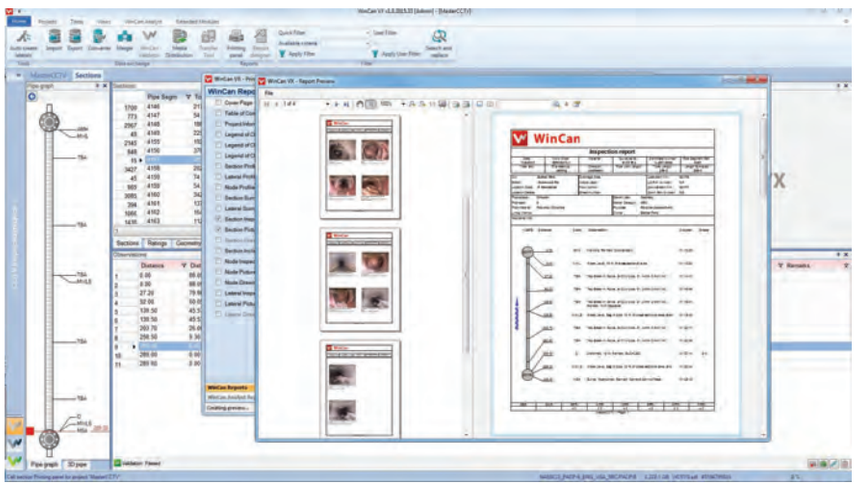

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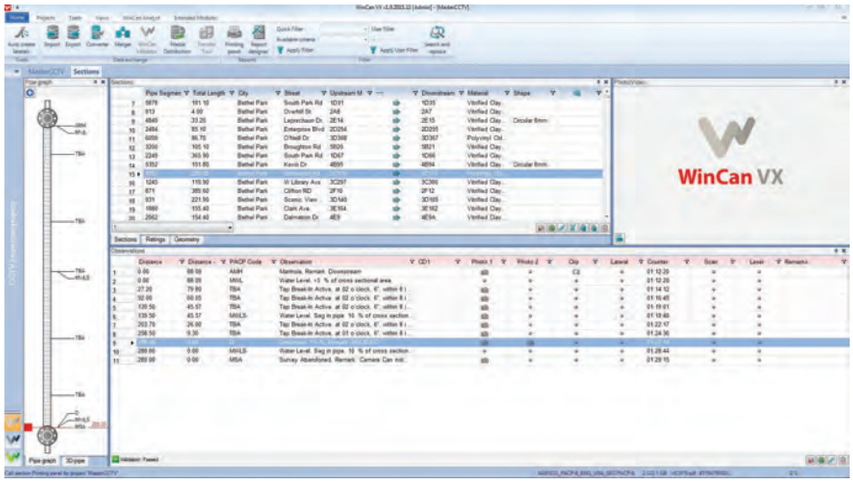
Following the adoption of WinCan — the oldest CCTV solution in the global industry today — this process was streamlined. The delivery of highly digitized data using efficient storage media made it a lot easier and faster to manage the data collection and reporting

operation. Further, the seamless use of defect codes from NASSCO enabled the municipality to readily adapt to an industry standard inspection management program and strengthen its compliance efforts.

So far in 2015, more than 35,000 ft of lines have been identified and rehabilitated through the inspection process that occurs on a 52-week, five day-week schedule. The municipality is now using WinCan VX, the latest version which includes, among a host of features, the ability to publish inspection data and videos in the cloud for anyone to look at any time and from anywhere. Staff also likes the robust mapping capability it offers. Besides allowing them to visualize their assets on a map, it also provides powerful and easy options for querying and exporting data into popular GIS systems such as Esri ArcGIS. For example, users find it very easy to query pipe material, identify and address the problem areas such as root intrusion, water infiltration and various other defects. This saves them a lot of time they would otherwise spend documenting such issues.



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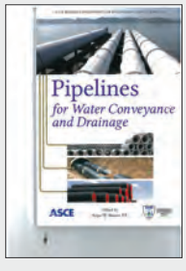

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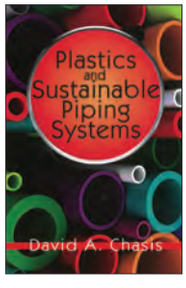

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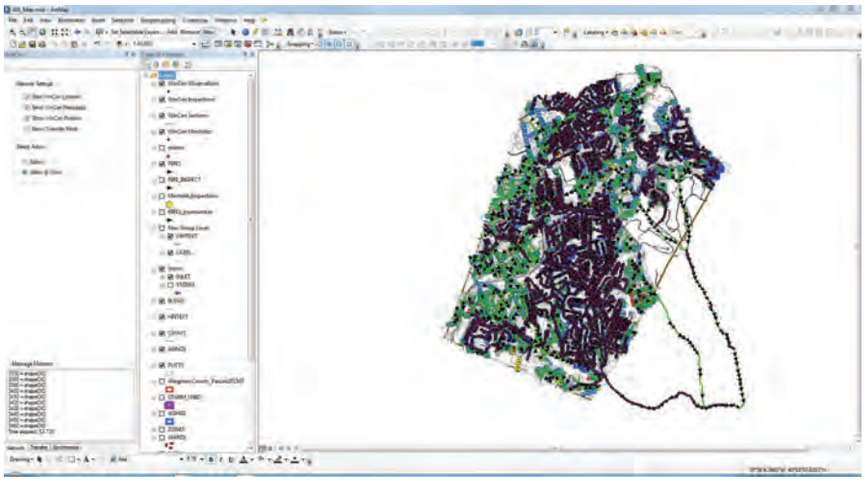

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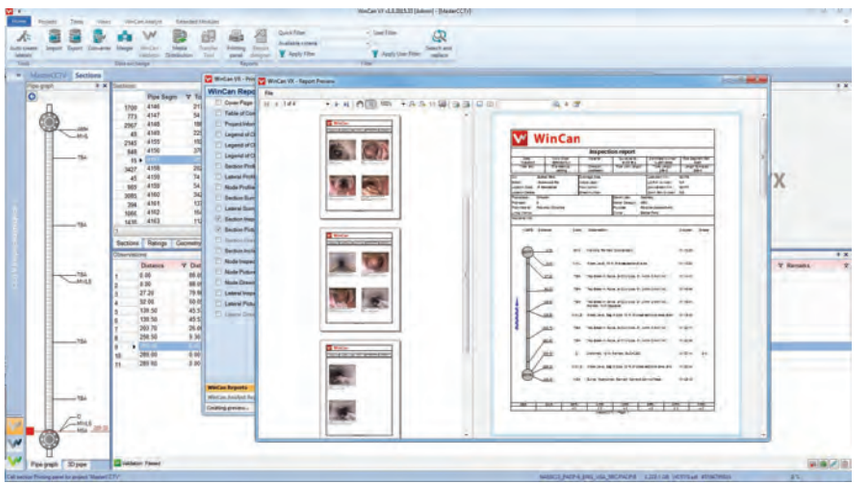

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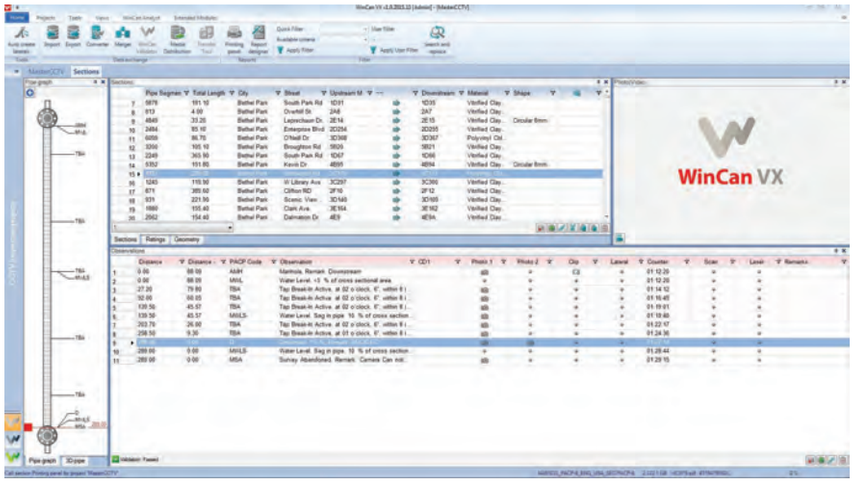

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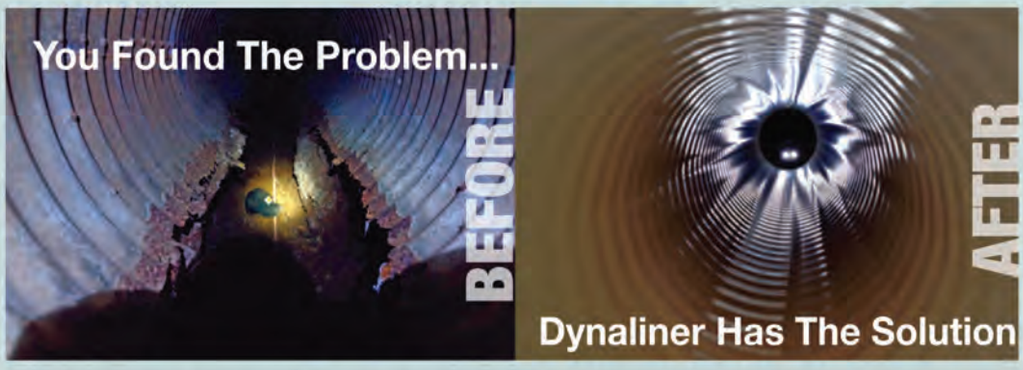

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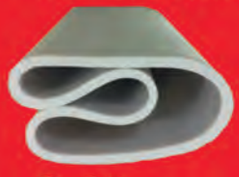

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UV CIPP

For Environmentally Sensitive Area Projects

BY MICHAEL A. HOFFMASTER

Whether it is a new project or a rehabilitation project, working in Environmentally Sensitive Areas (ESA) presents unique challenges. The Washington Suburban Sanitary Commission (WSSC) has encountered these same ESA dilemmas as it continues working on sewer-main improvements to its collection system.

WSSC is the eighth largest water and sewer utility in the United States and is responsible for more than 5,400 miles of sanitary sewer pipelines. The utility serves more than 1.8 million residents in Montgomery and Prince George's counties in Maryland, which are situated in the Washington, D.C., Metropolitan Area. Over the years WSSC has utilized a variety of trenchless rehabilitation technologies as part of its system upgrades.

Like many other sewer authorities, WSSC is currently working through a Consent Decree Order issued by the U.S. Environmental Protection Agency (U.S. EPA). Pleasants Construction is one of the contractors that has partnered with WSSC to implement the improvements necessary to their infrastructure. Pleasants Construction, a Montgomery County, Md.-based construction company, is also a certified installer of Reline America's Alphaliner.

The rapid growth of UV CIPP in the United States seems to be following the same pattern seen in Europe where it has gained the largest market share in the CIPP industry.

According to Ron Callahan, a project manager for Pleasants Construction, "WSSC's ESA contracts have involved working in areas with parklands, protected wildlife regions such as Bald and Golden Eagle Protection, wetlands, residential neighborhoods and fish rescues as part of stream restoration work."

Additional considerations on the contracts involved disruption to residential property and daily routines, topographical challenges (drastic elevation and terrain changes) on the project site and access to the work area. The work being performed had to comply with the mission statement of WSSC, which is "We are entrusted by our community to provide safe and reliable water, life's most precious resource, and return clean water to our environment, all in an ethical, sustainable, and financially responsible manner."

When faced with the decision regarding relining of a pipe WSSC has frequently used Reline America's Alphaliner, a fiberglass-reinforced cured-in-place-pipe (CIPP) liner cured using ultraviolet (UV) light. Utilizing this method of trenchless technology allowed WSSC to meet the goal of its mission statement.

According to Steven Radosevich, an engineer and administrative contract manager with WSSC, "WSSC applies a holistic

approach of the asset (repair technology) when evaluating a project. They take into consideration the fact that when they use fiberglass-reinforced UV CIPP, a much thinner liner thickness is able to be used."

Despite its thinner wall thickness, fiberglass reinforced CIPP has much greater strength than other CIPP methods.

WSSC also evaluates the product lifecycle before deciding on the technology it selects to implement. Since the liner is much thinner, it translates to less of an impact on the pipe diameter. This makes the pipe better suited for future relining, if needed, once the liner reaches it 50 to 75 year life span. Liners with thicker walls could result in dig and replace methods when future rehabilitation becomes necessary. This is not only more expensive but also more environmentally invasive.

"Another advantage to using UV CIPP is that it is controllable, predictable and accountable. I can see that every foot of the CIPP was cured properly," says Radosevich.

This is achieved through the use of Reline America's "Quality Tracker System." The Quality Tracker System is a computer-controlled curing and documentation system that allows for the monitoring and controlling of the entire curing process while providing supporting documents at the end of the installation to the municipality and/or engineering firm. The Quality Tracker System allows the installer to view the liner via CCTV once it has been pulled into place and fully inflated inspecting the liner for defects prior to curing. The built-in infrared sensors monitor and record every foot of the curing process.

Because of the smooth finish on the inside of the fiberglass reinforced liner Radosevich says it was another reason to use it in their collection system upgrades. The finished interior surface is similar to PVC pipe. While all CIPP reduces the inside diameter of the host pipe, in most cases, the UV CIPP actually increases pipe flow capacity due to the new surface being much smoother than the original host pipe and the liner thickness being so thin.

Furthermore, UV CIPP has less environmental impact compared to other CIPP technologies. Fewer pieces of equipment are required and the trucks necessary for liner installation are smaller permitting access to hard to reach areas more easily. On larger diameter trunk lines the cure time is shorter when using UV light technology resulting in less energy consumption. The temporary access roads required for UV CIPP into ESA's do not have to be as large or heavy duty as with other technologies, reducing environmental impact on the surroundings. The faster cure results in less money and energy spent on bypass pumping, as well.

Since the UV CIPP liners have a much longer shelf life, it allows WSSC (and municipalities) more time to make informed decisions as compared to liners with very short storage life. If issues arise once the bypass and cleaning have taken place the municipalities have the ability to make the right choice for each situation with the knowledge that they will not have to pay for a liner that expires. Reline America's Alphaliner has a six month minimum shelf life (with no refrigeration required). The long shelf life allows for Reline America, which is located in Saltville, Va., to ship the Alphaliner to their certified installer throughout North America.

The rapid growth of UV CIPP in the United States seems to be following the same pattern seen in Europe where it has gained the largest market share in the CIPP industry.

Michael Hoffmaster is business development manager at Pleasants Construction.

KANSAS CITY SPR

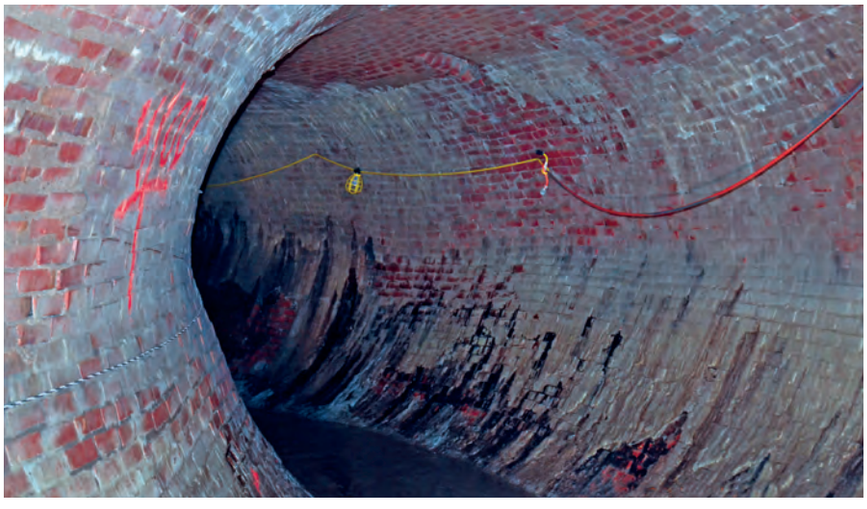
Kansas City Water Services Turns to Spirally Wound Relining to Rehab Circular Brick Combined Sewer

BY BRENT ADAMS

Kansas City Water Services desired to rehabilitate a 125-year-old original 114-in. circular brick combined sewer due to its age, deterioration and deflection. Ultimately, a crack had formed in the crown of the structure, affecting the structural integrity of the pipe. The sewer rehabilitation project at 22nd Street & Paseo — under four lanes of heavy duty traffic — is located in the heart of Kansas City, Mo., along the Paseo Parkway.

Design considerations had to include not only sheer size, but many other challenges such as depths up to 35 ft from surface to invert, flow levels averaging 10 to 14 in. during normal operations, bypass pumping (technology dependent), storm surcharging, soil considerations, slope, limited access and two sweeping 90 degree bends with tight radii.

Various technologies were included in the initial assessment, such as: Shotcrete, CIPP, CCCP, FRP sliplining and SPR. Each technology had their particular strengths and weaknesses in regards to maintaining 100 percent of the existing capacity, fully structural design and provide a 50-year solution. The final approved technologies were CCCP, sliplining and SPR.



GETTING STARTED

The project was competitively bid in February 2014 with an anticipated start for mid-summer of that year. Before award of contract was granted, a third

party stamped design was provided by Brierley Associates to KCMO for the SPR technology. Once the submitted design was received, reviewed and approved by KCMO Water Services, SAK Construction LLC was issued a firm contract and a formal notice to proceed. As a result, construction started in late August 2014. The Sekisui process uses a PVC-based material that is spirally wound into an existing pipeline. Successive wraps of profile are locked together and the annular space between the wound profile and host pipe is grouted. The result is a strong composite pipe integrated with the existing pipeline.

The SPR design called for the installation of a 100-in. ID SPR 102SRW liner with steel reinforcement that is integral within the profile. The primary reason behind using the 100-in. ID liner was due to internal dimensions of the host varying from 108.5 in. to 114 in. with significant deflection at the 4 o'clock and 7 o'clock positions in the crown of the pipe. The dimensions were verified by SAK, using laser profiling equipment, taken every 4 ft. By using the SPR process, the cross sectional loss still increased existing flow capacity, while also providing a fully structural 50-year solution.

WEATHER CHALLENGES

As construction progressed, another encounter was faced head on: Mother Nature. On three separate occasions, SAK personnel were forced to exit the pipe due to rising water from thunderstorms within that particular basin. SAK and KCMO developed and synchronized a communication network between local and national weather services, and the KCMO storm alert system was able to determine when they could safely enter and exit the pipe. Once the storm alert was signaled, SAK would secure the SPR winding machine to the host, cut the PVC profile, remove all ancillary items and safely exit the pipe. After the event had passed and water subsided to manageable levels, the machine was cleaned, profile was re-fed into the machine and construction continued.

The successful winding, bracing and grouting of the 100-in. SPR profile occurred in a continuous live combined sewer through two tight, opposite 90 degree bends. This was completed through existing manhole structures and one new access that the owner required. Matt Thomas of KCMO said, "This was the first for us in Kansas City, using the SPR product. We are very pleased with the performance of the contractor and of the product during the installation process of the project. We look forward to use this type of trenchless technology installation for future projects."

KCMO also noted that, due to the small footprint and not having to open additional access locations, there was very minimal interruption to traffic flow on the Paseo Parkway. The traffic control on 22nd Street was limited to one lane closure for less than two weeks over a 200-ft section while the profile was being fed down the existing manhole.

The project was completed on time, on budget, while having nearly zero impact on the local community. Most importantly, SAK and Sekisui were able to provide the fully structural, 50-year design with improved hydraulic flows for the 125-year-old combined sewer.

Brent Adams is SPR division manager at Sekisui SPR Americas LLC.

CIPP FOR DRINKING WATER MAINS — A RETROSPECTIVE

BY JIM RUSH

It's no secret that North America faces serious challenges to keep its sewer and water systems up to date. According to a 2012 report by the American Water Works Association, the United States alone must spend $1 trillion over the next 25 years to keep pace with updating aging infrastructure and meeting the demands of a growing population — and Canada's drinking water infrastructure is in a similar situation. According to the website *watermainbreakclock.com*, there are 850 water main breaks in North America every day, resulting in billions of dollars worth of repair cost.

So what is the best way forward?

For many years, trenchless technologies have played an important role in maintaining and upgrading sewer and water infrastructure. Introduced in the United Kingdom back in 1971, cured-in-place pipe (CIPP) has been employed on a wide scale by sewer system operators, but CIPP for drinking water infrastructure lagged behind. The reasons for the lag included addressing technical challenges associated with relining pressure pipe, regulatory requirements and approvals for use in drinking water systems and gaining cultural acceptance of new technology from the traditionally conservative drinking water industry.

As with the start of many technologies, there were a few pioneers in drinking water CIPP who led the way, showing the real-life benefits of the new technology that served as examples for others to follow. In Canada, one of the pioneering companies is Quebec-based Sanexen, developers of the Aqua-Pipe CIPP product for drinking watermains. Today, the company is installing its CIPP product throughout the country and in the United States, giving water system operators a valuable tool in addressing their infrastructure needs. Sanexen began by completing pilot projects in Montreal around 2000, before beginning larger programs in Ottawa and then Toronto that began the growth curve for CIPP in the country.

TALE OF TWO CITIES

The City of Ottawa was the first city outside of Quebec to use CIPP relining for water mains — and with great success, said Mike Willmets, currently the executive director of NASTT and formerly a project manager for the Region of Ottawa-Carleton and later the City of Ottawa. In fact, since beginning its watermain relining program in 1998 through the end of 2007, Ottawa had lined approximately 140,000 ft of pipe, including epoxy and structural lining.

Ottawa got its first taste of trenchless watermain relining in the late 1990s with the use of epoxy lining — primarily as a way to reduce costs related to road repairs. "Our trenchless program came out of necessity more than anything," Willmets said. "If we had a bad watermain, we had to dig it up, which was expensive. It was even more expensive if you had to fix the road from curb to curb, which was often required by the municipalities within the Region. So, we started looking at alternatives."

One of the clearinghouses for technologies is the Centre for Expertise and Research on Urban Infrastructure (CERIU) in Montreal, which is where Willmets first came to know the epoxy lining and structural CIPP lining technologies for watermains. Coincidently, Joe Loiacono, who would later serve as business development manager for Sanexen, was CERIU director at that time. It was also there that Willmets teamed with consultant (and future NASTT chairman) Piero Salvo, who had just started WSA Consultants.

After successful projects using epoxy lining, including a quick turn-around in the affluent Rockcliffe Village neighbourhood that demonstrated the benefits of trenchless, Ottawa began to use the emerging structural CIPP product from Sanexen.

"We had seen the product and knew that it would stand up to just about anything. It had also been approved by the WRc

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Which title group best describes your job title?
(check only one)

A ☐ Owner/Partner
B ☐ President
C ☐ Vice President
D ☐ C.E.O.
E ☐ C.O.O./C.F.O.
F ☐ Manager/Coordinator/Admin.
G ☐ Supv./Foreman/Insp.
H ☐ Superintendent
I ☐ Engineer/Estimator/Consultant
J ☐ Director/Commissioner
K ☐ Safety
L ☐ Operator/Field Personnel/Technician
K ☐ Other; Specify:_____

How would you describe your primary trenchless activity?

☐ Rehabilitation ☐ New Installation ☐ Both

What is your company's primary function? (check only one)

CONTRACTING FIRMS
A ☐ Utility
B ☐ Distribution
C ☐ Road Boring/ Directional Drilling
D ☐ Tunneling
E ☐ Pipeline
F ☐ Cable
G ☐ General
H ☐ Pipe Cleaning
I ☐ Other; Specify:

ENGINEERING FIRMS
J ☐ Construction
K ☐ Geotechnical
L ☐ Environmental
M ☐ Pipeline
N ☐ Other; Specify:

GOV./ PW
O ☐ Water and Sewer
P ☐ Gas and Electric
Q ☐ Other; Specify:

UTILITY COMPANIES
R ☐ Water and Sewer
S ☐ Electric
T ☐ Gas
U ☐ Cable/Telephone
V ☐ Other Utilities; Specify:

INDUSTRIAL FACILITY
W ☐ In-House Contracting
X ☐ In-House Construction
Y ☐ In-House Engineering
Z ☐ Other; Specify:

MFG/SUPPLIER
1 ☐ Manufacturer
2 ☐ Rehabilitation Systems
3 ☐ Pipe Manufacturer
4 ☐ Pipe Cleaning; Mfg/Supplier
5 ☐ Other; Specify:

OTHERS IN THE TRENCHLESS INDUSTRY
6 ☐ Consultant
7 ☐ Library
8 ☐ Student/Professor
9 ☐ Other; Specify:

in the United Kingdom for use in drinking water systems, so we decided to use it," Willmets said. The first contract called for epoxy resin in areas where the pipe was in decent shape, and structural CIPP on sections that suffered from many breaks.

"We completed that contract and it was incredibly successful, so we issued another $1 million contract to keep it going," Willmets said.

The City of Toronto's experience with structural CIPP watermain relining goes back almost as far as Ottawa's, according to Kamran Sarrami, senior engineer with Toronto Water. "We started testing and experimenting with watermain CIPP starting around 2001, and after a couple of years when we were satisfied, we started tendering contracts for CIPP," he said.

Sarrami said that before using CIPP, Toronto Water had used cement mortar lining as an alternative to open-cut replacement. Now, cement mortar lining has been essentially phased out. "When you compare cement mortar lining to CIPP many of the costs are similar — mobilization, labor, replacing valves and hydrants, clean and prep, setting up the bypass, etc. At that point, it becomes worth the incremental cost difference to use structural CIPP and get a solution that will last for 50 years."

The benefits of trenchless solutions are well-documented, including cost-savings, time-savings and reduced disruption to residents and businesses. Not only were those benefits being realized in direct comparison to open-cut replacement, but Ottawa and Toronto were getting up-to-date infrastructure that is expected to last at least 50 years.

Sarrami said that the City of Toronto had experience using CIPP for sewer mains and has taken an aggressive approach to implementing new technologies in the past, so Toronto Water wasn't hesitant to try a new approach. "We felt like there were many benefits to using CIPP and we wanted to take advantage of them as best we could," he said.

He added that the CIPP process has benefitted from the combined efforts of many parties. "The engineering consultants, testing facilities and especially the contractors/installers have all contributed greatly in advancing this technology and making water main CIPP better in general," he said.

IMPROVEMENTS

One of the most challenging aspects to the new technology, according to Willmets and Sarrami, was ensuring that connections to the main and house service could be re-opened. In early iterations of the CIPP technology, services could tend to get plugged with resin, which added time and expense to expose and replace the connections. However, Sanexen began inserting a plug that is robotically drilled out after liner installation to prevent blocked services.

Additionally, camera equipment includes the ability to survey the lined pipe while providing GPS coordinates, which allows for as-built maps. "We now have as-built maps for pipe that we previous didn't have — especially for those going under creeks, highways and buildings," Sarrami said.

Sarrami said that Toronto Water spends about $30 million annually for CIPP lining, which equates to 15 to 20 km per year, mostly small-diameter mains. In 2014, however, Toronto Water lined two large-diameter pipes — 750 and 900 mm — although the vast majority of pipes relined are in the range of 6 to 12 in.

BENEFITS OF TRENCHLESS

The benefits of trenchless solutions are well-documented, including cost-savings, time-savings and reduced disruption to residents and businesses. Not only were those benefits being realized in direct comparison to open-cut replacement, but Ottawa and Toronto were getting up-to-date infrastructure that is expected to last at least 50 years.

"In our case in Ottawa, we replaced all hydrants and improved the valving in conjunction with the lining program so that everything was up to today's standards," Willmets said. "On top of that, we were able to save a substantial amount of money vs. open-cut. So, we essentially were able to rehab a system that should last for years at a fraction of the cost … it is a really good way to go."

Sarrami concurred. "We know that once we go into a subdivision and bring it up to date, we shouldn't have to go back there for 50 years," he said. He estimated that Toronto Water saves 50 percent in construction costs compared to open-cut.

While beginning as a tool used strictly in the capital program at Ottawa, structural CIPP became a tool used for emergency repair too.

"To repair a typical main break, you dig down, cut out the broken pipe, replace it, and clamp either end," Willmets said. "But when the pipe is badly deteriorated, clamping the pipe becomes difficult, if not impossible. So, CIPP can be an effective tool in those cases. In fact, that is how our operations people began to embrace CIPP, and it took on a whole new life."

Other cities across the county and the continent are following suit. According to Sanexen, over the last 14 years, more than 350 cities have used structural CIPP to reline more than 400 miles of water mains to date throughout North America.

"The growth of CIPP for drinking watermains has been phenomenal," Willmets said. "The products have continued to improve and there are more of them now. It will save communities tons of money while minimizing the impact on residents and businesses."

Jim Rush is editor of *Trenchless Technology*.

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COLORADO CULVERT

Sliplining Used to Rehab Collapsed Pair of CMP Pipes

BY CHELSEA RABIDEAU

In mid-May 2015, a large corporation in the Boulder, Colo., area experienced a serious situation on its property when a pair of 48-in. elliptical corrugated metal pipes (CMP) collapsed in the immediate vicinity of many critical utilities.

The pipes were located at the very end of the stormwater system that handles all of the stormwater for the west side of the property. The pipes were connected to an existing concrete collection vault then ran 120 ft with the last 40 ft under an access road before discharging to an open stormwater ditch.

When the pipe collapsed, it interrupted site stormwater drainage during an unusually wet Colorado spring creating severe flooding on the property. Without a quick repair, the company was looking at significant ongoing costs for temporary measures and the possibility of severe damage to underground infrastructure systems. The company asked Fluor, one of the world's largest engineering and project management companies, to find a solution to the emergent situation.

"Part of the problem was that a section of the pipe itself ran under an existing access road that had critical utilities running through it. The prospect of digging up and replacing that section of the culvert was costly. So, we started looking for options to sleeve the pipe, but found limited solutions for oval pipe," explained Fluor project coordinator Jim Smith.

The project team looked at the possible solutions to the complicated problem and decided to go with Snap-Tite, an intelligent, cost-effective rehabilitation system. It uses lightweight, flexible and durable high-density polyethylene (HDPE) pipe to rehabilitate, and often outperform, corrugated metal. Fluor found that HDPE has tremendous advantages over

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concrete and corrugate metal replacement or repair. The Snap-Tite system segments could be "snapped" together, creating a water-tight seal at all joints.

Another concern with lining the pipe was a reduction in flow rate through the pipes. "We found that by sliplining the culverts with Snap-Tite, we actually increased the flow rate," Smith said. The system's joints are machined on the end of PE 3408 high density polyethylene pipe. The result is a water-tight joint whose inside and outside diameters are the same as those of the pipe.

Each of the pipes run approximately 120 ft through the affected area. Fluor was forced to excavate an area 80 ft long and 20 ft deep to remove the unsalvageable corrugated metal pipe and the remaining 40 ft of pipe stayed under the access road. Removing the remaining 40 ft of CMP under the access road was not an option. The drainage water needed to be continuously pumped away from the site of the damage and the underground utilities. That process was costing the company upward of $20,000 per day. This collapse needed to be fixed and fixed quickly.

"Once Snap-Tite received the order, they quickly processed the pipe in their Kingman, Arizona plant and delivered it to the site in Colorado," said Russ Wosk, Snap-Tite's regional manager. Fluor then tasked one of their contractors, Trautman and Shreve to install the new Snap-Tite pipe.

Because the existing corrugated metal pipe was elliptical shaped, Snap-Tite provided oval pipe to slide into the existing pipe under the access road. Snap-Tite then created a custom length of pipe that was ovaled only halfway. The remaining length was left the standard round and continued through the open-cut section. All of this work was done fairly quickly using a standard track hoe. Concrete contractor Thorcon tied the pipeline into the concrete vault with a poured concrete collar. Thorcon also completed the grouting process for the liner inserted under the access road. They mixed concrete and water to create a very flowable mix which they then pumped into the annular space between the existing CMP and the new Snap-Tite liner pipe.

"This process is used to not only fill and seal that annular space, but it also fills all the holes and voids that exist in and behind the existing CMP. It is these holes and voids that have played a major part in the failure and collapse of the existing pipe," explained Wosk.

It was also very important make sure all the stormwater coming from the drain in the adjacent parking lot was directed into the new HDPE pipeline. "Because the large area in between the driveway and the vault had been excavated, the drain pipe from the parking lot was also exposed," Wosk said. "They needed to be able to tie in this 24-in. concrete pipe to the new Snap-Tite HDPE pipe."

The process was relatively simple. The contractor cut a hole in the side of the Snap-Tite at the location of the incoming concrete pipe. He then took a small length of solid wall HDPE pipe with a slightly larger ID than the OD of the concrete pipe and slid it on the concrete pipe. He then matched the new piece of HDPE up to the hole on the Snap-Tite and used a process called Extrusion Welding to permanently attach it. This allowed all the drainage from the parking lot to now be captured and flow out to the storm water ditch.

The entire event from the collapse to the time the pipe was rehabilitated and buried took a little under six weeks. Snap-Tite was able to provide onsite support throughout the entire process. "It was extremely positive and working with Fluor was terrific," Wosk noted.

Chelsea Rabideau is public relations coordinator at ISCO.

THE PIPES WERE CONNECTED TO AN EXISTING CONCRETE COLLECTION VAULT THEN RAN 120 FT WITH THE LAST 40 FT UNDER AN ACCESS ROAD BEFORE DISCHARGING TO AN OPEN STORMWATER DITCH.

BREAKING WITH TRADITION

A Midwest City Turns to CIPP to Rehabilitate Water Main

BY DAVID ROSENBERG

All cities have traditions they are known for, whether it's specialty foods or holiday celebrations. There is comfort in those long-held localized traditions. But sometimes a break from tradition is precisely what is needed to solve a challenge in an effective and efficient manner.

In June, Michels Pipe Services used cured-in-place pipe (CIPP) technology to line a 16-in. water main that needed to be fixed without causing major disruptions to the surface above it in a major Midwestern city.

Michels Pipe Services is a division of Michels Corp., based in Brownsville, Wis. Michels is among the largest, most diversified utility contractors in North America. Michels Pipe Services uses CIPP technology to rehabilitate sanitary sewers, storm sewers and water mains in the United States and Canada.

General contractor James McHugh Construction Co. called on Michels to rehabilitate 302 lf of a deteriorating steel water main that is used by a metropolitan water district. The city had not previously used CIPP to rehabilitate water mains. The municipal line stretched under one of the busiest interchanges in the metropolitan area, crossing under eight lanes of traffic and two commuter rail tracks in a busy urban area. McHugh is reconstructing the interchange for the customer.

CHOOSING CIPP

The challenging location meant a structurally sound solution was essential, but the high volume of traffic coupled with ongoing construction in the area rendered open-cut options not viable.

CIPP was the best solution for this project for several reasons.

During the CIPP process, an epoxy-impregnated liner is inverted into the host pipe. Once the liner was completely cured, the new pipe-within-a-pipe is pressure-tested. On this project, Michels used air inversion to install the liner and steam to cure it. It was pressure tested to 70 psi to meet the customer's requirements.

Another advantage is that with proper planning and permitting CIPP installations can be completed much quicker than open-cut projects. The contractor had given Michels a 10-day window to complete installation of the liner. It was finished in half that time — an efficient five days. Thanks to the onsite efforts of Michels' CIPP crew led by Jason Gubin,

the project was completed ahead of schedule and on budget. Planning by the McHugh/Michels team was critical and extensive though. In total, it took about four months and several meetings to obtain all necessary approvals to proceed with the work.

PROJECT CHALLENGES

Michels needed to overcome several challenges to successfully complete the project.

Access to the water main was 30 ft deep at the upstream access point and 8 ft deep at the downstream access point, and less than 10 ft away from the on-bound ramp to the interstate. McHugh faced a difficult task of excavating a 30-ft shaft and installed a concrete chimney to gain access to the host pipe.

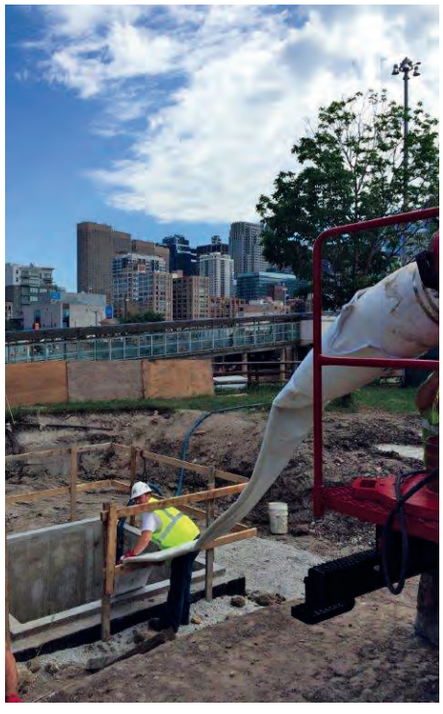
Once the shaft was prepared, another major challenge was finding a time to shut down the on-bound ramp to gain access to the downstream pit. The shutdown had to be coordinated with the state's department of transportation, city officials and the visitor and convention bureau to find a time when traffic back-ups would not interfere with preplanned activities. Because the downtown area is packed with summer activities, there were only three weekends that all three would allow the contractor to shut down the on-bound ramp to the freeway.

As a result, Michels adhered to a tight schedule to complete the necessary preparation and get the installation started without any delays.

For this project, Michels used a NordiTube lining system manufactured by Sekisui SPR Americas LLC, which is a pressure-rated CIPP liner that is certified to the NSF/ANSI 61 Standard for potable water. The liner was saturated with epoxy resin at Michels' wet-out facility in Brownsville, about 150 miles away, and shipped to the jobsite in a refrigerated truck.

Michels Pipe Services continues to grow its CIPP installations throughout North America and has become a leader in trenchless technology and pipe rehabilitation.

David Rosenberg is senior manager, water rehabilitation services, for Michels Pipe Services.

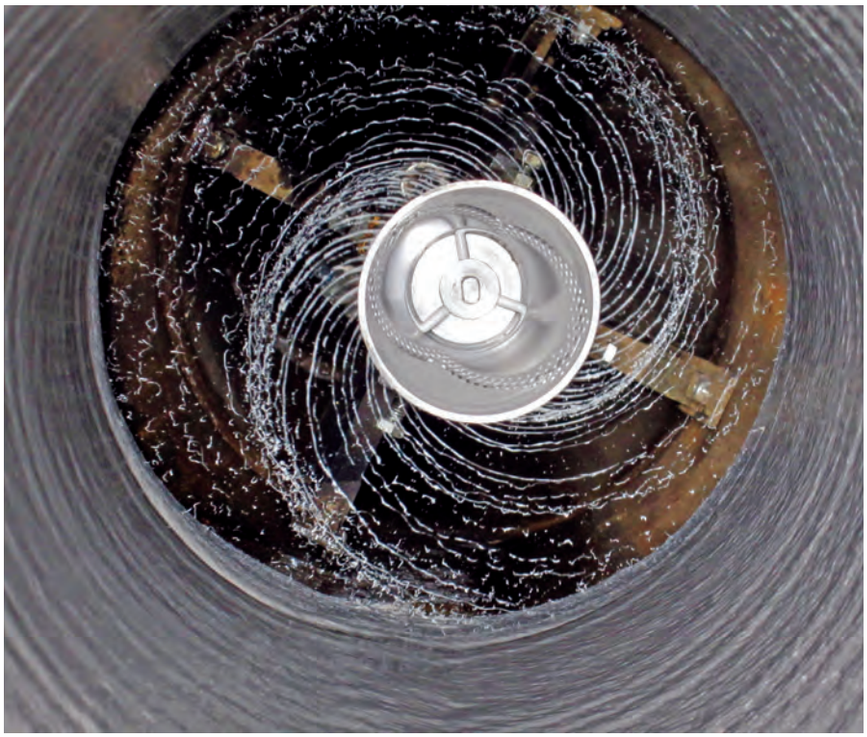


THE CITY HAD NOT PREVIOUSLY USED CIPP TO REHABILITATE WATER MAINS.

MINDING THE WATER MAINS IN MAINE

Bangor Water District Uses Polyurea Liner to Rehab Cast-Iron Pipe

BY SUNIDH JANI



Decades of normal use take a toll on municipal water infrastructure assets. Over time, mineral deposits build up inside potable water mains resulting in tuberculation, impeding hydraulics and compromising water quality.

The Bangor Water District, Bangor, Maine, was dealing with this common problem in the summer of 2012. The district had 1,100 lf of unlined 16-in. cast iron pipe dating back to the 1940s. Water discoloration was an occasional concern, along with lowered chlorine residuals, an inability to provide high fire flows (a C-factor in the mid-50s) and significant tuberculation.

The Bangor Water District wanted to improve water quality and increase volume in the mains, as quickly, efficiently and with as little disruption to customers as possible. District officials were aiming for a solution to solve their current problems and extend the service life of their water mains, which left them open to piloting a new solution that could provide comprehensive results.

OPTIONS FOR REPAIR

Bangor Water District considered several available technologies including replace-in-place, cement mortar lining (CML), pipe bursting, CIPP lining, epoxy lining and polyurea lining. District officials settled on 3M Scotchkote Pipe Renewal Liner 2400 because it provided the best combination of cost, durability, chemical resistance and reputation.

At the time, Scotchkote Liner 2400, a polyurea liner, was a relatively new product on the market with several differentiators. It offered a relatively fast installation time, structural pipe enhancement, inhibited tuberculation, corrosion protection and potentially extended service life of the water mains.

THE APPLICATION PROCESS

Scotchkote Liner 2400 is applied using a trenchless, spin cast process. The Bangor project site was located throughout an industrial yard facility located on a former concrete runway of the now closed Dow Air Force Base. The water main made a 75-degree turn underneath the facility before heading due west and continuing to Bangor International Airport. This layout required the excavation of five pits (each 8 ft by 10 ft), providing access for sprayhead launch and retrieval at key points along the pipeline.

The Bangor Water District performed the excavation, disinfection and reinstatement and engaged another contractor to clean the water mains by drag-scraping prior to application.

The project was scheduled for three days, requiring 400 to 435 ft of lining per day to stay on that schedule. Once the pipe was cleaned, it was inspected using closed circuit television (CCTV) to identify any unexpected conditions. An umbilical was pulled through the pipe. Then, the sprayhead was attached, engaged and pulled back through at a specified rate, lining the pipe. Flow rate and temperature were key factors of a successful application. Experienced applicators monitored and made adjustments as required during the process.

Scotchkote Liner 2400 offers versatility in its applications. For protection against corrosion and tuberculation, the lining can be applied at a thickness of just 1.2 mm. To reinforce structural integrity, a 5.75-mm lining was applied in the Bangor Water District water mains.

The project stayed on schedule and Scotchkote Liner 2400 was successfully applied at a total of 2,424 L during the project. Throughout the procedure, all involved in the project worked together to ensure the best possible results.

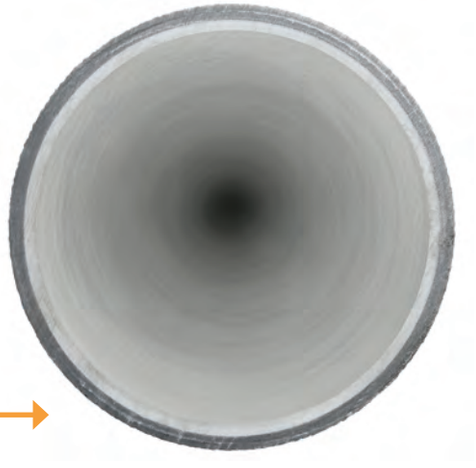
REINSTATEMENT AND RESULTS

A CCTV inspection was performed just 10 minutes after the application. After that, the mains were flushed, chlorinated and returned to service after successfully passing the required bacteria testing.

Using Scotchkote Liner 2400, Bangor Water District effectively addressed water quality issues by providing corrosion protection and inhibiting tuberculation in

EXAMPLE OF TUBERCULATED PIPE

EXAMPLE OF WATER MAIN FRESHLY LINED WITH SCOTCHKOTE LINER 2400



their water mains. In addition, it restored the pipe's internal diameter and increased the water flow.

"The C-Factor on this pipe went from the mid-50s to over 130 and helped to restore fire flow requirements. We plan to use this product for future projects," said Rick Pershken, district engineer at Bangor Water District.

Since the 2012 pilot project, Bangor Water District has used 3M products twice more on similar pipe lining projects. In both cases, the district chose to use Scotchkote Liner 2400 to repair and rehabilitate its water mains, preparing them for extended service life.

As of 2015, Scotchkote Liner 2400's reputation for comprehensive rehabilitation has grown considerably. 3M instituted an Authorized Applicator program, providing extensive training to contractors. The program helps ensure that end customers receive the best application of the product provided by highly trained professionals using only pre-approved high quality equipment. To date, there are seven Authorized Applicators of Scotchkote Liner 2400 in North America and six more around the world.

Sunidh Jani is a global business development manager for 3M Water Infrastructure.

PRESSURE ON THE SPEEDWAY

CIPP Used to Rehab Florida Pressure Pipe

BY JAYNE BRINGER

While traditional cured-in-place pipe (CIPP) for gravity pipeline systems has been around for 40-plus years, reinforced CIPP for pressurized force mains and potable water applications is still relatively new.

Today, Insituform Technologies, LLC is working to develop better technologies for pressurized systems. The company is also tackling tougher projects. One such project on a lift station and pipelines in Daytona Beach, Fla., presented a variety of challenges in high profile areas.

PROJECT BACKGROUND

The 30-in pre-stressed concrete cylinder pipeline (PCCP), originally a raw water transmission system that had been taken out of service decades ago, was being converted to a sanitary sewer force main. Project design and inspection for the City of Daytona Beach project was performed by the engineering firm McKim & Creed. After a public bid offering, a fiber-reinforced CIPP rehabilitation system was approved for the project. Known commercially as Insituform RPP (reinforced pressure pipe), the system is a reinforced pressure pipe liner and vinyl ester resin system that combines traditional CIPP with specially-needled fiberglass material to provide added tensile strength and adequate internal pressure resistance for pipeline performance.

As the general contractor for the project, Insituform was not only responsible for CIPP lining, but also for project management and onsite field management for all subcontractors. These subcontractors performed various duties such as CCTV, cleaning, jack and bore, installation of new ductile iron pipe and fittings, and excavation and concrete repair work.

LOCATION

Working in Daytona Beach presented several challenges, as long portions of the job were within the front parking lot of the world's most famous motor racetrack — the Daytona International Speedway — home of the Daytona 500 on Speedway Boulevard (Florida Highway 92).

There were numerous considerations working in such a well-known, high-profile area. The project spanned from late

the fourth quarter of 2014 to the second quarter of 2015. Working around holidays and many Speedway events such as Daytona Bike Week and Daytona 500 events presented special challenges. These events dominated the city and presented unique logistical challenges — such as finding hotel lodging and places for crew members to eat.

The project extended from golf course access on the western end through commercial business areas, passing through the Speedway and terminating on Daytona Beach airport property at the eastern boundary.

PROJECT OVERVIEW

The project consisted of three separate bids. Within project A, renovations and improvements were made to the lift station pumping sewage to the line. The second component, or part B, rehabilitated approximately 8,400 ft of 30-in. PCCP rehabilitated using the fiber-reinforced CIPP RPP product. The third and final portion of the project consisted of direct bury of a new ductile iron pipe (DIP) west of the CIPP lining termination point.

To access the jobsite, Insituform crews had to set up the project from a utility easement between holes on a golf course, proceed through a light commercial area, and then dig and replace sections with new DIP and jack and bore under Speedway Boulevard to the Daytona speedway property, and across the Speedway parking lot over to the airport entrance road. The jack-and-bore method consists of boring through the ground and then installing a casing pipe that protects a ductile iron pipe that is pushed through the casing in order to create a horizontal shaft. In these areas, new pipeline was installed.

Crews also employed the jack-and-bore method under the Daytona Beach Airport entrance road, and then continued the CIPP lining portion all the way to the Daytona Beach Airport property line. Since the pipeline was 30 in. in diameter, the liner was installed using a steel frame for the water inversion and the wet out tube was delivered to the top of this frame using a 30-ft long roller bed. The roller bed helped the crew load the pre wet-out tube straight from the refrigerated truck up to the top of the inversion unit.

During the project, dewatered and shored trench boxes were required due to the location of the pipe in relatively deep, wet sand soil. The lining was completed using a traditional downtube, water inversion and water curing process. The 8,400-ft long PCCP line was rehabilitated in two phases, requiring 14 separate CIPP installations.

SUBCONTRACTOR WORK

The cleaning was done using conventional jet cleaning, with access provided by two subcontractors. Hazen Construction provided the new pipe installation, and the jack and bore was performed by Downtown Underground Inc. J D Weber Construction provided additional access when required pits deviated from the contract document's original plans due to either shot length or unexpected jobsite issues.

According to Rick Baxter, Insituform operations manager for pressure pipe, the PCCP line was an old, abandoned line and had as-builts that helped define the scope of the job. However, when the pipe was cleaned and pre-video inspected, unforeseen bends were discovered that were not located on the original as-built.

Baxter explained that the City made the decision to excavate and replace these sections with new ductile iron pipe to remove the original fittings. Once the fittings were removed, the pipeline was able to be properly lined with CIPP, providing more consistent product performance throughout the length of the pipe.

Another challenge included dealing with Mother Nature. Numerous heavy rain events created area floods and access problems. Baxter elaborated: "Several rain events, topping out at 8 in. a day, created problems with pipe access, pit access and stability, and required re-cleaning previously prepared pipelines. Although not typical rainfall events, these storms are not unheard of in Florida. It is common that storms like the ones encountered on this project can create numerous construction challenges such as delays and rework."

After lining, Krausz USA's Hymax fittings were installed on the end terminations to allow the CIPP lining to be connected to the DIP pit closure pipes, as specified on project submittals. The fittings helped the liner meet the 50 psi design requirement.

Once installation was complete, the pipelines were pressure tested to comply with trenchless industry standards at 100 psi. This marked the successful completion of the project.

Jayne Bringer is senior marketing communications specialist at Aegion Corp.

NON-ROUND SEWER PIPELINES – WHAT TO DO WHEN IT'S TIME TO REHABILITATE

Los Angeles Turns to Sliplining and Fiberglass Pipe to Rehab its Sewers

BY JEFFREY LEBLANC, P.E.

Different shaped pipes have been used for centuries to help facilitate low flow velocities in sewer systems. These non-round sewer pipes were traditionally used in large cities where pipelines carried sewer and stormwater together. These pipes had the capability to maintain reasonable cleanout velocities for the sewer effluents during times of dry weather, but also had the capacity to carry stormwater during significant rain events.

These non-round sewer pipes are located all over the globe and the performance of these pipelines are incredibly important to each municipality.

More specifically, many of the largest cities in the United States — such as New York, Boston, Washington D.C. and Los Angeles — have these types of sewer pipes in its systems. These pipes were traditionally constructed of unreinforced concrete and bricks or clay tiles. The majority of were handcrafted manually by arguably some of the most skilled masonry laborers to create very specific profiles to achieve the necessary hydraulic conditions for these cities.

Many of these sewer lines were constructed in the early 1900s and with continued city expansion and developments, some of these sewers do not follow the public right of ways and even cross underneath existing buildings and residential housing. Due to the corrosive nature of a sanitary sewer environment, these sewers are now approaching the end of its service life and are in need of structural rehabilitation.

With the constraints of public disturbance of digging and replacing the pipes, many city engineers are exploring new methods of restructuring with corrosion-resistant materials. The difficult challenge that each engineer faces is coming up with rehabilitation solutions that not only create a new pipeline structurally, but it also has to be able to maintain capacity of the existing sewer.

In Los Angeles, the existing sewer conditions are continuing to deteriorate. Many of the decaying sewer pipelines in its collection system are made up of non-round brick and mortar pipes. The City is rehabilitating a number of non-circular sewers using methods, which are common in the industry, but using pipe materials that are new to the City.

As part of the design of a recently awarded rehabilitation project, the City specified the sliplining construction method using fiberglass pipes (Reinforced Polymer Mortar Pipe). The choice to use a slipline installation method was due to the existing flow conditions that eliminated that possibility of bypassing pumping. Los Angeles has used the slipline method of rehabilitation for its sewers for decades with round fiberglass pipes. It is recently where the City has started to use

non-round fiberglass pipes for these sewer rehabilitation projects.

For this non-circular sewer rehabilitation project, the pipes are manufactured using a filament wound manufacturing method. The product is manufactured by winding resin saturated continuous fiberglass filaments around a mandrel along with the addition of chopped glass fibers and silica sand. The end result is a very dense laminate that maximizes the contribution from all three basic raw materials. The continuous glass fibers along with the chopped glass fibers are incorporated for high hoop strength and axial reinforcement. The sand component is used to provide increased stiffness to resist external loading from the soil above the pipe and ground water pressures. This unique manufacturing equipment allows for the application of special liner resins which can be modified depending on the performance requirements of the project.

For manufacturing, the mandrel is custom fabricated to match the profile of the existing non-round sewer pipe. Using this manufacturing method, the pipe can be fabricated in practically any profile needed to match the shape of the existing sewer pipe. The profile of the mandrel is sized to allow a gap between the host pipe and the new fiberglass slipline pipe. Once the pipe is installed, this space is then filled with cellular grout through injection ports installed in the wall of the pipes.

The non-round fiberglass pipe are designed and manufactured in accordance with ASTM D3262, which is the standard specification of fiberglass sewer pipe. This standard requires that the pipe is corrosion resistant to combat the corrosive environment of an active sanitary sewer system. In addition, the pipes are designed to handle the axial loading conditions that are anticipated during the installation process. For slipline installations, the pipes are typically pushed into place in one continuous string of pipe. This requires that the pipe has the necessary allowable pushing forces to install the pipe inside the existing sewer pipe. One unique aspect on the exterior surface of the pipe is the "slides" or guides that are located on the lower quadrants of the pipe. The purpose of the "slides" is to help prevent rotation of the pipe material during the installation process.

The non-circular pipe is designed with a bell and spigot joints for connecting each segment. This gasketed joint system provides flexibility and sealing to prevent exfiltration of the sewer and infiltration of groundwater into the system. The bell of the joint system is also flush with the outside wall of the pipe to create a uniform pipe barrel from pipe segment to pipe segment.

The pipe manufactured for this project is Amiren non-circular fiberglass supplied by the Thompson Pipe Group. A total of 1,700 lf of the non-circular fiberglass slipline pipe has been delivered to the jobsite in 9-ft section lengths. Installation of the material is planned to begin this month and it is anticipated that all of the material will be installed over the next couple months. By using this product, the City is able to retain the original cross section and minimize the loss of hydraulic capacity while effectively rehabilitating the existing sewer line to prevent future failures.

Jeffrey LeBlanc, P.E. is director of engineering at Thompson Pipe Group, Zachary, La. Since 2004, LeBlanc has worked in the design, manufacture and installation of pipelines for water, sewer and hydropower utilities.

REPAIR ON THE GO

Baltimore Benefits from Emergency Storm Drain Repair

BY KEITH EYSAMAN, LUCIA NOYA AND AZZAM AHMAD

The Harris Creek Storm Drain starts at Eager and Wolfe Streets and traverses roughly 8,000 ft in a southerly route through East Baltimore. The drain was constructed between 1882 and 1888 using brick and mortar and installed using traditional cut-and-cover, tunnel or cradle construction methods. The entire Harris Creek watershed services roughly 1,300 acres, with the large portion of that being dense urban portions of the city.

Following the collapse of a section of the drain located in Monument Street in 2012, Baltimore City DPW Storm Drain Engineering Section engaged in a contract to inspect, assess and develop a maintenance and rehabilitation plan for the 8,000-ft long drain. The DPW conducted video and laser profiling inspections, which indicated severe deterioration. The approximately 400-ft long segment of drain along Eager Street from Wolfe Street to Washington Street is a 10-ft diameter round section constructed of brick and mortar with a stone invert. The brick walls and crown are approximately 1.5-ft thick and the invert is constructed of granite cobble stones.

Inspection of this segment of the drain identified longitudinal and diagonal cracks and deformations to the cross section above the spring line, as well as missing brick and mortar in the crown and invert allowing soil to infiltrate into the drain. The most critical section located at the intersection of Eager and Washington Streets.

In January 2015, DPW requested RK&K to conduct internal hands-on inspections of the Eager Street location. Subsequent follow-up inspections occurred in February and March in order to monitor the condition of the drain. After subsequent visits, the deficiencies noted were progressing in severity, which indicated the drain was in great distress and could result in failure. For safety of the public, traffic was detoured and the street closed above the drain. Samples of the infiltrating water were collected from within the drain and tested. It was determined that the infiltrating water was potable water likely originating from a leak in one of the two 40-in. diameter water main that traverse the drain.

Plans, special provisions and construction cost estimates were prepared by RK&K for the emergency repair of the severely deformed 100-ft long segment of the storm drain using one of three structural repair options. These included: 1) cured-in-place pipe (CIPP) lining; 2) carbon fiber reinforced polymer composite (CFRP) lining; and 3) conventional open-cut repairs using cast-in-place concrete. Plans and repair options were presented to contractors in a pre-bid meeting held in February. The lowest responsive bid, submitted by Spiniello Companies, entailed the use of CIPP to structurally repair the drain.

A pre-construction meeting was conducted in March and Storm Drain Contract (SDC) No. 7790 was awarded to Spiniello, with a completion schedule of 60 calendar days. Working closely with DPW, RK&K assisted with the emergency repair by providing construction phase services, including construction oversight and inspection.

Work commenced on March 25, with the investigation of water main leaks and the subsequent repair of a leak identified on one of the 40-in. mains. An internal flow isolation dam was installed in the 10-ft diameter storm drain downstream of the repair section and a temporary bypass system installed to control base flow.

To access the drain for the installation of the 120-in. CIPP liner, an approximately 20-ft deep excavation was made and the

top portion of the fragile brick drain removed above the spring line. Structural repairs were made to the drain using a CIPP liner system as soon as weather conditions allowed the inversion and curing of the liner system. During the installation of the access opening, it was determined that the segment of drain in this area was in a severely fragile state and an additional 50-ft of CIPP liner was installed in the downstream direction to stabilize the drain and aid in the closure of the access opening. Following the lining operations, grouting of the voids outside of the drain was completed from inside the repaired drain using pressure grouting. Approximately 3,900 gal of soil stabilization grout was used to fill voids and stabilize the soils outside of the repaired drain.

Closure of the access opening to the drain was completed by first installing reinforced concrete footers that would support and secure the 1.5-in. thick rolled steel closure section. The excavation and steel closure section was backfilled with concrete to the crown of the existing drain/closure section then a reinforced concrete slab was poured above the crown of the existing/repaired drain. The remainder of the excavation backfilled with stone, compacted and the roadway restored. Work on the project was on-schedule in June 2015 at a cost of approximately $2.2 million.

INSPECTION OF THIS SEGMENT OF THE DRAIN IDENTIFIED CRACKS AND DEFORMATIONS TO THE CROSS SECTION ABOVE THE SPRING LINE, AS WELL AS MISSING BRICK AND MORTAR IN THE CROWN AND INVERT ALLOWING SOIL TO INFILTRATE INTO THE DRAIN.

Keith Eysaman and Lucia Noya are with the engineering firm RK&K and Azzam Ahmad is with the City of Baltimore.

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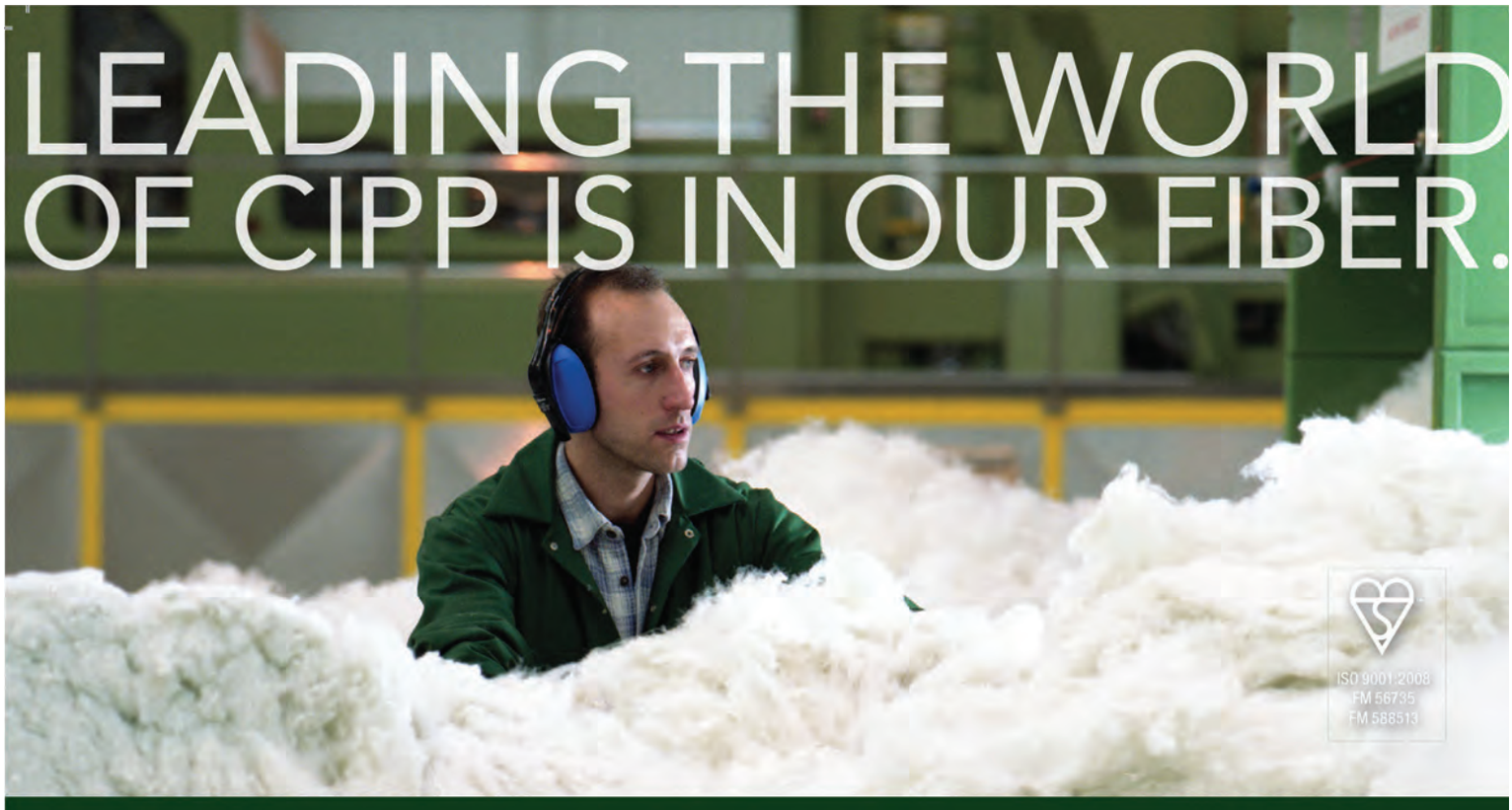

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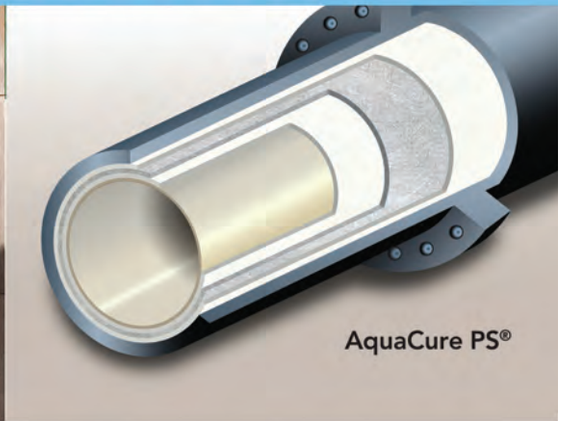

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