Southeast Journal of Trenchless Technology 2014

The Official Publication of the Southeast Society for Trenchless Technology

OUR INAUGURAL EDITION


The Best Just Got Better
HDR EASY LOCATOR
> Superior Depth Penetration
> Highest Resolution
> Automated Features
> Built in GPS
High Dynamic Range (HDR) Easy Locator* breaks new ground in performance for utility location worldwide. With its high band width, the utility detection performance from HDR captures the equivalent subsurface information from multiple antennas saving you both time in the field and money.
*U.S. Patent Pending
MALÅ
Malå GeoScience USA, Inc.
465 Deanna Lane • Charleston, SC 29492 • Phone: +1 843 852 5021 • Fax: +1 843 284 0684
www.malags.com • sales.usa@malags.com


STATIC PIPE BURSTING
FROM 30 TO 175 TON MACHINES
LATERAL PIPE BURSTING
REPLACE 4 & 6" LATERALS
PIPE RAMMING/HDD ASSIST
INSTALL STEEL CASINGS, RESCUE STUCK HDD BORES AND MORE!
PIERCING TOOLS
24 MODELS TO FIT YOUR CONDITIONS
HYDROGUIDE® WINCHES
FOR BURSTING AND LINING APPLICATIONS
TOUGH. TRUSTED. TRENCHLESS.
Whether you're replacing laterals or main lines, HammerHead® provides you with tough trenchless equipment, FREE PROJECT CONSULTATIONS and a full line RENTAL FLEET to complete your project on time and on target.
HAMMERHEAD
HammerHead, a leader in unique answers for underground utility installation andreplacement since 1989. Genuine HammerHead Trenchless equipment is available direct from HammerHead or at your local authorized dealer.
FIND YOUR LOCAL DEALER AT HAMMERHEADTRENCHLESS.COM OR CALL
MOLING | RAMMING | BURSTING | HDD ASSIST | WINCHES | LINING

Southeast Journal of Trenchless Technology 2014
The Official Publication of the Southeast Society for Trenchless Technology

FEATURED...

ALSO...

Published by:

PTR COMMUNICATIONS INC.

Unit 1 – 73 Fontaine Crescent
Winnipeg, Manitoba
Canada R2J 2H7

President
Elaine Chouinard
204.255.6524
elaine.ptrcom@mts.net

Editor
Mike Stimpson
204.231.4707
ptrcommike@gmail.com

Advertising Sales
Andrew Pattison
204.275.6946
ptrcom@shaw.ca

Bert Eastman
204.997.6371
ptrcom@outlook.com

Layout & Design
Lunch Pail Productions
204.237.6611
lunchpailproductions@shaw.ca

PTR Communications Inc.
Unit 1 - 73 Fontaine Crescent
Winnipeg, Manitoba
Canada R2J 2H7

Printed in Canada 03/14

Moving Forward

Jerry Trevino
Chairman, SESTT

Welcome to the first publication of the Southeast Journal of Trenchless Technology.

The Southeast Society for Trenchless Technology was founded in 2000 as a chapter of NASTT. SESTT was formed shortly after a very motivating and convincing meeting headed by Dr. Tom Iseley and Leonard Ingram in Atlanta, Georgia, in 1999. A handful of people from the corporate and municipal sectors were present.

I remember very keenly Dr. Iseley presenting the case that there was a need to create a local Southeast Chapter of NASTT. He suggested that universities, municipalities, companies involved in infrastructure rehabilitation, and engineering firms should develop venues on a local level throughout the Southeastern United States to share problem/solution forums.

During the first few years, most of the Trenchless Technology Seminars were held in universities across the Southeast. Having seminars in universities informed engineering students of career options that may not otherwise have presented themselves.

The SESTT chapter consists of the states of Georgia, South Carolina, North Carolina, Tennessee, Florida, Alabama, Mississippi, Louisiana, Arkansas and Puerto Rico. Since 2000, we have held numerous seminars every year. Leonard Ingram, the Executive Director of SESTT, has been the muscle pushing through many obstacles to schedule, organize, and conduct these seminars. There have been many new technologies developed and improved on during the last 13 years. Many companies have evolved and many new companies formed to meet the demands needed to maintain and refurbish our infrastructure.

> “The SESTT chapter consists of the states of Georgia, South Carolina, North Carolina, Tennessee, Florida, Alabama, Mississippi, Louisiana, Arkansas and Puerto Rico.”

The primary objective of SESTT is to provide opportunities to advance the science and practice of trenchless technology by promoting and conducting training and education through seminars, short courses and field demonstrations, and to make available information thereof to interested and concerned parties. The main purpose per the charter and bylaws is to “promote trenchless technologies.”

Our government and municipal leaders are always faced with daunting challenges in deciding how and where to best spend taxpayer dollars. Unfortunately, funding infrastructure upgrades has taken lower priority than more visible projects and social programs. Even though one of government’s foremost obligations is to provide its citizenry with clean and safe drinking water and an efficiently functioning infrastructure, the funding has fallen short. The economy, with fewer working Americans and therefore less tax revenue, has also placed a great strain on government’s ever-growing need for more cash. Meanwhile, vulnerabilities in our infrastructure result in it eroding just under our feet.

Moving forward, challenges ahead of us in the trenchless technology business include to highlight the need not only to maintain our infrastructure but also to upgrade it to the next level for future generations to maintain a healthy nation. It will challenge us to the core to create new materials, processes, and technology to achieve this.

Greetings From the Executive Director

Leonard E. Ingram, Sr.
Executive Director, SESTT

In 2000 I became Executive Director of the Southeast Society for Trenchless Technology (SESTT), and since then SESTT has presented 39 two-day seminars in 21 cities throughout the nine-state Southeast region. Through this active education outreach, SESTT has reached over 1,600 classroom attendees. If you know any of our exhibitors, food sponsors, presenters, guest presenters or ASCE co-sponsor members, please thank them for their support of SESTT. We could not have had such an active program without them.

Please consider joining them as an exhibitor, food sponsor and/or presenter at these upcoming 2014 regional seminars:

- SESTT – March 26-27 in Baton Rouge, Louisiana.
- MSTT – April 30-May 1 in Minneapolis/St. Paul, Minnesota (date may change).
- MASTT – June 18-19 in Bethesda, Maryland (date may change).
- MASTT – August 13-14 in Pittsburgh, Pennsylvania (date may change).
- MSTT – September 17-18 in Louisville, Kentucky (date may change).
- SESTT – October 22-23 in Jacksonville, Florida (date may change).

The SESTT "Trenchless Technology, SSES and Buried Asset Management" seminar will be held on March 26 & 27, 2014, at the Baton Rouge Marriott Hotel. ASCE Baton Rouge Branch is the co-sponsor for this seminar. The Guest Presenter will be Mrs. Amy Schulze, P.E., Special Project Engineer, City of Baton Rouge & Parish of East Baton Rouge, with the presentation "The Baton Rouge SSO Program." The networking and learning will be terrific.

Please contact me for additional information about attending or becoming more active.

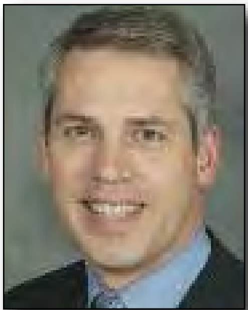
For the professionals responsible for design, installation and maintenance of infrastructure, certainty is critical, and the greatest obstacle they face is fear of the new and unknown. As "trenchless technologists," it is our charge to educate these professionals with case studies, experiences and demonstrations to help them overcome these fears. That is why SESTT and NASTT conduct seminars and trade shows.

We plan to use the publication of the Southeast Journal of Trenchless Technology to further those efforts. The magazine will be an annual publication that highlights some of the many trenchless projects performed in and around the Southeast. One clear sign of our success is the continued growth in trenchless projects. Please help me thank the Officers of SESTT and their companies for their support through the year and for making this journal a reality. The SESTT Board of Directors is listed in this journal.

The future of "water quality" is vital to maintaining our American standard of living. At each SESTT seminar, I ask how many of the attendees are attending a trenchless technology event for the first time. I usually get a show of hands that reflects over 50 percent. This means that the seminars are drawing interested participants on a first-time basis to learn and network. Therefore, the public will benefit from education about trenchless technology and how it can improve their current and future water quality. This makes me very proud to be a part of this process and a part of this organization.

Thank you for your support!

New Magazine! New Energy!



Derek Potvin
NASTT Board of Directors Chair
& International Representative

The North American Society for Trenchless Technology strives to be the premier resource for knowledge and education in trenchless technologies. What better way to make your chapter members aware of NASTT's educational resources and to showcase your trenchless champions than a new publication devoted to the volunteers of your NASTT chapter!

This is the first time that SESTT has published a magazine dedicated to delivering the latest trenchless news and articles about its membership. I'd like to recognize and applaud the many sponsors who have supported this initiative and the many trenchless professionals who share their expertise to improve infrastructure management through trenchless technology. These are the people who make us all more responsible and aware of the social, environmental and fiscal benefits of trenchless technologies.

As the trenchless industry continues to grow and take on new challenges, it is important for NASTT to serve and support our partners at the chapter level. We proudly represent municipalities and public utilities, consultants and engineers, manufacturers and suppliers, trenchless contractors and academia. Through the nine NASTT Regional Chapters and 13 Student Chapters, we reach out to trenchless professionals with our Good Practices courses, the No-Dig Show, webinars and the latest NASTT technical publications.

With more and more municipalities and public utilities embracing trenchless technologies, I am extremely optimistic about the future of this industry and our not-for-profit society. The grassroots strength of our chapters and the outreach they provide to local municipalities and utilities form the basis for much of that optimism.

Congratulations on the first issue of this publication and on the many more to come.

An essential part of your SMART lighting

The SceptaCon™ Solution

SceptaCon™ is one of the first PVC systems designed for the rigors of trenchless applications. Made of durable Schedule 40 PVC, SceptaCon links seamlessly to existing PVC conduit infrastructure and allows utilities to standardize on PVC throughout their entire electrical system.

Sceptacon is the ideal solution to short drilling projects where heavy local traffic can't be interrupted.

Now available in a 2" diameter, SceptaCon is ideally suited for street lighting and traffic signal applications where installation requires a smaller diameter pipe than your typical electrical raceway. As the only approved, boreable PVC electrical raceway available in a 2" size, SceptaCon allows contractors to install RW cables instead of the more expensive TECK cables.

No Fusion or Cementing Required

With SceptaCon's slide-in locking system, a watertight joint can be made in seconds, without fusion or cementing

Pressure Rating & Flexibility

SceptaCon is pressure rated to 80 psi and approved for a 65 ft bend radius

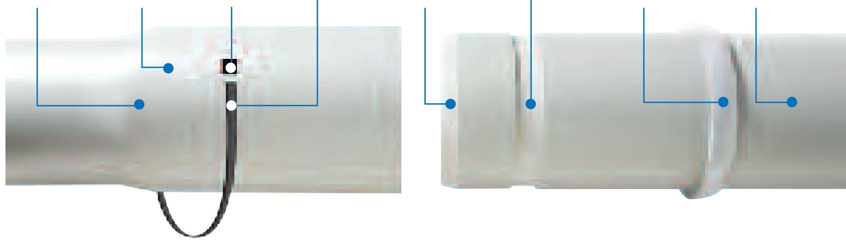
Easier to Handle & No Reel to Return

Installed one length at a time, SceptaCon doesn't require the use of a reel…no reel deposit, no reel truck, and no need to return the reel after use

For more information visit www.kraloyfittings.com

The SceptaCon™ Joint

Featuring slide-in spline locking system.



KRALOY®
The Fitting Choice

Toll Free: 1-800-265-1815
Phone: 519-681-2140
www.kraloyfittings.com

Products are manufactured by IPEX Electrical Inc. and distributed in the United States by Kraloy, a division of Multi Fittings Corp.

Online Asset Management Training for Water Utility Professionals

Exclusive Four-Part Series in Asset Management Certification

1 CTAM-100 – Overview of Asset Management
Available Now

2 CTAM-200 – Developing an Asset Management Program
Launching June 1, 2013

3 CTAM-300 – Managing an Asset Management Program
Launching December 2013

4 CTAM-400 – Funding an Asset Management Program
Launching December 2013

Why offer courses in Asset Management?

The Buried Asset Management Institute-International (BAMI-I) created the Certification of Training in Asset Management (CTAM) program to increase awareness and train utility personnel on the best way to implement and use asset management to extend the life and efficiency of their water and wastewater systems. CTAM is an online educational series for obtaining certification of training in management of underground asset infrastructure.

Levels of Certification

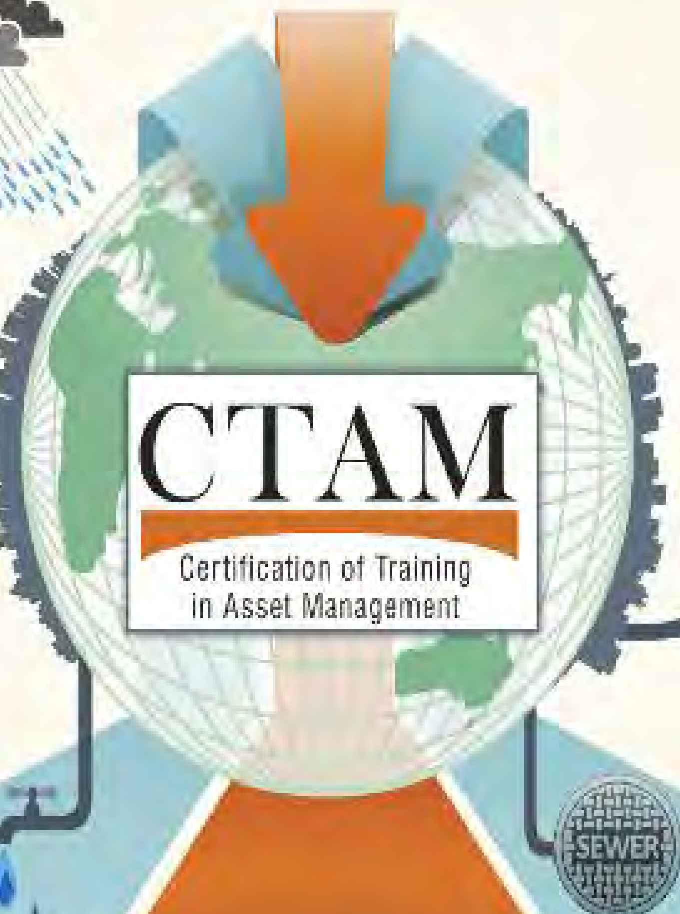
I. Certificate of Completion – requires completion of each course

II. Associate Water Asset Manager (AWAM) – requires completion of CTAM 100-400 and an application submitted to BAMI-I Asset Management Certification Board

III. Professional Water Asset Manager (PWAM) – requires completion of CTAM 100-400, four years of relevant asset management experience and an application submitted to BAMI-I Asset Management Certification Board

Benefits of the CTAM Series

- Expand your knowledge and access to resources to enable you to initiate, continue or improve your own asset management program
- Earn internationally recognized certification in the field of asset management
- Earn 1 CEU / 10 PDHs* for each course



For more information and to register, call 330.467.7588, e-mail, vlosh@benjaminmedia.com or visit Conference.com/Benjamin/CTAM/CTAM_Home.html

CTAM-100 At-a-Glance:

- Introduction to Asset Management
- Sharing Asset Management Knowledge on a Global Scale
- Asset Management Technologies
- Risk Management
- Government Regulations
- Case Studies
- Development of the Center of Excellence for Municipal Asset Management (CEMAM)

CTAM-200 At-a-Glance:

- Introduction, 'Total Asset Management Plan'
- 'Asset Management Origins'
- 'Asset Management' - Definition
- Infrastructure Asset Management: General AM concepts as related to water and wastewater systems
- Underground Infrastructure Asset Management: General AM concepts on buried infrastructure
- Asset Management – Advantages, Rewards, Obstacles
- Planning
- 'What' and 'Where' considerations
- System Inventory – Content
- System Inventory – Geographical Considerations
- System(s) Asset Naming and Numbering Conventions
- System Inventory Tools
- Condition Assessment – Wastewater Collection Systems
- Condition Assessment – Water Distribution Systems
- Data Content and Analysis
- Data Sharing
- Data Distribution

BAMI-I

IUPUI
INDIANA UNIVERSITY PURDUE UNIVERSITY INDIANAPOLIS

UIM

CTAM was developed by BAMI-I in conjunction with Indiana University-Purdue University at Indianapolis and in partnership with UIM: *Water Utility Infrastructure Management*. Visit Conference.com/Benjamin/CTAM/CTAM_Home.html for more information.

Course fees range from $345-$495 per course, which includes course manuals, exams, study tools, certificates of completion and CEUs/PDHs. Additional fees will be required for AWAM and PWAM certification applications.

Upcoming NASTT Events

Mar 26-27, 2014

SESTT Trenchless Technology Seminar

Baton Rouge Marriott Hotel

Baton Rouge, Louisiana

Information: Leonard Ingram, mastt@engconco.com

Sunday, April 13, 2014

NASTT's Trenchless Technology Short Course – New Installation

Gaylord Palms Hotel, Orlando, Florida

Information: www.nastt.org

Sunday, April 13, 2014

NASTT's Trenchless Technology Short Course – Rehabilitation

Gaylord Palms Hotel, Orlando, Florida

Information: www.nastt.org

April 13-17, 2014

NASTT's 2014 No-Dig Show

Gaylord Palms Hotel & Convention Center

Orlando, Florida

Information: www.nodigshow.com

April 16-17, 2014

NASTT's Good Practices Courses

Gaylord Palms Hotel, Orlando, Florida

Information: www.nastt.org

April 30-May 1, 2014

MSTT Trenchless Technology Seminar

Minneapolis/St. Paul, Minnesota

(Date may change)

Information: Leonard Ingram, mastt@engconco.com

June 18-19, 2014

MASTT Trenchless Technology Seminar

Bethesda, Maryland

(Date may change)

Information: Leonard Ingram, mastt@engconco.com

August 13-14, 2014

MASTT Trenchless Technology Seminar

Pittsburgh, Pennsylvania

(Date may change)

Information: Leonard Ingram, mastt@engconco.com

September 17-18, 2014

MSTT Trenchless Technology Seminar

Louisville, Kentucky

(Date may change)

Information: Leonard Ingram, mastt@engconco.com

October 22-23, 2014

SESTT Trenchless Technology Seminar

Jacksonville, Florida

(Date may change)

Information: Leonard Ingram, mastt@engconco.com

BOARD OF DIRECTORS

Jerry Trevino - *Chairman*

Mr. Trevino is President of Protective Liner Systems, Inc., and principal owner of other construction and consulting companies. Jerry is an engineering graduate from the University of Texas in Austin. Before specializing in infrastructure rehabilitation, he worked as a project engineer and in research and product development for Procter and Gamble and Mobil Oil. He now specializes in the development, manufacturing and installation of all types of polymeric and cementitious coatings, liners and FRP composites used to rehabilitate infrastructure for municipalities and the industrial sector. He strongly believes that Trenchless Technologies offer numerous methods to maintain and upgrade aging infrastructure.

Edward R. Paradis - *Vice Chair*

Ed Paradis is the National Sales Manager for Resiplast US Inc. A worldwide manufacturer of chemical grouts for over 25 years, Resiplast makes a full line of single-component and multi-component materials that are known as the new benchmark in chemical grouts. Mr. Paradis attended Boston College while serving in the U.S. Army. He has been involved in the construction and rehabilitation industry since 1989, and further contributes to and advances our industry through active membership in various associations such as NASSCO, NASTT, SESTT, UCT, ICRI, and DFI (Deep Foundation Institute). He speaks nationwide for these organizations and sits on various boards that support the industry's growth.

Kelly Derr - *Treasurer*

Mr. Derr has over 40 years of experience in the planning, design and construction of water and wastewater facilities. Since 1990, he has focused on the use of trenchless technologies for pipeline construction and rehabilitation. For the last six years he has focused on the inspection and condition assessment of water and wastewater pressure mains. He has written over 60 technical papers and is on the Board of Directors for the Southeast Society for Trenchless Technology. He is currently a Senior Associate with Brown and Caldwell, based in Raleigh, North Carolina, and is the firm's technical leader for trenchless technologies in the East Region.

J. Chris Ford - *Secretary*

Mr. Ford is a Senior Associate for Highfill Infrastructure Engineering, PC in Cary, North Carolina. He is a licensed engineer in North Carolina and has 20 years of experience, planning, designing, and performing construction contract administration for complex water and wastewater projects. Over the last 10 years his focus has been on condition assessment and rehabilitation using trenchless technologies including pipe bursting, horizontal directional drilling, and high pressure CIPP lining.

Southeast Society for Trenchless Technology Board of Directors

Chairman – Jerry Trevino
Protective Liner Systems, Inc.
Lithonia, Georgia – 877-462-6465
jerrytrevino@protectivelinersystems.com

Vice Chair – Ed Paradis
Resiplast US Inc.
Cornelia, Georgia - 706-894-2133
eparadis@resiplast.us

Treasurer – Kelly Derr
Brown and Caldwell
Raleigh, North Carolina – 919-233-9178
kderr@brwncald.com

Secretary – J. Chris Ford
Highfill Infrastructure Engineering
Cary, North Carolina – 919-481-4342
cford@hiepc.com

REGION 1 (FL & PR)
Rod Lovett
Miami-Dade WASD
Miami, Florida

REGION 2 (NC & SC)
Hunter Dance
Vaporooter
Raleigh, North Carolina

Kin Hill
Charleston Water System
Charleston, North Carolina

Steve Porter
Greenville Utilities Commission
Greenville, North Carolina

REGION 3 (GA & AL)
Ralph Carpenter
American Ductile Iron Pipe
Birmingham, Alabama

Refik Elibay
Hatch Mott MacDonald
Atlanta, Georgia

Alan McCloskey
Amtec Surveying, Inc.
Atlanta, Georgia

Jimmy Stewart
Brenford Environmental Services
Lafayette, Alabama

REGION 4 (LA & MS)
Jeff LeBlanc
U.S. Composite Pipe South, LLC
Zachary, Louisiana

John Matthews
Battelle Memorial Institute
Baton Rouge, Louisiana

REGION 5 (TN & AR)
Sanjiv Gokhale
Vanderbilt University
Nashville, Tennessee

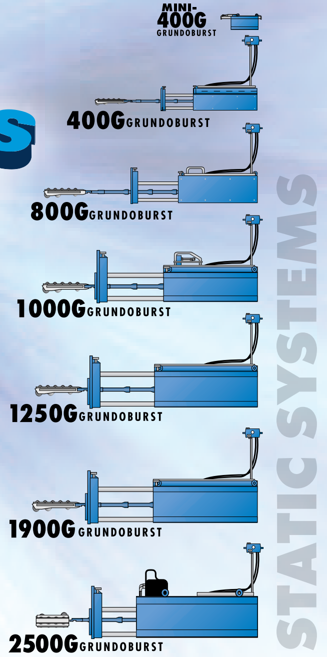
George Kurz
Environmental Engineer
Madison, Tennessee

Pipe Bursting SUCCESS Starts Here!

TT Technologies has been the worldwide leader in pipe bursting equipment since the 1980s.

Whether it's a challenging project or a routine replacement, choose the equipment that has the best track record and most respected technical support in the industry. Choose pipe bursting equipment from TT Technologies.

- **Over 50 years of Service & Support Behind Every Tool**
- **Widest Selection of Pipe Bursting Equipment, Static & Pneumatic**
- **Largest Rental Fleet**



TT Technologies

Call 1-800-533-2078 www.tttechnologies.com

Pipe Bursting • Pipe Ramming • Horizontal Boring • Directional Drilling • HDD Assist

Overcoming Obstacles:
A Case Study of Incorporating Expert Opinion and Spatial Analysis into Water Distribution Failure Prediction Modeling

Lindsay Jenkins, E.I.
Ph.D. Candidate, Vanderbilt University
Water Engineer, CH2M HILL

Sanjiv Gokhale, Ph.D., P.E., F.ASCE
Professor of Civil Engineering, Vanderbilt University

As more water distribution pipes are reaching the end of their useful lives, utilities and consumers have to address the problems associated with pipe breaks. A recent study released by the Environmental Protection Agency (EPA 2013) estimates the 20-year financing needs to maintain and replace U.S. water distribution assets to be upwards of $280 billion. The study also estimates that the average utility's distribution pipe replacement rate is just one percent.

Utility operators are tasked with developing maintenance, replacement and rehabilitation (MR&R) programs that minimize the long-term costs associated with deferred rehabilitation and replacement. Decision support systems (DSS) based on historical records are valuable tools for developing these programs, yet surveys indicate they have not yet been widely adopted, partially due to the large data requirements. By synthesizing maintenance histories, Geographic Information System (GIS) analyses, and expert knowledge of the network history and performance, utilities with limited and uncertain data can develop reliable capital improvement planning tools. The following presents a case study of developing a DSS for a large utility and provides guidance for small utilities wishing to develop prioritization models.

DSS for Large Utilities

Medium and large utilities with several hundred to thousands of recorded failures can develop statistical models to predict pipe failures based on previous performance. Specifically, Weibull Hazard Rate-based models have been introduced by many researchers and consultants, due to their capability to capture the "bathtub-shaped curve" of infrastructure degradation and to incorporate parameters that explain differences in failure rates. The most common parameters used are mate-

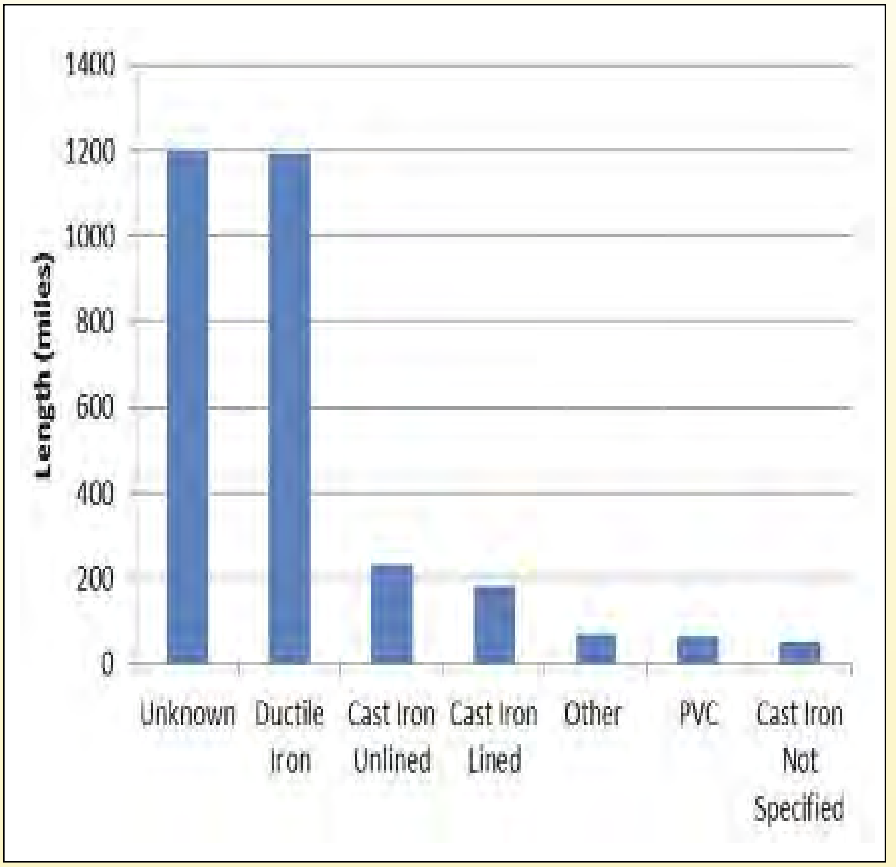


Figure 1. Pipe Materials – Utility A

rial, installation date, diameter, length, and number of previously recorded failures. Some models include additional parameters that describe pipe operating and environmental conditions including pressure, bedding depth, groundwater levels, and infrastructure above the pipe.

Of concern is that the parameters most commonly used in models including material, installation date, and pipe length, are often difficult to acquire with certainty. For example, Utility A in the Southeast United States has over 600,000 residents with 2,800 miles of pipe. The maintenance database for Utility A spans 10 years with over 2,600 recorded failures. Though the utility has plenty of failures with which to train a statistical model, many material properties are unknown, shown in Figure 1. Similarly, over 40 percent of the installation dates are not known. Utility A is like most older utilities that do not have exact information stored in databases regarding the age and composition of their network.

To address these uncertainties, the expert knowledge of Utility A personnel was incorporated into the model. Pipe materials were estimated by geographic location and knowledge of development timelines in the utility. The pipe material was estimated based on time of installation. For example, pipes in newer developments built in the 1990s are likely to be ductile iron, while pipe installed in older areas of town in the 1940s are likely to be cast iron. Parameters were added to the Weibull model to account for when the material and/or installation date was known, as recorded in the database, and when the material and/or installation date were assumed using the technique above.

In addition to the material and installation date, the recorded pipe length in the GIS database is the length obtained by digitizing as-built maps and does not reflect the true length of the pipe segments in the field. Recorded segment lengths range from less than one foot to several thousand feet. Though pipe length has been identified by other researchers as one of the most significant model parameters, this parameter often serves as a surrogate for the clustering of accidents because longer pipes have a greater occurrence of multiple failures than short pipes.

Instead of including the pipe length as a parameter in the model, a new parameter that analyzes the local clustering of pipe failures using spatial analysis tools within ArcGIS and estimates the break rate for small subsets of the network is introduced. Cells are drawn around failure points, shown in Figure 2, and spatial analysis tools in ArcGIS are used to assign an average local break rate to every pipe in the network.

The break rate parameter proved to be one of the most significant parameters used in developing the model. Validation studies of the final model for Utility A, which included the local break rate, diameter, material, installation date, and assumption parameters resulted in predictions of a significant number of failures and successfully identified the highest-risk group of pipes.

DSS for Small Utilities

The methodology described above is not applicable for small utilities with fewer than several hundred recorded failures documented over a period of five or more years. Extensive failure records are needed to train valid statistical models. Research is ongoing to evaluate the feasibility of using models developed for large utilities to improve model performance for similar, yet smaller, utilities.

Alternative techniques that incorporate expert opinion can still be used to prioritize pipes for replacement and rehabilitation. For example, the KANEW model developed for the Water Research Foundation requires users with expert knowledge of network performance to estimate the lifecycle of families of pipe that have similar physical properties. This expert knowledge of network performance is incorporated into survival models to predict long-term replacement rates for families of pipe. As an alternative to prediction-based prioritization models, data mining and spatial clustering tools, which are included in data analysis software packages, can be utilized to identify high-risk pipes.

Conclusion

While limited and uncertain data can be significant hurdles for utilities considering adopting advanced Decision Support Systems, the case study of Utility A shows that by incorporating expert opinion and spatial analysis results, valid failure prediction models can be developed for large utilities that lack extensive network data. Though most small utilities cannot develop models as sophisticated as the one proposed, alternative tools and methods can be easily utilized to estimate replacement rates and identify replacement/rehabilitation pipe candidates.

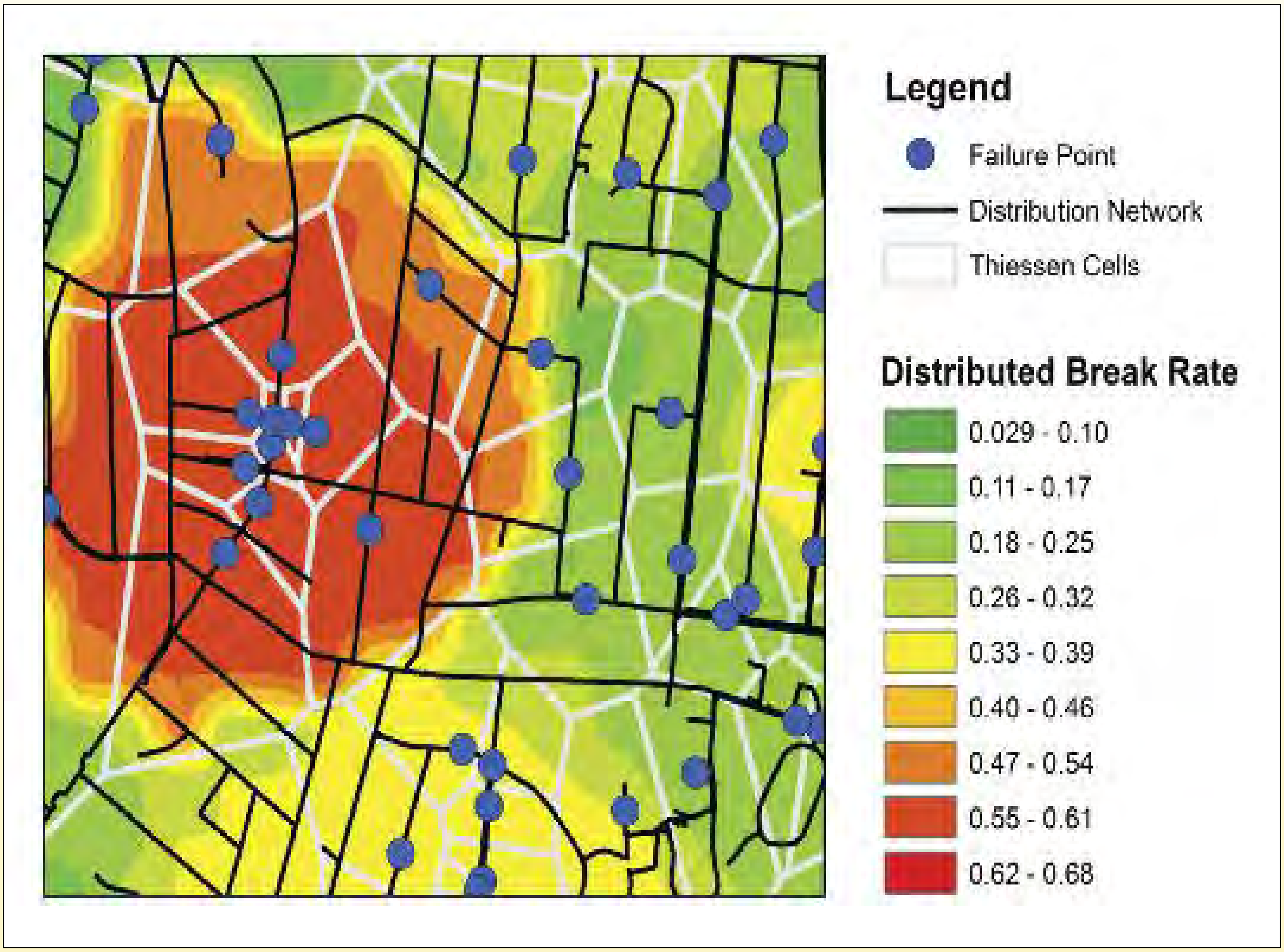


Figure 2. Break Rate Spatial Analysis

The Backbone of Your Collection System:
Large-Diameter Pipe Inspection and Cleaning

Jimmy Stewart
Brenford Environmental Systems

In cities across North America, large-diameter collection systems for storm and sanitary sewers present big challenges, with multiple solutions. This article outlines the use of sonar and closed-circuit television (CCTV) technologies for evaluating the condition of collection systems, and the different technologies used for cleaning large-diameter pipes that are the most effective and least intrusive to the system.

Evaluation Technologies

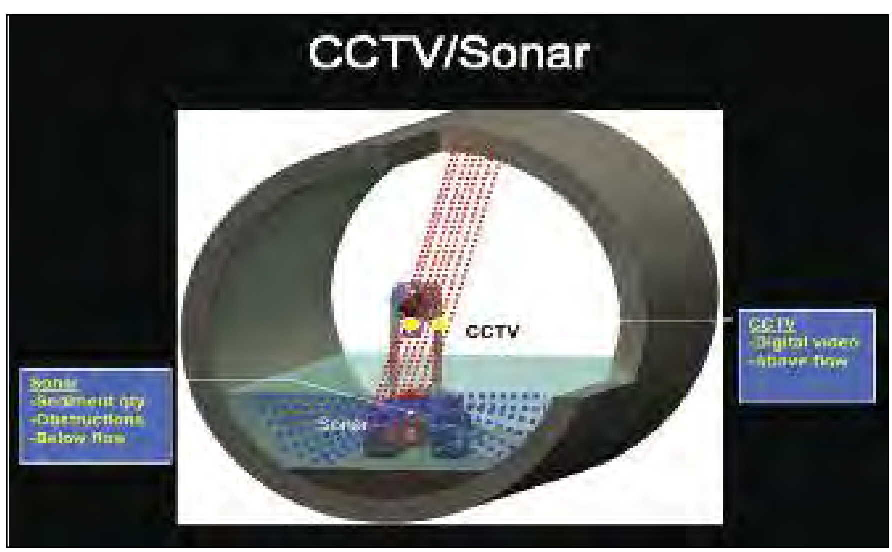
One of the most effective methods available to determine the internal condition within a closed piping system is CCTV inspection. This technology utilizes remote-controlled cameras to capture videos from inside a pipe. A rotating camera head provides a 360-degree view within the pipe. Inspection data is captured from above the flow line on the hard drive of a computer, and then analyzed by a NASSCO (North American Sewer Service Companies Organization) PACP-certified technician in the field.

A typical CCTV inspection will reveal the structural condition of the pipe, evidence of infiltration and inflow, maintenance requirements, roots, grease, debris, and hazardous underground conditions such as voids under roadways or cross-bored lines. After this initial review, the data is then transferred to the data management team for further review and analysis. This process is used extensively for the rating, prioritization and asset management of our nation's infrastructure.

Sonar is the technology of choice for mapping the location and volume of underwater debris in lines. Sonar inspection equipment utilizes liquid to carry sound waves; therefore, it only works below the water line. Sound waves are emitted by a transducer, travel until they are reflected from an object, and return to the transducer. The "time of flight" is calculated and converted to measurements. Computer software assembles multiple measurements to create a 2-D model over the length of a pipe. Debris deposits, missing wall, open joints, and other defects are then identified and quantified.

Different materials reflect sound waves differently based on their density and shape, making differentiation between displaced pipe, silt, grease, and other materials possible. Sonar is capable of showing deflection, missing pipe, resulting voids, and other defects. Sonar can also determine capacity loss, which helps to justify when cleaning is necessary, and provides valuable input for planning and pricing cleaning operations

When these technologies are used simultaneously, the data collected, the reports that are generated, and the data management result in scientific data that enables the planning for the proper cleaning technologies to be used in each pipe segment.



Sonar and CCTV technologies can be used together to evaluate the condition of a collection system.

Large volumes of debris are cleaned from sanitary and storm sewers.

These systems can be transported through the pipe in a number of ways, including wheel-driven, track-driven and floating platforms.

Technologies Work Together

Good data drives the planning for cleaning operations; Debris maps identify debris quantities by volume and location. Debris maps also provide information that will identify what cleaning technologies need to be used on each pipe size. This data can eliminate cleaning lengths of pipe that do not need to be cleaned.

In the CCTV evaluation process, pipe defects are identified and coded as to the severity of the defect. This defect coding standard in the United States has been standardized by NASSCO. The defect coding has a ranking of 1 to 5, with 5 being the worst-case scenario. This coding process provides the baseline for identifying and prioritizing structural defects in the collection system above the flow line. Another item that should be considered is the consequence of failure of the pipe. This data is crucial to the proper cleaning process and schedule.

All the challenges associated with cleaning large-diameter pipe need to be considered. These challenges include access, moving the debris, angles, depth, long-run capabilities, removing the debris from the pipe, removing the debris from the work site, and an adequate water supply for cleaning operations.

All of these challenges are overcome with the proper planning and equipment for each pipe size and location.

The concerns associated with cleaning LD pipes affect the public health and safety, air quality, noise, and access to a water supply or utilizing recycled water for cleaning.

The size or footprint of equipment has to be considered, as well as insertion and extraction points, high-traffic areas, lane closures, night work and environmentally sensitive areas including parks and wetlands. It is important to minimize the impact to your customers and our environment.

Cleaning Equipment

The equipment used for cleaning large-diameter pipes comes in many shapes and sizes and has typically been designed for this type of work. The equipment can be large combo units; specialty cleaning equipment that is truck- or trailer-mounted are the most common methods used. This equipment usually works with a high-pressure, high-volume design for moving large amounts of debris.

Large quantities of debris are removed from large collection systems; typically the debris is measured in tons. Proper planning for removal and disposal is important to providing a cost-effective solution. The removal or containment process is either an open-top or a closed-loop non-odor-emitting process. The disposal process is typically handled at a landfill where the debris consistency is capable of passing a paint filter test.

Something that is usually not considered but a real problem is the fact that there is debris foreign to the collection system found when evaluating and cleaning a large-diameter pipe. Some of the items most commonly found are sand, grit, gravel, settled sewage, rocks, boulders, collapsed pipe, fats, oil, grease, roots and rag balls. Anything and everything that can get into a pipe – and things you don't expect – are there.

Is the Pipe Clean?

The NASSCO industry standard is that a clean pipe has been restored to 95 percent of its original capacity. The post-cleaning CCTV/Sonar survey will verify that the pipe is clean and you have regained your capacity. It will also show you defects below the debris that would not have been seen prior to cleaning.

The ability to adapt to changing conditions above and below ground minimizes the impact on the public and ensures the right cleaning technologies will be used for each pipe and location.

Milestones, schedules and time frames need to be planned and met.

Water reuse from the collection system saves money and does not disrupt your customers or cause problems in your potable water system.

Case Study: Nashville

After the 2010 historical floods in Nashville (a 1,000-year flood event), Metro Water Services (MWS) had to inspect and clean sewers and combined sewers ranging in diameter from six to 198 inches.

Part of the scope was to inspect and clean if necessary one of the main trunk lines servicing the residents of Nashville. The difficulty with this trunk line was the distance between access points

The trunk line was 72 inches and had only three manholes covering over 9,000 feet. There were several vertical shafts located along the line that ranged from 10 to 24 inches in diameter.

The inspection was completed using a custom-built long-reach CCTV and sonar unit, 8400 LF per setup. The results of the CCTV/sonar inspection revealed close to 25,000 cubic feet of debris

The results of the inspection revealed debris build-up in many locations. The entire 9,000 feet would need to be cleaned.

Due to depths exceeding 50 feet and distances between manholes exceeding 5,200 LF, custom cleaning solutions would be needed. The solution was a system that had a long reach and the ability to remove debris from deep manholes

When cleaning started, there was over 27 tons of debris on the first day. A manned entry inspection revealed several large sections of stabilized debris were present. A 4,000-psi jetter was brought in to cut and remove the debris. The stabilized debris was removed and a final cleaning pass was made.

In the first phase of the project, over 970 tons of debris was removed. The 72-inch pipe was restored to 99.7 percent of its capacity.

Keeping Clean Water Clean

Jerry Trevino
President, Protective Liner Systems, Inc.

Keeping clean water clean is one of the primary objectives of trenchless technology. A hallmark of a thriving society is the availability of an abundant source of clean water and an efficient collection, removal and treatment of its waste water.

Unfortunately, drinking water in the United States contains trace amounts of pharmaceuticals, illicit drugs, dangerous chemicals and microbiological contaminants. A source of these contaminants is our aging infrastructure, as millions of gallons clean water unnecessarily enter the sewer infrastructure.

Once contaminated, water is difficult and expensive to clean. Thus, trace amounts of drugs, chemicals and microbes will be found in the drinking water of cities and municipalities downstream of waste water discharge.

As a society, it would be prudent keep clean water clean, by mitigating migratory leaks of clean water into the sewer collection systems.

Municipalities, state, and federal agencies must recognize that drinking water sources, including water and sewer infrastructure, are key and vital assets which are just as important and possibly even more important than buildings, parks, landmarks and other infrastructure. We cannot exist as a healthy society without clean water. Thus, appropriate capital expenditures should then be allocated to maintain and rehabilitate this infrastructure. Preserving

> **"Governments find it more politically advantageous to allocate financial resources to visible above-ground projects and programs"**

clean water supplies for this and future generation is paramount. By selecting proper rehabilitation methods, processes, and materials, we can further sustain life.

Ancient civilizations such as the city of Rome depended on abundant quantities of water for its citizenry. Great engineering feats of infrastructure works such as aqueducts still exists to this day. Most ancient societies and even today's largest cities are physically located near ample fresh water sources.

As the population grows, and as the need for more water required for our daily survival, industrial and manufacturing requirements, cooling for power generation, cooling for data centers, and agricultural needs, we have still more need to clean and reuse the water while protecting the overall clean water sources. The larger the city, the more underground sewer infrastructure is required, the more possibilities for inflow and infiltration resulting in more depletion of our clean water supply. Thus, we must begin to take accurate assessments of our sewer collection system, identify and quantify its defects, prioritize, and implement effective programs to correct these defects. We must muster the will as a modern society to acknowledge the state of infrastructure and take reasonable corrective measures to reduce the risks to human health.

Recent news of chemical contamination to drinking water sources in West Virginia and droughts in California is sobering news and highlights our vulnerability and mandates this to be a national top priority.

Since the infrastructure is typically underground, it becomes an "out of sight, out of mind" issue. Governments find it more politically advantageous to allocate financial resources to visible above-ground projects and programs than to those that are more difficult to show off as achievements.

Age, abrasion, wear and tear, large temperature fluctuations, system overloading, seismic movements, shock and vibration, poor design and construction practices and corrosive environments slowly erode our system and collectively become the culprit for allowing large quantities of our fragile clean water resource to be unintentionally contaminated. This combined with rain events can typically overwhelm water treatment facilities, and untreated water prematurely gets released to our creeks, streams, rivers and lakes. These watersheds then become the drinking water source for those living downstream.

The sustainability of healthy populations and nature go hand-in-hand. Humans depend on nature. Unlike in the days of ancient flourishing cities like Rome, today we depend on modern technology to clean the water via disinfection and filtration so that the same water can be used a multitude of times before humans consume it again. However, trace amounts of dangerous toxins are not easily removed.

In the past there was plenty of room for error for both humans and ecosystems to coexist; today, due to an ever-increasing demand for more manufactured products and the greater expectations of a higher quality of life, the margin for errors and neglect is always decreasing. We can no longer take clean water sources for granted. We can survive without parks, elaborate buildings and arenas, landmarks and other infrastructure. We cannot live without clean water. This is a core basic need.

Haphazardly patching the sewer infrastructure is no longer an option. Municipal authorities at all levels recognize that the cost of just digging up and replacing underground infrastructure is insurmountable. When sewer infrastructure is recognized as an asset versus a liability, municipalities and utilities turn to trenchless technology methods for protective measures for future generations.

Multiple Solutions Fo

Why do you need multiple rehabilitation solutions?

Every product has it's own advantages. To achieve the performance required, save valuable resources, and protect the environment, your structures need the appropriate product. With our product variety and expertise anything is possible.

Save Money, Without Sacrificing Performance

Lower Treatment Costs by Stopping Infiltration

Prevent Ground Water Contamination

Stop Corrosion Caused By H2S

ProtectiveLinerSystems.com ~ 1-877-4Manhole

or Multiple Problems

PerpetuSet™

PerpetuCrete™

PerpetuCoat™

PerpetuWall™

SewerFix™

Jacksonville HDD Project Completed Ahead of Schedule

Greg Goral and Jill Badzinski
Michels Corporation

When performed at its highest level and under extreme conditions, construction management can drive a project to achieve an exceptional level of success. This was the case in Jacksonville, Florida, when a technically challenging high-profile design-build river-crossing project was performed.

Michels Directional Crossings successfully completed the horizontal directional drilling (HDD), reaming a 36-inch steel water main pipe pullback installation for the 6,575-foot project that included a crossing of the St. John's River. Michels Pipeline Construction also played an integral role by performing HDD site preparation, steel pipe fabrication, X-ray, ID/OD field joint coating, hydrostatic testing and HDD pullback pipe handling. The operations were all performed within a limited right-of-way along a major Florida expressway.

Michels Directional Crossings and Michels Pipeline Construction are divisions of Michels Corporation, a Brownsville, Wisconsin-based utility contractor.

The complete JEA Total Water Management Plan Pipeline Project included installation of 43,300 linear feet of piping, which ranged in diameter from 24 to 36 inches. The water transmission pipeline was designed to connect JEA's north grid with its south grid to alleviate reductions in consumptive use permits for wells in the south grid area.

JEA is the seventh largest community-owned electric utility in the United States and one of the largest water and sewer utilities in the nation, providing electric, water and sewer service to residents and businesses in northeast Florida. The utility serves 305,000 water and 230,000 sewer customers.

The 6,575-foot-long segment was the longest 36-inch

Michels Directional Crossings and Michels Pipeline Construction were part of a successful design-build team in Jacksonville, Florida.

drill ever attempted by Michels Directional Crossings. The monumental project was made even more challenging by its direct proximity to the Arlington Expressway, a major east/west artery to downtown Jacksonville, and EverBank Field, home of the Jacksonville Jaguars professional football team.

The pipe and equipment remained highly visible throughout construction as it was staged in the grass median adjacent to the only opened eastbound lane of the expressway, giving daily commuters a chance to track progress during their descent over the Matthews Bridge as they left the city. Due to this high level of visibility, the project received substantial public scrutiny and media attention, being the subject of live news reports, daily blogs, forums and tweets that were soon silenced upon the swift disappearance of the pipe and equipment from the side of the expressway once pullback was successfully completed.

Work for the project started in early June and was completed by Aug. 15, more than a month ahead of the original projected schedule.

Michels Directional Crossings began HDD construction from the entry-side stadium parking lot (west side of the river) by driving down 160 feet of 60-inch-diameter steel containment casing using a Grundo Ram pneumatic hammer. On the exit side (east side of the river) Michels installed 200 feet of 60-inch-diameter steel casing from the ground surface using the pneumatic hammer. The casing was needed at exit side so the HDD operation would not destabilize the soil supporting an existing 42-inch storm sewer running parallel to and eventually crossing above the proposed HDD alignment.

Due to the size, length and complicated soil formation present, pilot hole intersect was the method of choice for drilling. It also served to alleviate environmental concerns regarding the use of HDD construction under a major U.S. waterway.

While drilling operations proceeded from both sides of the river, Michels Pipeline Construction crews were in the process of manipulating multiple strings of 36-inch steel water main and configuring the pieces for preassembly, welding, X-ray and coating. The temporary strings were then staged in three grass medians along the expressway between highly congested on- and off-ramps. Traffic and emergency plans had to be developed and implemented as eight highly traveled ramps had to be closed during pipe pullback so that the multiple pipe sections could be welded together in one continuous string immediately prior to pullback. The closure of the ramps, movement of the pipe sections into place, the tie-in welds between the pipe sections, and the internal/external joint coating all had to be scheduled weeks in advance and then expedited once the ramps were closed to meet Florida Department of Transportation requirements. On the HDD operations front, final reaming and hole preparation had to be coordinated as closely as possible with this same ramp closure date, adding yet another complex element to this project.

Along the colossal length of this HDD alignment, the crossing traversed through various geologically mixed-face transition areas consisting of sand, marl and limestone layers. These conditions and a particularly hard rock layer near the exit end of the HDD combined with several geometric design constraints also present-

The Jacksonville project was completed more than a month ahead of schedule.

ed some unique challenges for the installation. The sum of these challenges caused a big enough concern that Michels' new 300-ton Herrenknecht Pipe Thruster was mobilized and set up at the exit location as a contingency measure to assist with the pullback if necessary. In hind sight, it was an invaluable decision. After trying a couple of different pulling configurations and hole preparation techniques to get the pipe installation launched through the first and most difficult transition area near the exit end, ultimately the successful combination of equipment, HDD tooling and pipe buoyancy controls was quickly adopted to mitigate the challenges.

To complete the project with minimal expressway ramp closures, Michels Directional Crossings and Michels Pipeline Construction crews worked 24/7 to complete six tie-in welds and the HDD pipe installation. That effort allowed the project to be completed within 10 days of the initial road closures, well ahead of the start of the NFL regular season, which was a critical completion date.

"The teamwork, skills and dedication you have shown on this project is greatly appreciated," said Colin Groff, JEA Director of Technical Support Services. "It's great to see a plan 'come together,' but we know it takes hard work and skilled team members to make it happen."

Michels Directional Crossings Vice President Tim McGuire extended his praise to the crews.

"Every member of the team can take pride in the fact that you contributed to this great success and were part of something that will be long remembered as a significant milestone not only within our company but within the entire global HDD industry for years to come," he said.

Michels performed this project as a member of a design-build project team that included The Haskell Co., Jacobs Engineering Group and Michels Corporation. Successfully navigating and participating in the year-and-a-half-long JEA design-build process was also a first for Michels Directional Crossing. The team had to overcome numerous design constraints, permitting issues, bid protests, and budget limits to ultimately convince JEA of the unique value of the Michels-anchored team and move forward with construction of this monumental crossing.

Greg Goral is design engineer with Michels Directional Crossings. Jill Badzinski is Michels Corporation corporate writer.

Billions of Dollars in Sewer Upgrades Ahead for Miami-Dade

Mike Stimpson
PTR Communications

Southeastern Florida's Miami-Dade County is (according to the 2010 United States Census) home to 2.5 million people on its nearly 2,000 square miles. The most populous county in the state, and one of the most populous in the U.S., it includes the bustling city of Miami, which is also the county seat.

The Miami-Dade Water and Sewer Department (WASD) is responsible for seeing that residents and businesses in the county get clean tap water and reliable wastewater services. Its Vision Statement pledges "the continuous delivery of excellent, cost-effective water supply and wastewater services in compliance with all regulatory requirements." The WASD employs about 2,400 people in its mission of "serving the needs of Miami-Dade County residents, businesses, and visitors by providing high-quality drinking water and wastewater disposal services while providing for future economic growth via progressive planning; implementing water conservation measures; safeguarding public health and the environment; and providing for continuous process improvements and cost efficiencies."

Miami-Dade's population has been growing for decades. Unfortunately, the County's sanitary sewer system didn't keep up with the resultant increasing demand as well as it could have. Pipes eroded and leaked, and treatment facilities struggled to meet growing volumes.

Miami-Dade County agreed with state and federal authorities that something had to be done, and last year reached an agreement with the U.S. Environmental Protection Agency (EPA) and Florida Environmental Protection to implement $1.6 billion in upgrades to the wastewater system over the next 15 years. County commissioners approved the agreement in May 2013 by a 12-1 vote.

Miami-Dade WASD projects include replacement and rehabilitation of forcemains. (Photo: Smith Aerial Photos)

Miami-Dade has, overall, more than $4 billion in water and sewer work ahead in the next 15 years, Rodney Lovett notes at his office in Miami. He's chief of the WASD's wastewater collection and transmission line division.

"We typically have a lot of rehab on the gravity lines, and that's pretty much most of the work we do as far as trenchless work is concerned," he adds. "We do a lot of manhole-to-manhole CIP work, we have a lot of sectional work. We have a CIP contract that goes out on a yearly basis, and we're probably doing somewhere in the neighborhood of $3 million a year in CIP work, and probably another $500,000 to 750,000 in sectional work every year.

"Our big projects, however, have been the microtunnel and the Government Cut that's just been completed."

The Government Cut project is replacement of an aging line that an internal inspection determined was at grave risk of rupturing. The first phase was completed last September, on time and within budget.

Big projects ahead include rehabilitation of a 72-inch forcemain, which Lovett says will likely be done by either sliplining or cured-in-place or "maybe a combination of both." It will involve about 3.5 miles of pipe, and the selection process for a design-build team will start soon.

Also, the WASD has a design-build project to replace a 54-inch forcemain that runs from the Virginia Key Central District Wastewater Treatment Plant to Fisher Island. The project will include more than 5,000 linear feet of tunnel boring to accommodate a 60-inch pipe, approximately 1,000 feet of horizontal directional drilling to install an eight-inch pipe, and open-cut construction.

The EPA settlement or consent order followed more than a year of negotiation with the U.S. Department of Justice, the EPA and the state. Without it, the federal and state governments could have imposed more costly penalties on Miami-Dade.

What was the reaction in Miami-Dade County?

"It depends on who you talk to, I guess," says Lovett. "If you talk to the operational and maintenance staff, we wonder how it's going to get done and we understand it needs to be done. It's something we've been pushing for many, many years but we didn't have the funds or the support to get it done. In that point, we've actually embraced the consent order."

Upper management has a different perspective. They've authorized bonds to fund projects, Lovett remarks, "but I don't know if they fully appreciate the amount of work that has to be done."

For sewer services 15 years from now, he envisions "an improved utility that is able to have a greatly reduced amount of SSOs [sanitary sewer overflows] and operates lot better. I think the money and the resources will help. However, we've been through one previous consent order in my career here, and the problem is that once we're through the consent order, it seems that … we forget about all those things, and things pretty much go back to the way they were before.

"We kind of rely on the regulators to get certain work done, because we can't seem to do that without the regulators filing a consent order on us. That's unfortunate, but that appears to be the way it is. The really unfortunate part of it is that we're the ones taking the blame for it when all is said and done, and we're doing the best with what we've got."

All that work on Miami-Dade's water and sewer systems will have an impact on the cost of keeping a home there. "Our customers are going to be looking at rates that are going to probably at least double over the next 15 years," says Lovett.

Prospective bidders with questions about the bid process for projects should contact the office of Juan Carlos Arteaga, deputy director of the Miami-Dade WASD.

Resin Selection for CIPP

CIPP contractors are continuing to expand the envelope and rehabilitating pipes in new and expanded industries. Depending on the specific requirements, contractors will choose polyester, vinyl ester or novolac vinyl ester resins. Each has unique characteristics to meet specific needs for chemical exposure, temperature and pressure, or use with reinforced liners. Resin manufacturers can assist with proper resin selection, but there are some general guidelines for starting the resin selection process.

Various chemicals, temperatures and the pH levels of the materials that go through the pipes are critical factors in corrosive resistance.

- **Polyester resins** have excellent corrosion resistance in the pH range of 2 to 10 and a temperature range up to 150°F in water/wastewater.
- **Standard vinyl ester resins** can handle any pH and up to 180°F in water, but as with polyester resins this range can be limited based on specific chemicals present.
- **Novolac vinyl esters** can handle the full pH range at ambient temperatures, but high pH is an issue at elevated temperatures. Novolac vinyl esters are the most resistant to many organic solvents.

Both standard polyester and novolac vinyl esters resins have enough elongation for use with composites made entirely of glass. The addition of felt reduces the elongation of the resin so a higher elongation standard vinyl ester should be used to achieve the desired properties in glass/felt hybrid composites. Polyester resins can be used with reinforced liners designed to increase flexural modulus.

To select the specific resin that is best for an individual job, contact your resin supplier.

Statewide Study of I/I in Tennessee May Promote Trenchless Rehab

There is no simple test to directly measure inflow and infiltration.

George E. Kurz, P.E., DEE
Consulting Engineer

Results from a preliminary study of 34 municipal sewage collection systems in Tennessee for the year 2012 suggest that two-thirds of the systems may experience levels of inflow & infiltration (I/I) greater than 50 percent. (Figure 1) That means wastewater facilities in those communities may be annually treating flows twice the amount discharged by their domestic customers. The additional flow may include ground water entering through defects in the piping systems and rainfall-dependent I/I (RDI/I), which may include additional water percolating into the ground from rainfall or gross inflow from surface runoff.

The collection systems were randomly selected to be representative of size, popu-

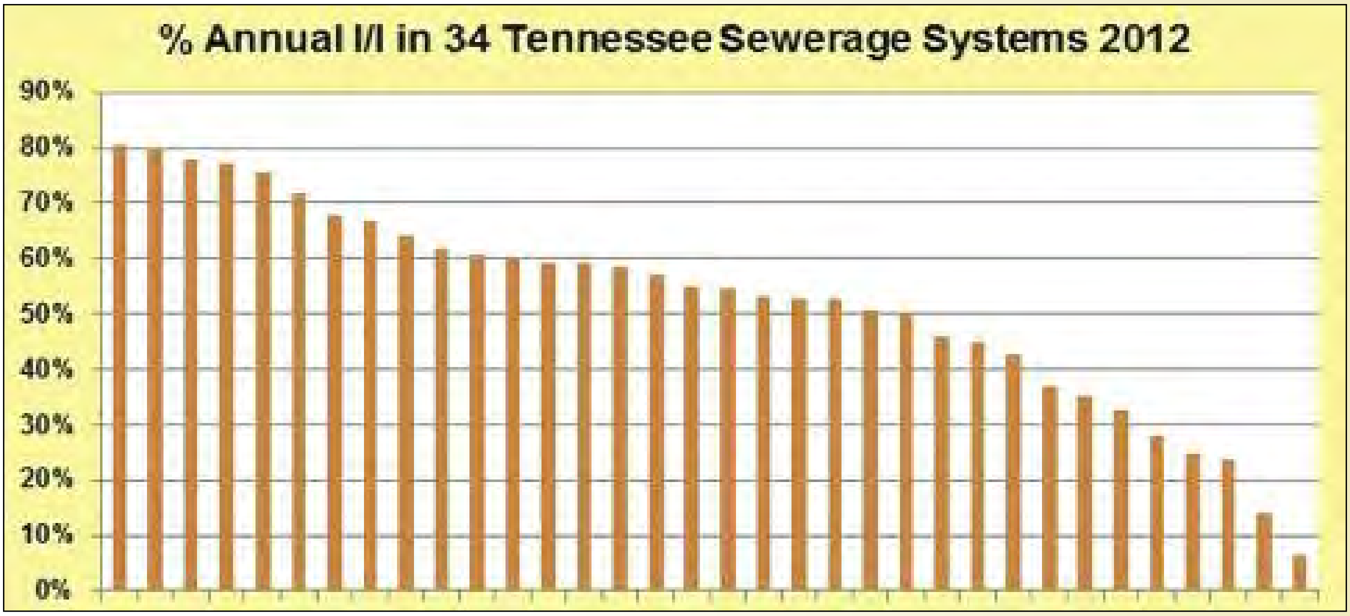


Figure 1. Percentage of annual I/I in 34 Tennessee municipal sewage collection systems

lation and geographic distribution across the state. This study is continuing and will include all 235 permitted municipal systems in the state by the end of 2014. The work is being conducted independently and not-for-profit, and is not supported or endorsed by any agency or organization.

Over the past several decades, municipalities and engineers have increasingly applied trenchless techniques to rehabilitate sewers to stop leaks and regain structural integrity. Many smaller communities, however, are unaware of (or not considering) the gradual deterioration of the collection system until overflows occur or treatment processes are hydraulically overloaded during rainfall events.

There is no meter or simple test to

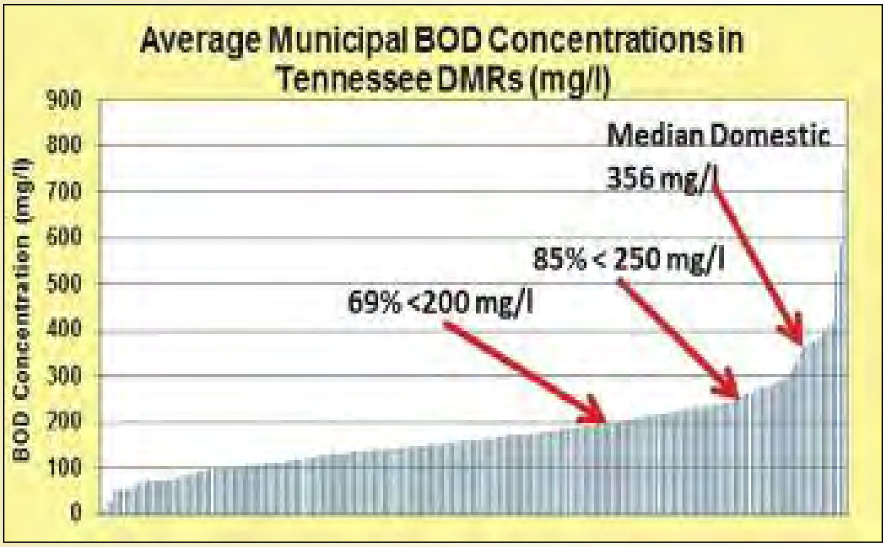


Figure 2. Range reported in DMRs for the average organic strength of wastewater influent to 228 treatment plants in Tennessee in 2007–2008. Various threshold levels are indicated to highlight that most systems experience significant dilution

directly measure I/I. Detection and quantification has typically been a process of analyzing sewage flow and rainfall monitoring results at varying levels of complexity. In Tennessee, I/I is not one of the numerical standards of compliance in an NPDES (National Pollutant Discharge Elimination System) permit for municipal dischargers. However, the regulatory agencies understand that I/I may be the root cause of some permit violations and a municipal system may be required to initiate a program to reduce I/I and rehabilitate its system in response to violations of permit conditions.

The huge amounts of data collected by EPA and states on treatment plants prompted the question: "Is there a way we could measure I/I in every permitted system for developing (or improving) a comprehensive state (and national) control strategy?" One purpose of this study was to illustrate simple techniques to develop a broad database for better management.

The first phase of this study was to evaluate the influent data from Discharge Monitoring Reports (DMRs). An 18-month period in 2007-2008 was studied. Results from an earlier study (Kurz & Qualls, 2001), suggested that dilute BOD (Biochemical Oxygen Demand) concentrations may be a good indicator of I/I levels. The range of average influent BOD reported in DMRs for 228 municipalities was 3 to 898 mg/l.

An examination of all 4,218 monthly records revealed that some of the extreme low values were invalid and related to poor data entry by the permittees. Some of the high values were reported in cities that have large, high organic strength discharges (e.g. a brewery in Memphis). However, the overall range shown in Figure 2 is considered to be representative. If we knew the concentration of undiluted wastewater in these cities, then the level of I/I may be calculated easily.

If the assumption about dilution is correct, then what BOD concentration should be used as a baseline? Various textbooks and design manuals have suggested ranges for "weak, medium, and strong" BOD levels influent to a treatment plant when influent data is not available. However, practitioners generally understand that these concentrations represent various degrees of dilution. So: "What is the concentration of raw, undiluted domestic sewage?"

T.R. Bounds (1997) summarized the results of several studies where wastewater was collected at individual residences – before any chance for dilution by I/I. He reported BOD levels ranging from 146 to 598 mg/l with a median of 356 mg/l. That concentration is indicated for reference I Figure 2. His numerical results are depicted in Figure 3.

To be conservative, the second phase of this study uses a BOD concentration of 300 mg/l as the basis for calculation. This

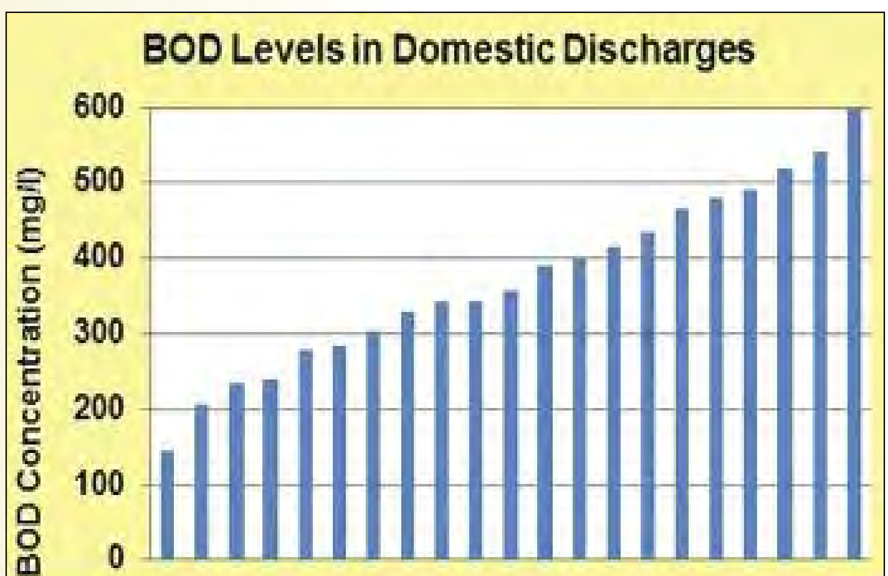


Figure 3. Organic strength (measured as BOD concentrations) of domestic wastewater measured from residences and reported by T. R. Bounds (1997)

phase will evaluate the MORs (Monthly Operating Reports) submitted by 235 permittees to the state for the year 2012. These reports include daily flow and rainfall figures, and influent BOD information (generally collected less frequently). Some of the early results were shown in Figure 1. The procedures for analysis were described by Kurz, et al. (2009).

The condition of infrastructure and I/I problems are assumed to be similar for sewage collection systems across states in the southeast United States. However, Tennessee was selected for this study due to a renewed interest in controlling I/I in that state. The regulatory staff launched an initiative to focus on stopping I/I in municipal systems by revising the state's Design Criteria, evaluating funding mechanisms, and improving O&M (Operations and Maintenance) procedures with respect to I/I detection, control and reduction. These ideas were included in a set of "Guiding Principles" (Dudley, 2012). The first phase of work was completed by the end of 2013.

Estimating I/I from daily rainfall and plant influent records is generally a poor substitute for a state-of-the-art I/I flow and rainfall monitoring study. However, the cost of such studies may inhibit smaller communities from considering evaluating I/I in their collection systems and conducting rehabilitation to reduce leakage. One intention of this study is to describe a simple, non-proprietary technique that can be applied by any treatment plant operator or state regulator to existing information for the purpose of estimating I/I. Those systems that determine that I/I levels are excessive may then see value in conducting a more detailed Sewer System Evaluation Survey that leads to sewer rehabilitation and a reduction of wasteful I/I.

REFERENCES

- *Bounds, T.R., (1997) Design and Performance of Septic Tanks. Site Characterization and Design of Onsite Septic Systems ASTM STP 901, M.S. Bedinger, A.I. Johnson, and J.S. Fleming, Eds., American Society for Testing Materials, Philadelphia.*

- *Dudley, S. (2012) Tennessee Collection Systems – Guiding Principles, Goals, and Implementation Methods. Tennessee Division of Water Resources, Nashville, Tennessee.*

- *Kurz, G., Qualls, S. (2001) Estimating the Extent of I/I in EPA Region 4 Using NPDES Monitoring Reports, Proceedings of WEFTEC-2001, Atlanta, Georgia.*

- *Kurz, G., Ward, B., Ballard, G. (2009) Rainy Day Calculations. Water Environment and Technology, September 2009, 97-103.*

Repair of Culverts with StifPipe™

Mo Ehsani, PhD, PE, SE
President, PipeMedic, LLC

Corrugated metal pipe (CMP) culverts have been used for decades in highway construction. Many of these structures have deteriorated over the years and are in need of repair. In most cases, the culverts support traffic loads, so any repair or replacement must restore the structural integrity of the original culvert.

The newly developed StifPipe™ takes advantage of developments in the aerospace field to build a lightweight but very strong pipe. Unlike conventional pipes, the wall of this pipe is not solid. It consists of a lightweight honeycomb that is covered with glass or carbon fiber reinforced polymer (FRP) as skin reinforcement. Similar to an I-beam, the honeycomb acts as the web portion, while the strong FRP layers represent the flanges in an I-beam.

The construction of the pipe begins by building a mandrel of the desired size and shape. The mandrel is covered with a nonbonding release material. Depending on the design requirements for internal pressure rating of the pipe, one or more layers of carbon fabric saturated with resin is wrapped around the mandrel. These fabrics typically have a thickness of less than 0.05 inches per layer. For gravity-flow pipes, lower-cost glass fabrics can be used in lieu of carbon.

Next, a honeycomb sheet is coated with epoxy and wrapped around the carbon fabric; the thickness of the honeycomb typically varies between a half-inch and 1 1/2 inches, and is determined based on the overall stiffness and strength requirements for the pipe.

Additional layers of carbon or glass fabric saturated with epoxy are wrapped on the outside of the honeycomb. The pipe section is cured in ambient condition before it is removed from the mandrel. If necessary, the curing process can be accelerated by heating the assembly to a moderate temperature (e.g., 180 degrees Fahrenheit).

The relatively simple construction technique allows pipes to be made to virtually any size or shape (Fig. 1); this is particularly helpful for repair of non-circular culverts or sewer pipes. The pipe weighs only 10-15 percent of what conventional pipes weigh, which lowers transportation and installation costs. The non-metallic pipe does not corrode.

FIELD INSTALLATION

The first installation of StifPipe was recently completed at the Arc Terminal in Mobile, Alabama, to repair a 60-foot-long 24-inch CMP that was corroded. Due to access limitation, the client required pipe

Figure 1. StifPipe can be made to virtually any shape.

Figure 2. StifPipe is made and connected on site.

sections that were only eight feet long. The construction of the pipe consisted of two layers of glass fabric on each face of a half-inch-thick honeycomb. This resulted in a nominal wall thickness of 0.7 inches. In order to maximize the flow through the pipe, the internal diameter of the pipe was selected as 20 inches. Figure 2(a) shows the manufacturing of the pipe.

To connect the pipe segments, a slightly larger-diameter StifPipe of the same construction was built. As shown in Fig. 2(b), the pipe segments can be connected using the sleeves. The completed eight-foot-long pieces of the pipe weighing about 50 pounds each can also be seen in the photo. The pipe segments were shipped to the job site.

The corroded culvert is shown in Fig. 3. The lightweight StifPipe segments were easily lifted by hand and assembled together. The finished segments were manually pushed into the pipe. The annular space around the liner was filled with grout, and the completed installation is shown in Fig. 4.

Figure 3. Highly corroded culvert at Arc Terminal

Figure 4. StifPipe at Arc Terminal – completed installation

ADVANTAGES

The main advantage of the new StifPipe for gravity-flow applications is the fact that the pipe can be manufactured to virtually any size and shape. This will minimize flow loss and grouting requirements during installation. Depending on the size of the project, a temporary manufacturing facility can be set up at or close to the job site. The constituent materials are shipped in a compact container that will reduce transportation charges compared to shipping completed pipe sections. The lightweight pipe reduces labor costs and minimizes the need for heavy equipment during installation. A mobile manufacturing unit is currently being designed that will further facilitate on-site construction of the pipe.

The method of manufacturing StifPipe and repair of pipes described above are subject to pending U.S. and international patents by the author.

A Challenging Water Transmission Main Inspection and Condition Assessment for the City of Asheville

Kelly Derr, P.E.
Brown & Caldwell

Keith West, P.E.
Brown & Caldwell

Mark French
Wachs Water Services

Most of the potable water for the City of Asheville, North Carolina, originates from two pristine water reservoirs east of the city, delivered through two water transmission mains. One is a 31,400-foot-long, 87-year-old 24-inch-diameter cast iron main and the other is a 67,500-foot-long, 52-year-old 36-inch steel main. The first section of the 36-inch main is prestressed concrete cylinder pipe (PCCP). Flooding due to a hurricane in 2004 caused severe localized soil losses which undermined a section of the steel pipe, causing it to fail. The City decided it needed to inspect these pipelines to assess their condition and to determine what actions needed to be taken to maximize their reliability and integrity.

The two mains presented a number of challenges: they could not be taken out of service due to their critical nature; the pipelines drop over 450 feet in elevation over their length, resulting in pressures ranging from 15 psi at the upper reservoir to almost 200 psi at the lower end; the precise location of the mains was not certain due to missing records; and access to the mains was difficult, with portions of the mains in paved roads, portions in remote areas with no access, and numerous sections suspected of being under structures.

Brown and Caldwell was tasked with developing and implementing an inspection program, assessing the pipe condition, identifying risks and developing an action plan. This article discusses the inspection phase of the project.

Inspection

There are a number of inspection technologies available for ferrous mains. Due to the lack of insertion points and the requirement to keep the pipeline in constant operation, it was decided to use a relatively new tool called the LDS1000 which combines CCTV inspection with acoustic leak detection. Developed in the United Kingdom by JD7 and provided in the U.S. by Wachs Water Services, the LDS1000 is a tethered tool that provides both a digital video and digital audio record of the interior of the main. It can be inserted into the active main through a two-inch-diameter hot tap. The section of PCCP pipe at the water plant was inspected using the PipeScanner technology from Pure Technologies. This electromagnetic tool checks for broken wire zones in the pipe and is applied to the exterior of the pipe wall.

Desktop and surface inspections of the pipeline route were used to screen for potential external corrosion sites due to stray currents from other utilities or due to corrosive soil conditions.

The LDS1000 is a tethered tool which uses the energy of the flowing water against a parachute to propel the tool through the pipe for up to 3,000 feet, depending on pipe geometry. Due

Figure 1. View of the CCTV Camera of the LDS1000

to the pressure and flow rates in the water mains and the presence of bends and fittings, a practical limit of less than 2,000 feet was used. This meant that an insertion point was required every 1,500 to 2,000 feet. Existing ARV sites were used where feasible, and hot taps were installed elsewhere along the route.

Challenges

The inspection faced a number of challenges. These included:

1. Lack of original pipe construction details. The type of joints used, and the nature of both internal and external coatings were not completely known. It turns out the steel pipe joints were a combination of welded joints and dresser type couplings. The pipe was found to have an internal lining and an exterior coal tar wrap.
2. Pipeline route. The exact location of the mains was not known in several areas where development had taken place over the pipeline; 32 of the parcels along the route did not have a recorded easement.
3. High pressures. Operating pressures exceeded 200 psi at the lower elevations. The insertion equipment operated well up to about 150 psi but proved more difficult at the higher pressures. The inspection team augmented the insertion process by applying the "ten digit" insertion method. This was slow going, but it worked.
4. Difficult access. Structures had been constructed over the mains, and much of the route went through heavily wooded terrain, through 'occupied' pastures and through the grounds of Warren Wilson College. Many of the sites were in residential back yards and along roadsides.
5. Weather conditions. Inspection work took place in the North Carolina mountains from October 2012 to April 2013. Conditions were often wet, cold and snowy.

These challenges were successfully addressed during the inspection program through on-site adaptation and cooperation among all parties.

Results

The inspection ultimately delivered visual and acoustic inspection data on 93,883 feet (17.8 miles) of transmission main.

The 36-inch steel main was free of any construction debris, air pockets or leaks. The fit-up and welding of the joints, as viewed from inside the pipe, was of very high quality, including sections where the profile had extreme angles of deflection.

There were areas of minor sediment accumulation in the higher elevations of the pipeline nearer the North Fork Water Plant. While the sediment was not significant, there was enough to suspend in the water flow when the LDS1000 inspection device traveled down the main. In order to prevent stirring up the sediment and causing water quality issues downstream, the inspection insertions near the North Fork Plant were spaced out a week apart and only performed early in the work week. This action significantly reduced discolored water issues.

There was very little tuberculation observed in the 36-inch main and insignificant levels of internal wall corrosion. What little corrosion was observed was at the welded joints. The overall internal visual and acoustic condition of the 36-inch was very good. The pipe wall showed minimal to no visible interior corrosion or pitting.

The CCTV inspection included observation of the valving in the transmission mains. The valves were observed to be in good condition and operating properly.

The 24-inch cast iron transmission main was free of any construction debris. There were no air pockets detected, but three small leaks were identified. The fit-up and joints, as viewed from inside the pipe, were of very high quality, including sections where the profile had extreme angles of deflection.

There were areas of minor tuberculation in the cast iron main and very little visible corrosion on the interior. As with the steel main, there were areas of minor sediment accumulation, chiefly in low spots in the main near blow-offs or where the pipe changed direction. The amount of sediment buildup had no significant impact on capacity.

Overall, both transmission mains are in very good condition with many years of useful service left. Minor repairs needed to address surface risks and leaks are being undertaken to further improve reliability of these critical transmission mains.

Figure 2. Inspection of transmission main in Asheville, North Carolina

1,133 Feet of Microtunneling

Michael Gibson, P.E.
Area Manager, Bradshaw Construction Corp.

Lester M. Bradshaw Jr.
President, Bradshaw Construction Corp.

Bradshaw Construction Corporation (Bradshaw) recently completed a single 1,133-foot-long microtunnel drive of 96-inch OD Permalok steel casing for the Metropolitan Sewer District (MSD) of Louisville & Jefferson County, Kentucky. This paper highlights certain challenges of slurry microtunneling long drives of steel casing in fine-grained soil conditions, as well as project specific difficulties related to the microtunneling and installing two carrier pipes to design grade through a single casing.

The River Road Interceptor project was designed to improve MSD's sewer network. It is located partially within the City of Prospect, Kentucky. The scope of the project included a 42-inch gravity sewer and 30-inch PVC force-main installed underneath Harrods Creek, U.S. Highway 42, and then Harrods Creek again. The project was designed with six separate trenchless crossings. The contract geotechnical report indicated the trenchless crossings would be installed through a full face of silt, well below the water table, with an approximate depth of 35 feet, to invert from the ground surface.

The bidding process allowed the contractor to propose an alternative trenchless design and installation method with their bid. Bradshaw proposed one long, larger-diameter trenchless installation in lieu of the six designed. This would allow both sewer lines to be installed within a single jacked steel casing. To accomplish this, the casing diameter was

Bradshaw provided intermediate jacking stations and a high-volume bentonite lubrication pump.

increased to 96 inches and the three relatively short trenchless crossings increased to 1,133 feet in length. Slurry microtunneling was chosen for the installation method because the casing was below the water table in silt and there was less than one diameter of cover at both crossings of Harrods Creek. The casing grade was set to that of the 42-inch gravity sewer and a custom cradle designed and built to ensure proper grade of both sewer lines.

Flynn Contracting (Flynn) bid the project using Bradshaw's alternative trenchless design and method. They were awarded the project and subcontracted the trenchless work to Bradshaw.

Geology & Environment

With the proposed single-drive alternative, one of Bradshaw's primary focuses was to understand the ground conditions to be encountered. The ground needs to be excavated, transported, and separated for the slurry-based microtunneling system to work. Although the contract geotechnical report detailed a full face of silt, Bradshaw obtained additional soils information to better understand the behavior of the soil. Key parameters to understanding ground behavior include geological makeup, particle size distribution and plasticity index. This information was used to determine the type and size of the slurry separation plant and then supplementing them as needed. Even with the additional pre-construction soil borings, the soils encountered contained a greater percentage of plastic clays than anticipated.

In addition to the geological conditions, weather and potential flooding was a significant factor when planning this project. The elevation of Harrods Creek is highly dependent on the Ohio River, which fluctuates greatly depending on regional and local rainfall events. The choice of a single longer drive increased the exposure time to potential flooding. Bradshaw therefore chose to do the construction in the dry-season. However, even with this precaution, the project experienced a few flooding events. Flynn and Bradshaw were prepared with contingency operations to keep the microtunneling equipment from being damaged from flooding.

Microtunnel Construction

Bradshaw analyzed and adjusted the tooling of the MTBM cutter wheel, optimized the slurry line transport lines, mobilized four centrifuges and a de-silter, and implemented a unique polymer injection system at the point of separation. In addition, Bradshaw made contingent resources available to minimize stoppages. This proved critical since the jacking forces experienced were high due to the long drive, soil conditions, and shallow cover under the creeks. Among other features, Bradshaw provided intermediate jacking stations in the Permalok casing and a high-volume bentonite lubrication pump.

Another challenge with long drives includes access to the MTBM for any routine maintenance or unexpected repairs, as well as surveying. Due to the jacking length, Bradshaw implemented three layers of alignment and grade checks. These included the standard tunnel laser, self-performed and outside subcontractor survey checks. Bradshaw recommends any subcontracted surveying be quality-control checked on a regular basis, as many surveyors do not understand the necessity for accurate results, or the potential for atmospheric laser deflection within a jacked casing environment.

The ground needs to be excavated, transported, and separated for the slurry-based microtunneling system to work.

After completion of the microtunneling, Bradshaw restrained the casing against floatation beneath the Harrods Creek crossings by installing a concrete cradle to counterbalance the flotation pressure, as well as welding many of the Permalok joints.

Carrier Pipe Installation

The two sewer lines were installed on a custom-built steel cradle one pipe joint at a time, surveying the invert of each joint. Although this process took substantial time, it was the only way to ensure the gravity line was installed to the 0.037% design grade and the forcemain had the specified clearance with no peaks to trap air.

Bradshaw assisted Flynn with the testing of the sewer lines by building a 71-ton capacity thrust restraint in each shaft. After successful pipe testing, Bradshaw backfilled the annulus between the sewer lines and the casing with a foam entrained cement slurry mix. This "cellular" backfill mix required on-site engineering quality assurance to verify the specified air-entrainment and unit weight goals were reached.

Large-diameter and long-length microtunnel drives can be successfully completed with a great deal of planning and an experienced microtunneling contractor. This type of project also necessitates the use of an on-site engineer full-time for problem solving and quality assurance. Such microtunnel drives necessitate a thorough soils investigation program as well as understanding those results in terms of properly excavating, transporting, and separating the microtunneled soils. As illustrated by this project, allowing a prudent trenchless contractor to implement alternative means and methods of construction can lead to a more efficient design which provides the desired product at less cost to the owner.

Avast Ye Auction

APRIL 14, 2014

NASTT'S 13TH ANNUAL EDUCATIONAL FUND AUCTION & RECEPTION

AHOY! Mark your calendars for NASTT's fundraising social event of the year – the 13th annual Educational Fund Auction and Reception! Since 2002, NASTT has raised over $600,000 in gold coins to support our educational initiatives. Due to your generosity, NASTT is able to sponsor students' attendance at the No-Dig Show, award scholarships and provide targeted training courses to the membership at-large.

This year's event will feature live and silent auctions, a costume contest, and the popular Caribbean and 50/50 raffles.

For more information about the auction visit:

NASTT.ORG/AUCTION

INDEX TO ADVERTISERS

Please support the advertisers who have made this publication possible