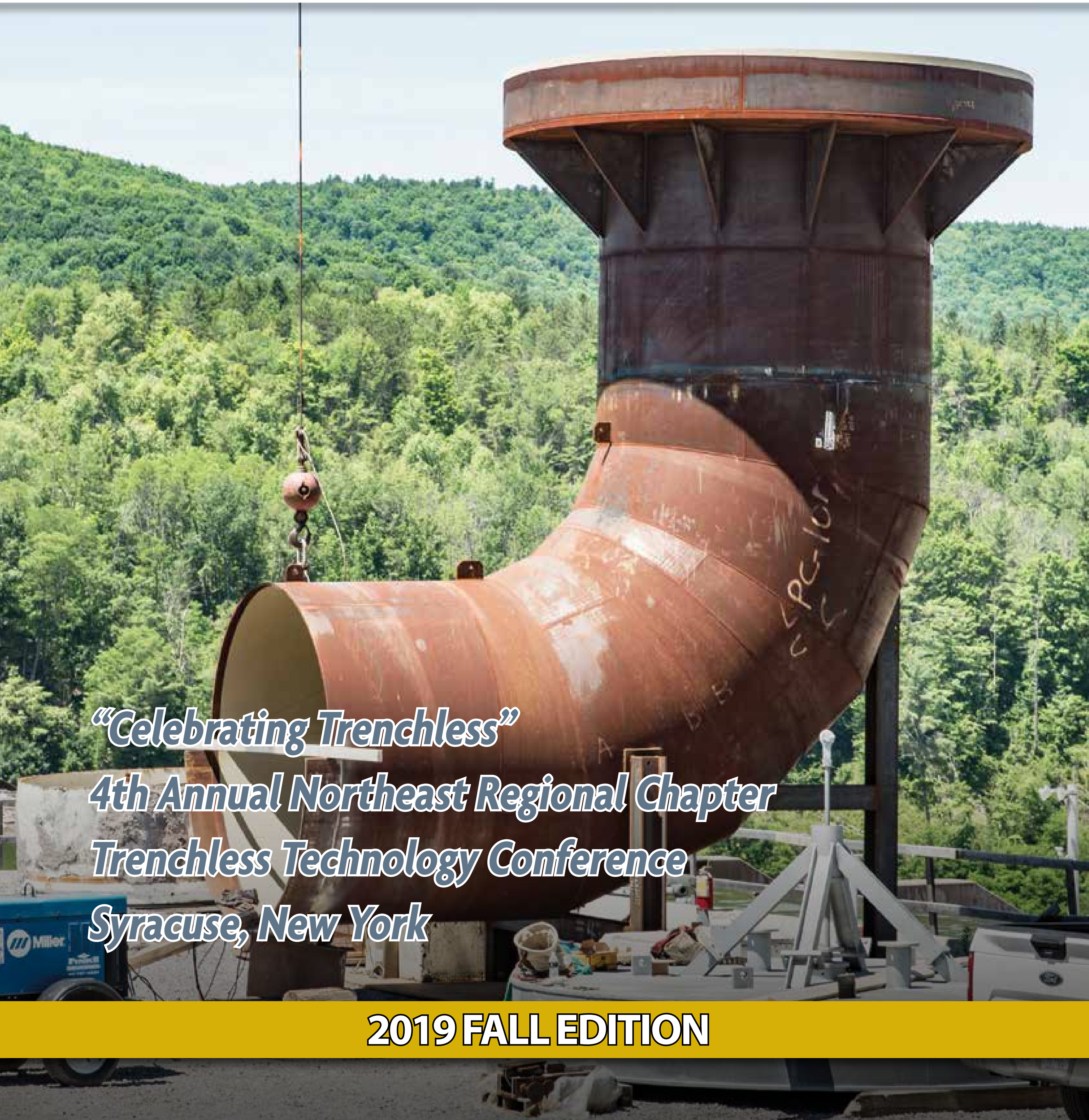
NORTHEAST REGIONAL CHAPTER
NASTT

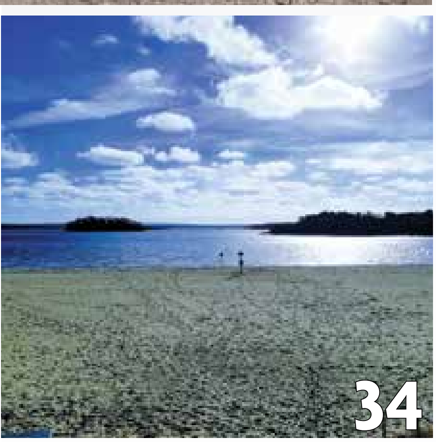
NORTHEAST JOURNAL
OF TRENCHLESS TECHNOLOGY PRACTICES

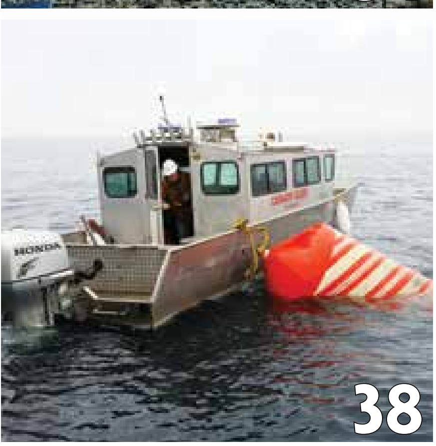


"Celebrating Trenchless"
4th Annual Northeast Regional Chapter
Trenchless Technology Conference
Syracuse, New York

2019 FALL EDITION

CONTENTS





FEATURES:

17 NASTT-NE 2019 PAPER OF THE YEAR:

The NASTT-NE 2019 Paper of the Year was selected from 8 entrants from the Northeast Chapter region that were presented at the 2019 NASTT No-Dig Show in Chicago. The entrant papers cover trenchless work across the Northeast. Each year NASTT-NE honors those members that work on exciting and innovative trenchless applications and research that directly benefits the industry and helps it grow.

29 Another Gilboa Dam Milestone: MTBM Wet Retrieval

One of the largest microtunneliing machines ever built recently completed mining a 2160 LF 108-inch Low Level Outlet as part of a major dam reconstruction program. In mid-July the MTBM was retrieved from the bottom of the reservoir Intake Structure at a depth of approx. 153 feet. Gate Shaft, Valve Chamber and Intake Structures are completed. Project winds up in 2020.

34 Protecting Marshes, Waterways and Coastline

Details on an important CIPP Sewer Rehabilitation of a 1.8 mile 18/21-inch RCP interceptor running directly underneath the beaches sensitive bays and salt marshes within the seaside community of Wareham MA. Trenchless technology has helped this seaside community preserve its valuable coastline resources for future generations.

38 Pigging Restores Intake Flow Capacity

Large diameter hydraulic pipeline cleaning using pigging has proven effective at clearing fouling of deep water intakes from quagga mussels, zebra mussels and other debris. After cleaning the pipelines will at times demonstrate better water flow conditions than when they were new.

ALSO:

43 Effects of New England Glacial Lakes on Microtunneling
46 Checking the Health of Cast Iron Pipe
50 UMass Lowell Student Chapter Report – 102-inch Slipline

Departments:

Welcome Message from the NASTT-NE Chair 7
Message from the NASTT Executive Director 8
Membership in NASTT 9
Introducing NASTT-NE 2020-2021 Board Executive Committee 10
NASTT-NE 2020--2021 Board of Directors 12
In Memoriam: Tom Perry 1961 – 2019 13
Center of Excellence (CETTUE) 13
2019 NASTT-NE Trenchless Conference Agenda 14
Thank you Mike Willmets! 16
Save the Date – 2020 NASTT-NE Conference 54
Index to Advertisers 55

COVER PHOTO CREDIT: **John Arciszewski, Southland/Renda Joint Venture**

NASTT NORTHEAST REGIONAL CHAPTER

Chair – Ian Mead
imead@tighebond.com

Vice Chair – Babs Marquis
marquis@mcmjac.com

PUBLISHER

A to B PUBLISHING INC.

662 Dudley Avenue
Winnipeg, MB Canada
R3M 1R8

EDITORIAL
Andrew Pattison
204.275.6946
marcomap@shaw.ca

ADVERTISING SALES
Bert Eastman
204.997.6371
bert@atobpublishing.com

PRODUCTION TEAM

harper media
your social media strategy & web marketing partner

700 - 200 Main Street
Winnipeg, MB
R3C 1A8

DIRECTOR
Aaron Harper
204.318.1121 xt. 101
aharper@harpermedia.ca

LAYOUT & DESIGN
Joel Gunter
204.318.1121 xt. 108
joel@harpermedia.ca

Printed 10/19 in Canada.

HOLE HAMMER

MESSAGE FROM NASTT-NE CHAIR

Ian W. Mead, P.E., BCEE, NASTT-NE Chair

Welcome to the Fall 2019 edition of the NASTT Northeast Regional Chapter's *Northeast Journal of Trenchless Technology Practices*. In this edition, we are pleased to announce the second annual **NASTT-NE 2019 "Paper of the Year**." Congratulations to authors Brian Lakin, Joe Schrank, Daniel Ebin and Lawrence Marcik on the recognition of their paper: **"Great Hill Tunnel Rehabilitation: A Comparison of ROV and Manned Inspections of a 1927 Water Tunnel" (reproduced in full pp. 19-28**). They will also be recognized at our Fall 2019 conference.

There is an impressive lineup of articles in these pages, featuring a report on completion of the Schoharie Reservoir low-level outlet involving wet retrieval of the MTBM unit; a look at a CIPL project preserving valuable marshlands and coastline in Wareham MA; non-destructive testing for assessing wall thickness and graphitization in cast iron and steel gas pipe; use of a pigging method to clean water intakes; and Part 3 of the series on geological history examining the effects of New England's glacial lakes on microtunneling. There is also a report from our UMass Lowell NASTT Student Chapter on a field visit to a large diameter sliplining project.

The NASTT-NE Chapter has been hard at work finalizing details for the 2019 trenchless conference in Syracuse, NY on Tuesday, November 12th, at the Embassy Suites by Hilton Syracuse Destiny. A free welcome reception will be held at Dinosaur Bar-B-Que Monday, November 11th for all conference attendees. Municipal scholarships for NY public sector employees are still available. Please visit our website at www.nastt-ne.org for the latest information, registration and hotel details.

The annual conference will also include a changing of the guard at the chapter level. We have completed elections for the next two-year cycle of the Board of Directors. The new Executive Committee and Board of Directors are noted in this edition and will also be announced at the Conference. Congratulations and welcome to our new Directors!

We continue to work with our UMass Lowell student chapter, now that they are back in classes, to schedule guest lectures and field trips for the year. More in depth discussions on the establishment of a trenchless center of excellence at UMass Lowell have occurred. We are now actively seeking industry partners to support this initiative with a financial commitment, to support the continued improvement of trenchless technologies and aid in the training and development of the next generation of trenchless professionals. **Please take a moment to engage with our student chapter members and advisors when you see them at our annual conference, as they represent the future of our industry**.

Conducting the business of this chapter (especially hosting our annual conference and the publication of this journal) would not be possible without the generous support of our sponsors and vendors. Please reach out to those who have advertised and contributed to the journal, and visit with our vendors at the annual conference. We hope the time you spend reviewing the articles and information in this latest edition will encourage you to get involved in the chapter, perhaps with an article for the next journal or a presentation at the next conference. The Northeast Chapter is a strong voice for trenchless in the region, and we need your support to ensure that the Chapter succeeds and grows.

"PLEASE JOIN US"

The past two years as Chair of this chapter have flown by for me. It's been a lot of fun, and I'm proud to say our Chapter has set the bar high for others. We have a great, energetic group of trenchless professionals in this region! Thank you to all our chapter members for participating, reading and sharing the journal, and joining us at our annual conferences. Thanks also to our current Past Chair, Executive Committee, and Board of Directors for your time and dedication to the chapter.

Please join us!

Ian W. Mead

Ian W. Mead, P.E., BCEE
(Outgoing) Chair, NASTT-NE

NASTT-NE SITE

MESSAGE FROM NASTT EXECUTIVE DIRECTOR

Michael J. Willmets, NASTT Executive Director

Our trenchless industry is rapidly expanding its reach every year. 2019 has witnessed this growth and the feedback from our membership is nothing but positive news. As a reflection of this growth, NASTT's 2019 No-Dig Show held in Chicago this past March was once again an incredible success and an event we are so very proud to call our own. We welcomed over 2,000 attendees from all over the world. We presented the premier trenchless technical program and had more exhibitors than we've ever hosted! None of this would be possible without our dedicated volunteer membership including your Northeast Chapter members.

Looking ahead to November, I am excited to be able to join you once again at the 2019 Northeast Trenchless Conference in Syracuse, New York. This conference promises to offer excellent learning and networking opportunities for trenchless industry professionals. The event includes many technical presentations covering a wide variety of trenchless topics and an exhibit hall bringing you industry innovations for trenchless products and services. You will also want to make sure that you attend the networking event prior to the conference as well. The connections you can make will be invaluable!

Our organization is also extremely excited about the first annual No-Dig North conference in Calgary this October. In recognition of the need for quality trenchless education in Canada, all three Canadian NASTT Chapters have joined forces for the first time to host a combined trenchless technology conference. If you do business in Canada, make plans to join us at the Telus Convention Centre, October 28-30.

As you can imagine, plans for NASTT's 2020 No-Dig Show in Denver, Colorado, April 5-9, are well under way. The 2020 technical paper program will have 160 informative and innovative presentations. The exhibit hall will be full of new products and services to support the trenchless industry as well. We will also host our Good Practices training program which includes nine different specialized full and half-day courses. This is an event you simply cannot miss! If you are a municipal or public utility employee, be sure to apply for NASTT's Municipal & Public Utility Scholarship Program Award. You can find all the details at www.nastt.org. The application deadline is November 1.

Again, I cannot thank our Northeast Chapter volunteers and members enough for your dedication and support. Your chapter epitomizes the mission and vision of NASTT. I look forward to joining you in Syracuse, New York for the regional conference as well as seeing you in Denver next April and maybe even in Calgary in October!

Michael J. Willmets

NASTT Executive Director

MEMBERSHIP IN NASTT

Carolyn Hook, NASTT Membership Outreach & Database Manager

MEMBERS TALK NASTT MEMBERSHIP

As the Membership Outreach and Database Manager at the North American Society for Trenchless Technology (NASTT), it's my job to be able to speak about the value of NASTT membership and all it offers beyond professional credibility and information. NASTT is a community of peers where members are connected to go-to people in the trenchless industry – innovators, experts and a network of students and future trenchless professionals.

At every stage of their career, NASTT members have access to a comprehensive set of tools ensuring success.

- **Engage in learning**. NASTT member-only pricing for top-notch training courses, conferences and webinars.
- **Expand your knowledge set**. Largest online trenchless library of technical papers.
- **Increase your visibility**. Opportunities to speak at conferences, write for publications, volunteer to serve and give back.
- **Propel your career**. Career resources, including NASTT's Job Board.
- **Empower your position**. *NASTT's No-Dig Show* - North America's premier Trenchless Technology Conference and Trade Show.
- **Connect locally**. Regional educational and networking events.
- **Find answers at your fingertips**. Subscriptions to *NASTT's Trenchless Today*, *NASTT's Regional Chapter magazines*, *ISTT's Trenchless International* and *Trenchless Technology*.

NASTT is the largest community of trenchless professionals in USA and Canada committed to promoting better and more responsible ways to manage underground infrastructure and advance trenchless technology for the benefit of the public and the natural environment.

That's what I would say. But what about NASTT members, do they agree? It's also my job to know what NASTT members think about membership. So, I asked a few to share their insights. Here's what I found out.

NASTT Transforms Careers

"Having come from an entirely different industry focusing on natural gas, the common link of construction bonds the two industries closely together. Membership has made me a well-known nationally recognized expert in the use of trenchless and its applications in two industries. When I do not know the answer, I can call on an established network of key contacts and access a library of technical papers. Membership allows me to maintain a current and state-of-the-art awareness of trenchless methods and potential improvement areas that I address through my R&D activities." *– George Ragula, Distribution Technology Manager, PSE&G*

NASTT Provides Leverage for Corporations, Municipalities, Educational Institutions and More

"NASTT is far and away the leading educator and networking pool in the trenchless industry. If your company plays a part in the trenchless industry, you will benefit from NASTT membership much more than you realize." *– Joe Lane, Vice President, International Operations, Infrastructure, Aegion Corporation*

"We advertise that our staff are members of NASTT for RFPs and on Trenchless resumes." *– David Crowder, C.E.T., C.D., Senior Associate, Trenchless Practice Leader, R.V. Anderson Associates Limited*

"I get to network and share ideas with other like-minded professionals. I've learned about new technologies that make us work more efficiently." *– Tayo Olatunji, PE, PMP, CCM, Supervisor Construction Projects, DC Water*

"The bottom line is that active membership benefits me professionally and, in turn, my company can provide unique and cost-effective solutions to challenging projects." *– George Ragula*

Regional Chapters Bring NASTT to Your Backyard

"The quality and dedication of local volunteers makes working in the industry much easier, more fun and extremely fulfilling." *– Joe Lane*

"Regional chapters make it easy to meet locally with engineering consultants and municipal staff who share the same passion for trenchless technology, learn new ideas and discuss other trenchless topics." *– David Crowder*

"Seeing the impact that trenchless technology has on our communities and the country makes chapter participation worthwhile." *– Alan Goodman, Strategic Accounts Sales Manager, HammerHead Trenchless Equipment*

What about you? How has NASTT membership made a difference in your career? Email me at chook@nastt.org and let me know. You Belong in NASTT!

YOU BELONG IN NASTT!

INTRODUCING 2020 – 2021 NASTT-NE BOARD

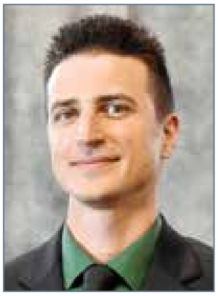
BABS MARQUIS – CHAIR

Babs Marquis is presently the Trenchless Practice lead for the East Coast and Construction Manager with the Burlington, Mass., office of McMillen Jacobs Associates. He previously worked for Jacobs Engineering Group for 10 years and Stone & Webster for 11 years. During his extensive career in the trenchless industry, Babs has been involved in major tunneling and trenchless projects in the Northeast for clients such as the Massachusetts Water Resources Authority, Boston Water & Sewer Commission, the Metropolitan District Commission (Hartford, CT), Narragansett Bay Commission (Providence, RI), NYC Dept. of Design & Construction and NYC Dept. of Environmental Protection.

For the past 19 years, he has focused on underground construction management for tunnels and conveyance including water and wastewater pipeline design and construction projects, with emphasis on trenchless construction methods. He has worked on various pipeline projects utilizing microtunneling, pipe jacking, horizontal auger bore, pipe bursting and pipelines renewal methods. From 2009-2011 Babs was resident engineer on the pivotal Microtunneling, & Pipe Bursting components of the East Boston Branch Sewer Relief Project. His commitment to the trenchless practice includes co-author for revision and update of the ASCE Manual of Practice (MOP 106) for Horizontal Auger Boring Projects and is the chair leading the effort for review and update of ASCE MOP 112 for Pipe Bursting Projects. Babs was instrumental in the development of the Auger Boring School at the Louisiana Technical University where he continues to assist with the annual planning and teaching at the auger boring school.

Babs views the NASTT-NE Regional Chapter as an important vehicle to promoting greater awareness and understanding of trenchless applications at the local level. He sees the level of interest and confidence in trenchless technology growing among owner groups based on the successful completion of many high profile projects across the Northeast. Drawn to the varied unique and innovative aspects of trenchless technology, Babs believes access to ongoing education is key to even greater owner acceptance and NASTT-NE Chapter is a key component towards achieving this acceptance by making information available at the grassroots level as well as attracting student chapters from the region and a robust local participation in the Chapter activities throughout the region.

ERIC SCHULER – VICE CHAIR



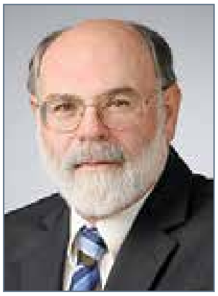
Eric Schuler is the City Engineer for an upstate-New York community that is rich in history. As a Department Head, he oversees all of Public Works, Sanitary Sewer, Storm Sewer, Water Distribution, Water Treatment, Wastewater Treatment, Facilities, and Traffic departments. Mr. Schuler has over 8 years of experience as a consulting engineer for nationally-recognized firms prior to switching to the municipal world. He earned his Bachelor of Science in Civil Engineering degree from Clarkson University in Potsdam, NY and has primarily been involved in wastewater, drinking water, civil-site, and stormwater sectors. Eric is a licensed Professional Engineer in New York whose design, project management, and construction-related experiences have helped successfully execute many “trenchless”-focused projects.

Early in his engineering career he gained exposure to various trenchless technologies through utility evaluations and development of utility project design alternatives. He immediately started to envision great opportunities for communities plagued by utility deficiencies and construction constraints to utilize CIPP, HDD, among other trenchless technologies; and for them to be able to benefit from both social and economic perspectives. Eric has also stressed the importance for municipalities to incorporate asset management into utility system evaluations and system rehabilitation designs in order to aid development of capital projects and to determine the most suitable trenchless applications for implementation.

In addition to NASTT-NE, Eric is also a Board Member for the Central New York Branch of the American Public Works Association (APWA), a Director of the Central New York Water Works Conference (CNYWCC), and is active on New York State American Water Works Association Committees (NYAWWA). Eric continues to push for growth of trenchless technologies in upstate-New York and has trained utility owners on the use of hydraulic modeling methods for proper development of utility rehabilitation project design. He is an advocate for educating (designers & installers) of trenchless applications through proper training and increased accessibility of industry standards/ guidelines to ensure successful project design and execution. The successful use and increased awareness of modern-day trenchless technologies that incorporate innovative equipment and materials are what Eric believes will continue to shape and drive the direction of the utility industry for the coming decades.

EXECUTIVE COMMITTEE

MARSHALL GASTON – TREASURER

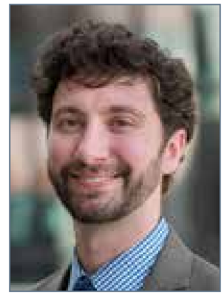


With more than 40 years of experience in the construction industry, Marshall Gaston's diverse background and experience bring a unique perspective to trenchless project development. Marshall has always maintained a foot in both the academic and practical fields. Earning a Bachelor's Degree in Construction Technologies from Purdue, he was heavily influenced by his father's job as a contactor. This duality of education and hands-on experience has been evidenced throughout his career. After graduation, Marshall went back to work for his father, literally learning from the ground up. His career then shifted to work in smaller consulting firms, where he was first introduced to trenchless technology. Marshall currently serves as a Senior Project Manager in the Water and Natural Resources Department at Fuss & O'Neill.

Marshall's current focus is design and construction of major sewer extension and roadway projects. He sees trenchless technology as a useful component to his work, as there is increased demand for less invasive technology. He believes that trenchless technology is fast becoming mainstream as the demand for less intrusive construction techniques will drive both improvement in technology and costs downward.

As NASTT-NE Treasurer, Marshall looks forward to a deeper understanding of the industry and translating that knowledge to his clients. A problem solver by nature, amplified by a lifelong interest in construction, Marshall's devotion to his clients is evidenced by the numerous facility planning, gravity and low pressure wastewater collection systems, pump station design and commissioning, and on-site decentralized renovation systems changing the landscape of New England.

JONATHAN KUNAY – SECRETARY



Jonathan Kunay, P.E., PMP is a Principal Engineer and the Northeast Conveyance Market Leader for CDM Smith in Boston, MA. He has over 16 years of experience working as a design engineer and project manager on a variety of trenchless projects including infrastructure assessment with traditional and state-of-the-art investigative techniques, rehabilitation using CIPP, HDD and pipe bursting, facilities planning and master planning, leak detection of water distribution systems, enterprise asset management and risk/criticality studies.

While trenchless technologies have been his primary focus over the past 10 years, he also has worked on civil site design for commercial developments and municipalities, navigated Consent Order driven long-term programs, designed new pumping stations and developed alternatives for sewer separation projects. Although Jonathan is based in New England, his diverse project experience has brought him many places to experience unique perspectives in the trenchless marketplace. He has worked on trenchless projects all over the United States including California, Texas, Illinois, Tennessee, Louisiana, South Carolina and Georgia. He has also implemented trenchless projects and programs internationally in the Middle East, China, South America, the Pacific Islands and Europe.

Jonathan was the project manager and design engineer responsible for helping to bring service lateral lining into the New England market in 2008 as part of a comprehensive sewer system rehabilitation program. This comprehensive model has now been adopted across the country as a proven methodology by which infiltration and inflow can be removed in large quantities from the sewer collection system. This comprehensive approach has been presented at conferences to showcase the validity of utilizing a holistic trenchless methodology when large percentages of I/I by volume must be eliminated.

Jonathan has a Bachelor's of Civil Engineering and a Minor in Environmental Engineering from the University of Cincinnati, is certified in NASSCO's Pipeline Assessment and Certification Program (PACP), Manhole Assessment and Certification Program (MACP), and Lateral Assessment and Certification Program (LACP), and is active in the National Association of Sewer Service Companies (NASSCO).

EXECUTIVE COMMITTEE - CONT'D

IAN MEAD – PAST CHAIR

Ian Mead, P.E., BCEE is a Senior Project Manager with Tighe & Bond in Worcester MA, and has over 20 years of experience working as design engineer, project manager and construction coordinator. His varied experience includes work on drinking water, wastewater, pipeline, site and civil, energy and other municipal infrastructure projects. His more recent focus is on development and delivery of projects for municipal clients across New England.

Born and raised in the construction industry, Ian has spent his entire lifetime on and around heavy equipment on various construction sites. While working for a private engineering company doing survey and site design work, Ian studied civil engineering at the University of Massachusetts Amherst. His first job after graduation was doing site inspection work on pipeline projects throughout MA and RI. He was quickly introduced to trenchless technology as many municipal clients were then expanding sanitary sewer collection systems, and some of this work involved trenchless applications such as HDD, bursting, and CIPP. More recently his experience has also included comprehensive pressure pipe condition assessment and rehabilitation, and the incorporation of this information into enterprise asset management programs.

Ian thinks that increasing owner acceptance, and convincing local decision makers that trenchless methods should be part of any utility's asset management plan, are important keys to future growth of the industry. Education and information provided to municipalities and utilities will help spread the word that trenchless is a viable and proven option. Ian feels there is a great opportunity to generate more interest in trenchless technology with mid to smaller sized utilities across the Northeast. Another major goal he has is building general awareness of the NASTT-NE Chapter, and coordinating its resources and activities, such as website, publications and conferences, with the parent NASTT organization and other regional chapters across North America.

2020-2021 NASTT-NE BOARD OF DIRECTORS

Chair – Babs Marquis
McMillen Jacobs Associates
marquis@mcmjac.com

Vice Chair - Eric Schuler
City of Oneida NY
eschuler@oneidacity.com

Treasurer - Marshall Gaston
Fuss & O'Neill Inc.
mgaston@fando.com

Secretary - Jonathan Kunay
CDM Smith
kunayje@cdmsmith.com

Past Chair – Ian Mead
Tighe & Bond
imead@tighebond.com

Pat Ambrosio
Hallen Construction
pambrosio@hallenconstruction.com

Guy Campinha
Town of Wareham MA
gcampinha@wareham.ma.us

Connor Collier
Vortex Companies
ccollier@vortexcompanies.com

Bill Jeffery
TT Technologies Inc.
bjeffery@tttechnologies.com

Jean Rivard
Progressive Pipeline Management
jrr@progressivepipe.com

Paul Savard
Parsons
paul.savard@parsons.com

Charles Tripp
Kleinfelder Inc.
ctripp@kleinfelder.com

Chad Whiting
Town of Plymouth MA
cwhiting@townhall.plymouth.ma.us

IN MEMORIAM, TOM PERRY

TOM PERRY, 1961 – 2019

The NASTT-NE Chapter and Board of Directors are saddened at the passing Friday July 26, 2019 of their fellow Board Member, colleague and friend, Tom Perry, at the age of 58. A graduate of Pequannock High School and Montclair State University, Tom was owner and President of Multi Utilities Ventures in Mount Olive Township NJ.

Tom had a strong background in the utility/infrastructure field, and worked closely with consulting engineers, government agencies and contractors in the selection and design of trenchless technologies used in infrastructure rehabilitation. His experience with trenchless applications and working knowledge of various industry manufacturers and their processes were assets to the NASTT-NE Chapter Board and the membership. Tom enjoyed working with innovative new technologies and had a deep appreciation for the many social and environmental advantages gained from using trenchless applications.

He will be deeply and truly missed by all of us who knew and worked with him, and the NASTT-NE Chapter extends condolences to his family.

FORMING A "CENTER FOR EXCELLENCE IN TRENCHLESS TECHNOLOGY AND UNDERGROUND ENGINEERING"

UMASS LOWELL

PURDUE UNIVERSITY

RUTGERS THE STATE UNIVERSITY OF NEW JERSEY

The University of Massachusetts Lowell is exploring forming a **Center for Excellence in Trenchless Technology and Underground Engineering (CETTUE)** in collaboration with Purdue and Rutgers. The planned NSF-supported Industry-University Cooperative Research Center (IUCRC) would build long-term collaborative partnerships among industry, academia, and government to address industry-relevant, pre-competitive research needs.

The IUCRC provides significant value to the stakeholders including (1) identify and address real-world challenges through multidisciplinary research, (2) innovate and enhance trenchless methods and underground engineering practices, (3) access to intellectual property and pre-publication research, (4) serve as training partner for practice firms and public agencies, (5) develop a skilled workforce and prepare work-ready engineers, (6) investment leveraging, and networking. Potential interests of the Center include trenchless installations, material science, rehabilitation and repair methods, subsurface investigations, inspections, underground engineering practices, and securing critical underground infrastructure.

The proposed Center is actively seeking partners from industry and government agencies. If interested in learning more about this initiative, please contact Prof. Pradeep Kurup (Pradeep_Kurup@uml.edu) or Prof. Raj Gondle (RajKumar_Gondle@uml.edu) at UMass Lowell, or Prof. Dulcy Abraham (dulcy@purdue.edu) at Purdue University, or Prof. Nenad Gucunski (gucunski@soe.rutgers.edu) at Rutgers University.

NASTT
NORTHEAST REGIONAL CHAPTER

Monday, November 11 Schedule

	Event	Location
6pm-9pm	NASTT Northeast Chapter Social Event	Dinosaur Bar-B-Que 246 W.Willow St, Syracuse, NY
9pm-TBD	NASTT Northeast Chapter After Hours Social	Embassy Suites by Hilton Syracuse 311 Hiawatha Blvd W, Syracuse, NY

Tuesday, November 12 Schedule

Morning Technical Sessions

6:00 - 7:30	**Exhibitor Move-In and Set Up**			
7:30	**Registration Desk Opens**			
7:30 - 8:15	**Breakfast and Networking - Vendor Area Open**			
8:15-8:45	**Opening remarks:** NASTT-NE Chair, NASTT Executive Director, UMASS Lowell			
	AM Track 1 - Gas, Power, Telecommunications		**AM Track 2** - Storm Sewer, Domestic Water, & Asset Mgmt.	
		Speaker		Speaker
9:00 - 9:25	Cast Iron Pipe Replacement and Priority Assessment (BEM) Broadband Electro-Magnetic Testing	*George Ragula (PSE&G)*	Choosing the Right Stormwater Pipe Rehabilitation Method: One Size Does Not Fit All	*Connor Collier and Matt Timberlake (Vortex)*
9:30 - 9:55	Microtunneling Under the Buffalo River	*Carrie Layhee (Haley & Aldrich)*	Cured-in-Place-Pipe (CIPP) for Pressurized Pipelines	*Andrew Costa (Insituform)*
9:55 - 10:35	**Break - Vendor Time**			
10:35 - 11:00	Trenchless Pipe Slitting for Gas Line Replacement	*Greg Conklin, (Hammerhead Trenchless)*	Asset Management for Buried Infrastructure	*Lauren Livermore, P.E. & Tim Taber, P.E. (B&L)*
11:05 - 11:30	Pipe Bursting Demo	*Centerline Trenchless Construction*	Centrifugally Cast Concrete Pipe Demo	*Arold Construction*
11:25 - 11:55	Utility Mapping/ Locating Demo	*Vermeer*	Sewer & Water Leak Detection Demo	*ElectroScan*
12:00-1:00	**Lunch & Keynote Speaker** Onondaga County Department of Water Environment Protection			
1:00 - 1:25	**Vendor Time**			

Afternoon Technical Sessions

	PM Track 1 - HDD & Microtunneling		**PM Track 2 - Sanitary Sewer Rehabilitation**	
		Speaker		Speaker
1:30 -1:55	Five rules for HDD contractors who want to be paid what they deserve without a legal fight	*Ted Roberts*	Low-Impact Repair Solutions to a High-Impact Sewer Problem	*Rebecca J. Caldon, P.E. (City of Albany)*
2:00 - 2:25	Work Activity Matrix for Microtunnel Inspection and Risk Management	*Babs Marquis (McMillen Jacobs)*	A Contractor’s Point of View: A summary of the diverse manhole rehabilitation specifications that exist in the marketplace	*Dennis Sullivan, P.E. (NWMCC), James Fleming (NWMCC)*
2:30 - 2:55	Roundtable: Directional Drilling Frack-Out Planning/Mitigation		Bypass Pumping 101	*Darrin Ruiz, EIT (Xylem)*
3:00 - 3:55			Advances in UV Cured In Place Pipe Lining in Heavy I&I Environments.	*Mike Ralbovsky (PIM)*
3:55 - 4:10	**Closing Remarks - NASTT-NE Chair and Vice Chair**			

THANK YOU MIKE!

MIKE WILLMETS

The NASTT-NE Board of Directors salutes outgoing NASTT Executive Director Mike Willmets for his efforts and encouragement on behalf of the NASTT-NE Chapter, for his aid and support of the NASTT-NE Chapter's foundation and rapid growth over the past 5 years. You've been our "super-hero"!

NASTT-NE 2019 PAPER OF THE YEAR

Great Hill Tunnel Rehabilitation: A Comparison of ROV and Manned Inspections of a 1927 Water Tunnel

Each year, the Northeast Chapter of NASTT honors those members that work on exciting and innovative trenchless applications and research that directly benefits the industry and helps it grow. The Northeast Chapter is proud to announce the second annual Paper of the Year recipient selected from eight final entrants. Each entrant was chosen from the papers given at the 2019 No-Dig conference on topics related to and by authors from the Northeast area.

ENTRANTS:

1) **"Construction of 5,550 LF of 30-inch & 40-inch Relief Sewer Using Trenchless and Conventional Technologies in Connecticut"** (John Ososkie, PE, Jacobs Engineering Group, Inc., Jason Waterbury, PE, Metropolitan District Commission)

2) **"Westport's Pump Station No. 2 Force Main Replacement Project Using HDD"** (Bryan Thompson – Town of Westport, CT, Abhinav Huli, Haley & Aldrich, Inc., Lori Carriero , Tighe & Bond)

3) **"Engineered and Innovative - Taking the Trenchless Approach in Springfield, MA"** (Jonnas Jacques, Kleinfelder)

4) **"Not on My Watch - Using CIPP to Ensure Disaster Doesn't Strike"** (Justin deMello, P.E, Woodard & Curran, Paul Costello, P.E., City of Quincy MA)

5) **"Great Hill Tunnel Rehabilitation: A Comparison of ROV and Manned Inspections of a 1927 Water Tunnel"** (Brian Lakin, Joe Schrank, Daniel Ebin McMillen Jacobs Associates, Lawrence Marcik, South Central Connecticut Regional Water Authority)

6) **"Strategic Horizontal Directional Drilling of Two Sub-Aqueous Water Mains Across Eastchester Bay in New York City"** (Ozlen Ozkurt, PhD, PE, ENV SP, CFM; Dewberry Engineers Inc., Thomas M. Leung, P.E, Esq; Department of Design and Construction, New York Emilio Barcelona; Dewberry Engineers Inc)

7) **"Assessment of Soil and Bedrock Abrasivity for Horizontal Directional Drilling Projects"** (Nick H. Strater, P.G., Brian C. Dorwart, Jim Williams, P.E., Brierley Associates, Danny Crumpton, P.E., Inrock)

8) **"Sliplining of the Gaillard Water Treatment Plant Raw Water Pipeline"** (Noel Guercio, P.E., Benjamin Backer, P.E., Erez Allouche, PhD, P.Eng., Stantec Consulting Services Inc)

The authors of each of these papers deserve our recognition for their positive contributions sharing what they have learned and helping others apply new thoughts and approaches to the unique challenges we face every day in the trenchless industry. The selection committee determines the recipient of Paper of the Year as the paper that best provides its topic in a new or original way and that helps move the trenchless industry forward by informing, teaching, and highlighting significant achievements in the trenchless industry. The entrants covered trenchless work across the Northeast area. ***THIS YEAR'S RECIPIENT IS: ...*** ***(See pg. 18)***

NASTT-NE 2019 PAPER OF THE YEAR AWARD WINNER:

"Great Hill Tunnel Rehabilitation: A Comparison of ROV and Manned Inspections of a 1927 Water Tunnel"

Written by: Brian Lakin, Joe Schrank & Daniel Ebin of McMillen Jacobs Associates and Lawrence Marcik of the South Central Connecticut Regional Water Authority

ABOUT THE AUTHORS:

Brian Lakin *is an Associate with McMillen Jacobs Associates in New York City and has been with the firm for 6 years. Brian is a graduate of Worcester Polytechnic Institute in Worcester, MA with a BS in Civil Engineering. Mr. Lakin has worked extensively in buried infrastructure condition assessment over his 20-year career, utilizing both remote inspection and manual inspection methods. He is a professional engineer in Connecticut, New York, and Rhode Island.*

Joe Schrank *has 20 years of experience in geotechnical and tunnel engineering, and is a Senior Associate in the Nashville office of McMillen Jacobs Associates. Mr. Schrank's project experience has focused on the feasibility evaluation, design and construction management of tunnel repairs and rehabilitation. Joe is a graduate of the University of British Columbia in Vancouver, BC with a Master of Engineering degree in Mining Engineering and a Bachelor of Applied Science degree in Geological Engineering. Joe is a professional engineer in 10 states and British Columbia, Canada.*

Daniel Ebin *is a Project Engineer with McMillen Jacobs Associates in Chicago. He is a geostructural engineer with experience in water, wastewater and transportation tunnel projects. He is a graduate of Tufts University with a BS in Civil Engineering and MS in Infrastructure Engineering and is a Professional Engineer in California, Illinois, and New York.*

Lawrence J. Marcik, Jr., P.E. *is a Capital Program Lead at the South Central Connecticut Regional Water Authority, practicing as a Geotechnical Engineer on dams and large capital projects. Mr. Marcik received a Bachelor and Master degrees from the University of Connecticut. He worked as a contractor, consultant and currently in the public sector.*

North American Society for Trenchless Technology (NASTT)
NASTT's 2019 No-Dig Show

Chicago, Illinois
March 17-20, 2019

TM1-T6-02

Great Hill Tunnel Rehabilitation: A Comparison of ROV and Manned Inspections of a 1927 Water Tunnel

Brian Lakin, McMillen Jacobs Associates, New York, NY
Joe Schrank, McMillen Jacobs Associates, Nashville, TN
Daniel Ebin, McMillen Jacobs Associates, Chicago, IL
Lawrence Marcik, South Central Connecticut Regional Water Authority, New Haven, CT

1. ABSTRACT

The Great Hill Tunnel (GHT) is owned and operated by the South Central Connecticut Regional Water Authority (RWA). It is a 100 MGD, 3,600-foot-long, 6-foot horseshoe-shaped raw water transmission tunnel that cannot be taken out of service and dewatered without installation of a bypass system. After completion of the tunnel in 1927, the first documented inspection was by divers in 1973. Subsequently over the past seven years, the tunnel was inspected by remote operated vehicle (ROV) three times, most recently in the fall of 2017.

During the 2017 inspection, routine leakage from the tunnel was noted to have increased dramatically. The owner became concerned that known defects observed during the ROV inspections—including a large defect at the transition from the tunnel to a 48-inch-diameter cast iron pipe—were not only getting larger, but also that the increased leakage was a sign of impending failure of the system. Therefore, an emergency manned inspection and repair program was planned based on the information from the three ROV inspections. This manned inspection and rehabilitation work was completed in the spring of 2018. Regular inspection of water infrastructure, especially manned, is often challenging because of lack of redundancy, limited shutdown windows, or aging infrastructure that could be compromised by dewatering. ROV inspections can alleviate some of these issues but do have limitations. This paper will compare the differences between ROV and manned inspection results and how such results can be applied to tunnel rehabilitation.

2. BACKGROUND

The GHT, originally constructed in 1927, consists of two separate sections. Section 1 is the drill and blast tunnel section and extends from the intake within Lake Gaillard approximately 2,700 feet to the southwest, where it transitions to a 48-inch-diameter cast iron pipe that extends an additional 860 feet to a control valve. The pipeline portion, Section 2, was installed using standard cut-and-cover methods and links the rock tunnel portion to the raw water transmission main and eventually to the RWA's water treatment plant nearby as seen in Figure 1. The GHT is an integral asset in the RWA's water collection system. The unreinforced concrete tunnel is horseshoe shaped and is the last link in a series of connected reservoirs and tunnels that convey raw water from remote areas to the treatment plant. The tunnel could only be accessed through the Intake Gate House within Lake Gaillard prior to this project. The original contract drawings for the tunnel show that a downstream access shaft was installed, but the condition of the access shaft and the watertight cover were unknown as the portal was buried beneath a quarry access road. Therefore, until the tunnel was depressurized, and the shaft uncovered, the functionality of this access point was unknown.

The GHT, operationally, is the sole conveyance of raw water between the reservoir and the water treatment plant, making routine manned inspection and maintenance nearly impossible. Available outage times are measured in hours at off-peak demand times, so putting personnel into the tunnel to inspect on a regular basis is not an option for the RWA.

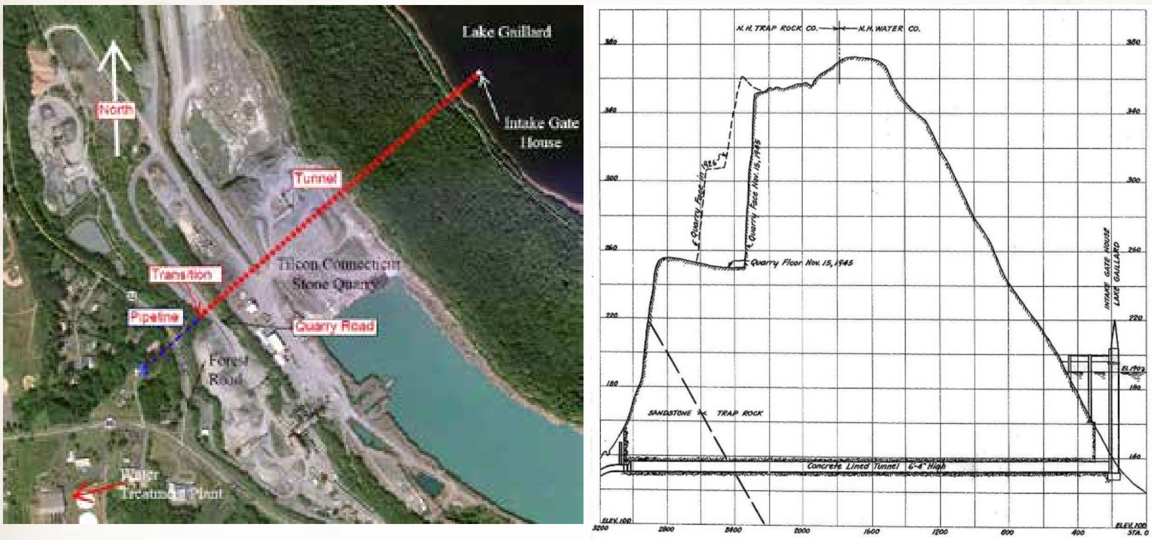


Figure 1. Plan and profile of the Great Hill Tunnel.

3. GEOLOGIC SETTING

The project area is located in the central lowlands of Connecticut within the Gaillard graben (down-dropped bedrock block). This graben formed over 140 million years ago during regional extensional faulting along the Foxon Fault (west side) and Eastern Border Fault (east side). As the graben dropped, sediments eroded off the bordering metamorphic highlands and were deposited as sedimentary strata within the graben. Concurrently, thick, tabular basalt flows periodically covered the sedimentary strata within the graben and became interbedded with these strata as the graben subsided.

Differential movement along the faults that border the graben caused the interior block and overlying sediments and flows to become rotated. The bedding in the project area dips at approximately 13 degrees to the northeast. Subsequent erosion of the highlands and graben material has removed the sedimentary rock and exposed the resistant basalt flows. These exposed flows form a northwest-southeast monocline (Totoket Mountain) that dips at approximately 12 to 13 degrees to the northeast.

The GHT alignment is located between the inlet along the western shoreline of Lake Gaillard and the outlet portal on the west side of Totoket Mountain. The tunnel crosses beneath both Totoket Mountain and the arcuate-shaped North Branford trap rock (basalt) quarry, which is located on the west side of the mountain. The tunnel alignment crosses beneath the North Branford quarry along a 200-foot-wide restricted zone that bisects the quarry. Quarry excavation within this restricted zone is maintained at no lower than El. +211 feet to provide adequate cover (approximately 70 feet) and mitigate the impacts of blasting on the tunnel.

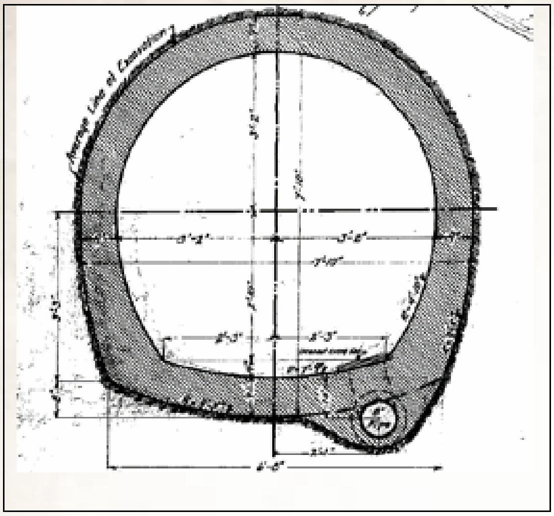


Figure 2. Cross Section of Tunnel

The tunnel was excavated through the trap rock and sandstone in a 7 foot 10 inch wide by 7 foot 10 inch high horseshoe shape, as seen in Figure 2. As shown in the figure, there is a minimum 9-inch-thick plain concrete final lining that results in finished inside dimensions of 6 foot 4 inches wide by 6 foot 4 inches high. Based on geologic mapping, the GHT penetrates the Holyoke Basalt (trap rock) from the Intake Gate House to approximately Sta. 24+30, and the underlying Shuttle Meadow Formation (sandstone) west of Sta. 24+30.

The Holyoke Basalt, which overlies the Shuttle Meadow Formation, consists of at least two thick flows of massive, finely crystalline basalt that directly underlie the majority of Totoket Mountain, including the North Branford quarry. This lower Jurassic-age basalt is at least 350 feet thick in the project area, is generally fresh to slightly altered, and the originally near vertical columnar joints now dip at approximately 13 degrees to the southwest.

The Shuttle Meadow Formation is exposed along the western edge of Totoket Mountain and underlies the lowlands in the vicinity of State Route 80. This lower Jurassic-age unit consists of interbedded sandstone (arkose), siltstone, shale, and conglomerate. The thickness of each of the sedimentary layers is generally less than 3 feet but ranges up to about 20 feet in the project area for shale layers.

The contact between the Holyoke Basalt and Shuttle Meadow Formation is baked (hardened), welded together from the heat of the overlying basalt flow, and occurs at around Sta. 24+30 in the tunnel. No weathering is present on the upper contact of the Shuttle Meadow Formation where it underlies the Holyoke Basalt in the project area.

4. GROUNDWATER CONDITIONS

Based on available groundwater information, the Holyoke Basalt and Shuttle Meadow Formation are considered to be poor aquifers. The interbedded siltstone and shale of the Shuttle Meadow Formation most likely act as aquitards within this unit, restricting vertical groundwater flow. Additionally, the contact between the Shuttle Meadow Formation and the overlying Holyoke Basalt is tight and relatively impermeable. Artesian groundwater pressure may be present at the contact between the gently dipping, truncated sandstone beds in the Shuttle Meadow Formation and the Holyoke Basalt.

The contact between Holyoke Basalt flows observed in the quarry is distinct but not open. No water has been observed flowing from the contacts between the two exposed basalt flows. Additionally, no holes or cavities were observed in the basalt. The contact between the basalt and the underlying Shuttle Mountain Formation is baked and tight. No permeable zones were observed along the upper and lower contact of the Holyoke Basalt (JA, 2011).

5. PAST INSPECTIONS AND MAINTENANCE

The GHT is the sole raw water transmission line supplying water to the RWA's nearby water treatment plant, the largest in the RWA system. This treatment plant supplies potable water to most of the 16 towns within the RWA's distribution system and, because of pressure zone configurations and existing legacy restrictions within the distribution network, only local clearwell storage is available during water treatment plant outages. In a total shutdown of the treatment plant, RWA has only a couple of hours of supply, necessitating any inspection work to be undertaken while the tunnel remains in operation. Performing inspections at low demand times, such as overnight during winter months, would allow for the facility to operate at low flows, thus enabling personnel and/or equipment to enter and function within the tunnel.

The first documented inspection of GHT was conducted in 1973 with a commercial diver (JA, 2011). Diver entry, at the time, did not follow any Occupational Safety and Health Administration (OSHA) standards. OSHA, established in 1971, did not adopt its first commercial diving safety standard until July 22, 1977 (OSHA, 2011). For the 1973 inspection, the diver entered the watered tunnel with both a tether to the surface and air bottles within the tunnel, which were moved around during the inspection on a hand truck. As the diver neared the point at which the tunnel transitions to a pipeline at approximately Sta. 29+61, the diameter of the conduit narrowed. Flow, which was still ongoing, increased in velocity, causing the air bottles and hand truck to be pulled into the pipeline, dragging the diver with it. The diver was unable to climb his way out of the tunnel, so the diver's attendants obtained the aid of some of the miners at the nearby quarry and physically dragged the diver back to the surface. To aid in his rescue, the diver removed his weight belt and left it in the tunnel. He was then rushed to the submarine base in Groton, CT, for decompression treatment. The diver survived this incident, however the owner has been reluctant to repeat this method.

In 1998, the first 160 feet of the tunnel (starting at the intake building) were inspected, again by a commercial diver. This was done only to investigate what appeared to be air bubbles in the lake. It was believed that a hole in the concrete lining was allowing air to escape the tunnel and providing a means for eels to enter. This limited inspection did not find any damage to the liner.

Apart from some localized inspections of the intake chamber (the entry point into the tunnel), the next documented inspection of GHT did not happen until 2011, 34 years after the failed diver inspection. For the 2011 inspection, RWA opted to use an ROV equipped with high-definition cameras, halogen lighting, and sonar. This inspection became the baseline for the RWA, noting that the tunnel was generally in good condition. During this 2011 inspection, two main defects were identified by the ROV. The first, located in the crown at approximately Sta. 23+15, did not appear to pose a risk to the operation of the tunnel. Although the liner had failed in a small area of the crown, the area was still watertight, even though the void was the full thickness of the lining. The defect was estimated to be about 2.5-feet wide and 3-feet long. Just upstream of the transition point at approximately Sta. 29+61, however, a large liner defect was identified, measured, and monitored for leakage, see Figure 4a. The defect in the lining was estimated to be approximately 6-inches wide and 8-inches long with a larger cavity behind the lining. This cavity was estimated, based on sonar measurements, to be a minimum of 1.6 feet deep, 6 feet wide, and 3 feet long. More definitive measurements could not be obtained because the sonar array could not look further back into the void. Although the observed exfiltration was noted, the team was unable to quantify it. Through dye injection into the water stream, water was seen to flow into the defect and out of the tunnel; however, a crew stationed on the surface at a nearby suspected leakage point did not observe the dyed water. Therefore, the team was unable to conclude that the two were linked. The inspection report recommended installing leakage monitoring because of the poor condition of the transition point. Additionally, reinspection was recommended within 10 years if leakage monitoring was installed or within 2 years if not.

6. RECENT ROV INSPECTIONS

6.1. 2017 Planned ROV Inspection

In the spring of 2017, RWA performed a second ROV inspection of the GHT (MJA, 2017). This was both a reinspection of those portions of the tunnel that were inspected in 2011 and an inspection of the 48-inch-diameter cast iron pipeline and associated 36-inch-diameter cast iron access portal riser between the tunnel transition point and the gate house located near Forest Road. The specific purposes of the inspection were to observe, document, and assess the tunnel and pipeline conditions and, should the need for repairs be evident, to make recommendations. Information gathered during the inspection was compared to data collected during the 2011 inspection and used by the RWA to identify capital investments to ensure reliable operation and water delivery through the GHT. Because of a combination of low reservoir levels and excessive wind conditions at the time of the inspection, water quality within the tunnel was poor, with high turbidity. This made for poor visibility in the water column for the ROV throughout the course of the inspection. In addition, there appeared to be more organic material coating the interior surface of the tunnel than in the 2011 inspection, making detection of some surface anomalies difficult.

Because the various shrinkage cracks observed during the 2011 inspection were not felt to pose a risk to the integrity of the tunnel, the inspection team did not spend any significant time attempting to relocate and reinspect any of these locations during this planned 2017 inspection. The organic material coating made it extremely difficult to see the concrete lining of the tunnel directly, and any attempt to find these smooth, healed cracks would have taken significant effort and time, with little benefit. The previously identified crown defect at approximately Sta. 23+15 was found to have changed little, and it again appeared that no water was exfiltrating the tunnel at this location. This defect was again classified as a narrow and fully penetrating structural feature defect because it locally interrupted the concrete lining but did not appear to have a cavity behind the lining nor was it considered to affect operational reliability at the time.

What was of concern to the inspection team was the apparent increase in the size of the defect at the transition point at approximately Sta. 29+61. The defect now measured 24 inches radially by 36 inches longitudinally in the liner with a large cavity behind it, measuring at least 23 inches deep by 39 inches wide (MJA, 2017). There was also concrete debris in the invert that was not previously seen in 2011. While exfiltration was observed, the inspection team was unable to quantify the exfiltration at this location. In addition to optical cameras, side scanning sonar was used to map the extent of the defect. This inspection was able to continue through the 48-inch pipeline to the gatehouse.

6.2. 2017 Emergency ROV Inspection

During the fall of 2017, increased leakage, as well as a secondary leakage site, were noted at the surface above the tunnel alignment. The RWA grew concerned that the condition of the known defects had changed or that a new defect was also leaking, either of which could lead to failure of the lining. Therefore, the RWA commenced an emergency ROV inspection. Because the RWA had started to perform routine inspections with ROVs, their operations personnel and the ROV contractor were familiar with the facilities and inspection process, especially the safety and operational aspects. This greatly expedited the mobilization and completion of this new emergency ROV inspection.

The emergency ROV inspection found that the dimensions of the defection at the transition point at Sta. 29+61 had not significantly changed since the previous inspection in the spring (SeaView, 2017). However, cracking was observed propagating from the defect, which suggested that an additional part of the liner could fail. It was unknown if this cracking was new since the last inspection or was just now being seen because the visibility was considerably better than during the previous inspection. The ROV continued down the pipeline in an attempt to determine the source of the newly noticed secondary leakage. With the use of saline dye, the secondary leak was found in the invert of the 48-inch pipeline at approximately Sta. 30+05. It was also in this area that the 1973 diver's weight belt was found.

7. MANNED INSPECTION AND REPAIRS

Based on the ROV results from the 2011 inspection, the planned 2017 inspection, and the emergency 2017 inspection, RWA began procurement for the design and installation of a temporary bypass system, to allow for the continued operation of the water treatment plant while taking the GHT out of service. Separately from this procurement, RWA also procured contracts for the Design/Resident Engineering Inspection for repairs to the tunnel and construction of the necessary repairs.

The temporary bypass system, designed and installed by others under a separate contract, was built to carry approximately 30–40 MGD from the reservoir to the raw water transmission line, downstream of the tunnel repair work area. It was installed, maintained and operated throughout the duration of the repair work by a contractor, hired specifically by the RWA for this piece of work.

7.1. Tunnel Repair Design

Design for the tunnel repair began on November 1, 2017 and was based on the information collected during the three previous ROV inspections as no other data was available. Because of operational restrictions from the RWA, McMillen Jacobs Associates completed the design, aided in procurement, and inspected the tunnel repairs under a hard deadline, which required that the tunnel and pipeline be reassembled and operational before May 1, 2018. This six-month timeline, in conjunction with the relatively unknown condition of the tunnel liner outside of the few areas identified in the ROV inspections, created the need for a design that was both fair to the RWA and the contractor, but also provided a mechanism to monitor construction costs, time, and quality. The resulting design provided a series of standard repair details to be used by the contractor, based on the field determination of the specific defects identified in the tunnel, once access was available. In addition, volume estimates for the amount of grouting behind the existing liner were provided as a "worst case." All bid items were based on unit pricing. The contractor was provided an estimated quantity of work shifts that it would be responsible to cover (which included all costs for equipment and manpower on the site), while performing some of the basic, generic tasks. All other items were added to the contractor's shift rate as additional work items, to be paid in addition to the shift rate.

On November 29, 2017, the RWA and McMillen Jacobs met with two prequalified contractors with the draft design and specifications. The project was explained to both contractors, and time was provided for them to ask questions and comment on the design. Those questions and comments were then used by the design team to finalize the contract document package. These final documents were revised and issued to the preselected construction firms on December 4, 2017. These contractors then had until December 8, 2017, four days, to prepare their cost proposals for consideration by RWA. By the following Monday, December 11, 2017, RWA had elected to enter into negotiations with one of the contractors. Once these negotiations were completed a preconstruction meeting was held on January 9, 2018. The original contractor mobilization date was set for mid-January; however, due to complications with the bypass installation work this was delayed by a few weeks.

7.2. 2018 Initial Manned Inspection

The initial manned tunnel inspection of the GHT was performed on Friday, February 16, 2018, and included representatives from the contractor, McMillen Jacobs, and RWA. A rescue team provided by a subcontractor was present throughout the initial inspection and for all the in-tunnel work. The inspection team accessed the tunnel from the intake shaft, and the rescue team provided a safety attendant who remained at the bottom of the intake shaft during the tunnel inspection. The remaining four members of the rescue crew were stationed in the intake building at the surface.

The purpose of the manned inspection was to visually evaluate the stability of the liner for rehabilitation and document major defects. There were concerns about the stability of the liner at the downstream end where the major defects through the liner had been observed by the ROV, and whether some initial repairs were required before the rehabilitation program could begin.

The major observations from the initial manned inspection included:

- Seepage under pressure was observed entering the tunnel through construction joints in the first 71 feet of the tunnel (section within Lake Gaillard), but no seepage was observed coming through the concrete tunnel liner between the joints. The inflow was approximated at 50 to 100 gpm.
- Holes in the liner (other than minor seeps) started appearing at Sta. 15+50. The holes went through the entire thickness of the concrete liner, so any void space and the bedrock behind the liner were visible. In one hole at Sta. 17+29, a half-barrel from a blast hole from tunnel construction was visible in the bedrock.
- The holes in the liner consistently showed void spaces between the extrados of the liner and the bedrock. The void spaces meant that the bedrock was self-supporting and not putting weight on the liner and was interpreted as the best-case scenario.
- Some of the void space behind the liner was extensive, including some greater than 2 feet thick and extending upstream and downstream from the holes in the liner.
- Some honeycombed concrete was visible in the tunnel liner exposed by the liner defects, particularly where the largest holes in the liner occurred.
- The largest holes in the liner were at the downstream end near the transition to the pipeline. Also, at the downstream end the cracks in the liner were more open and wider than those upstream. There were also several deep concrete spalls that did not fully penetrate through the liner.
- One of the largest holes in the liner, at Sta. 23+15, was 38 inches long, 18 inches wide, and 18 inches deep with seepage into the tunnel occurring through it. Concrete debris—including one piece 33 inches long by 11 inches wide by 7 inches thick—was observed in the tunnel invert below this hole. Another hole, at Sta. 24+90, was 4 feet long, 12 inches wide, and 19 inches deep. A piece of wood was visible behind the liner and was likely a piece of formwork from the original tunnel construction.

- At the start of the transition zone at Sta. 29+61, the largest hole in the liner was present from the 1:00 to the 3:00 position in the tunnel arch, with water flowing out of it at the base. The hole was 2 feet 3 inches wide, 4 feet 11 inches long, 9 inches deep, and penetrated through the liner. There was significant cracking of the liner adjacent to this hole with two large pieces of concrete (approximately 2 feet long by 1 foot wide) that were clearly deteriorated that appeared ready to fall out. Extensive void space and self-supporting sandstone bedrock were visible behind the liner and concrete debris was present on the tunnel invert.

7.3. 2018 Initial Manned Inspection Conclusions and Recommendations

The main conclusion from the 2018 initial manned inspection was that, in general, the concrete liner was in good condition considering the age of the tunnel and the concrete technology available at the time of construction. There were some honeycombing and segregation of the concrete visible in the liner around the larger defects, which could explain why the holes occurred where they did (in the areas of poorest quality concrete); however, the majority of the tunnel had a limited number of defects. No bulging or deformation of the liner was observed, which indicated that the liner was not taking any weight from the surrounding rock mass, and the bedrock observed behind the liner was self-supporting.

For the initial inspection, four types of defects were defined. Type I defects were defined as surficial features that are minor, localized, and penetrate less than one-quarter of the liner thickness. Type II defects were non-penetrating structural features that penetrated up to half of the liner thickness. Type III defects were fully penetrating structural features that were narrow and did not compromise the structural integrity of the liner. Type IV defects were defined as structural integrity defects that fully penetrated the liner and that may compromise the integrity of the liner.

Based on the initial inspection, the first priority after the contractor installed the required utilities in the tunnel was to scale the hole at Sta. 29+61 and install 5-foot-long epoxy resin rock bolts into the bedrock through the hole for temporary support since all of the manpower, equipment, and supplies for the tunnel rehab needed to pass through this section of the tunnel. Once the rock bolts were installed, it was recommended that the concrete liner be carefully scaled back to sound concrete to remove any deteriorated concrete and debris, and as the liner was scaled, shotcrete and additional rock bolts were to be installed as needed as the bedrock was uncovered. The additional shotcrete and rock bolts were recommended since there was concern that the concrete across the entire crown of the tunnel at this location may have been of very poor quality and deteriorated. Once scaling began, the extent of the deteriorated concrete was found to be limited and did not even extend to the top of the crown.

Another recommendation resulting from the initial inspection was for the heavy seepage at the construction joints in the first 71 feet of the tunnel to be injected with chemical grout. At each joint, the injections were supposed to chase the seepage around the joint and then seal them off. This was attempted with limited success and was not considered critical for the operation of the tunnel (Figure 3). Because this was not deemed critical to the continued operation of the tunnel, no other methods for sealing the joints were considered.

Figure 3. Before and after chemical grouting on the left arch.

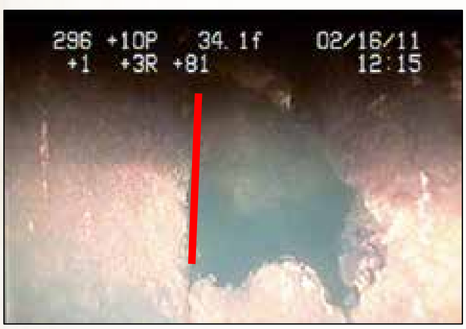
Paper TM-T6-02 - 7

The other holes, defects, and major cracks were repaired in accordance with the design. The initial manned inspection allowed a general classification of the number and types of repairs to be completed, and their prioritization for the rehabilitation program. This included 54 defects ranging from Type I (surficial feature) to Type IV (structural integrity defect). This initial classification was further defined once work in the tunnel began and additional inspections could occur.

Once construction access and utilities were established within the tunnel, an additional approximately 15 defects were identified, which were generally classified initially as Type I and Type II.

8. COMPARISON OF INSPECTION FINDINGS

The main defect observed in each of the four inspections (2011 ROV inspection; 2017 ROV planned inspection; 2017 ROV emergency inspection; 2018 initial manned inspection) was at the transition to the pipeline at Sta. 29+61, as shown in Figure 4. Images from the spring 2017 planned ROV inspection are not included because of low visibility. As can be seen, the ROV images from the 2011 inspection and 2017 emergency inspection show the surficial condition of the liner when there is good visibility. With low visibility, overall condition of the defect is hard to discern. However, sidescanning sonar was used to take measurements of the defect and its change in size. Additionally, to a limited degree, the ROV was able to view into the large defect.



(a) Defect during 2011 ROV Inspection (SeaView, 2011).

(b) Defect during 2017 Emergency ROV Inspection.

(c) Defect after dewatering and minor scaling for safety.

(d) Looking into void (downstream), approximately 10 feet deep.

(e) Defect after sawcutting and chipping in preparation for repair.

(f) Welded wire mesh in place during shotcrete repair.

Figure 4. Views of defect at transition to pipeline at Sta. 29+61 from various inspections. Note that the red line is in approximately the same location in each image.

Similarly, Figure 5 shows views of the crown defect at Sta. 23+15 as seen during the various inspections. As shown in Figure 5(b), there was a similarly sized defect, although slightly less severe immediately upstream. Because of the poor visibility during the 2017 planned ROV inspection, it is unclear when this defect arose.

Finally, Figure 6 shows images from the 2011 ROV inspection and the manned inspection of a surficial crack at Sta. 6+90. With good visibility, the defect was fully visualized with the ROV. However, during the 2017 planned ROV inspection, the defect could not be found because of the poor visibility.

(a) Defect during 2011 ROV Inspection (SeaView, 2011).

(b) Defect after dewatering.

(c) Welded wire mesh in place for shotcrete repair.

Figure 5. Views of defect in crown at Sta. 23+15 from various inspections.

(a) Defect during 2011 ROV Inspection (SeaView, 2011).

(b) Defect after dewatering.

Figure 6. Views of defect in tunnel sidewall at Sta. 6+90 from various inspections.

9. CONCLUSIONS

Facility owners, responsible for the ongoing monitoring and maintenance of our country's aging infrastructure, are faced with many difficulties. Rising costs, shrinking budgets, and increasingly stringent safety standards are just a few of the many issues that are faced when attempting to provide for reliable facilities and uninterrupted operations. As such, it is important to use the best and most cost-effective tools for each task. For inspections of tunnels, it may not always be feasible to put a team of people into a structure to perform a regular inspection. Safety requirements for divers and manned entry may introduce undesirable risks that owners are not willing to take. Operational restrictions may also play into the decision on how best to monitor critical tunnels and pipelines. The inability to remove a tunnel from operations severely restricts the possible inspection methodologies. Each of these issues may strongly suggest that an ROV inspection is the best available option. Owners and consultants must be aware, however, of the capabilities and limitations of the technology so that inspection results are understood fully.

ROVs are great at seeing surficial defects. However, from the experience of this project it is apparent that what often appeared to be a small surficial defect during the ROV and initial manned inspections, that potentially could be repaired with cement mortar patching, was actually a TYPE III repair once the sawcutting and chipping commenced. While the surficial defects could be small, the surrounding concrete was often of poor quality, decomposed or honeycombed. On other occasions there was a large cavity behind the surficial concrete that was only found when sounding the concrete with a hammer, or commencing saw cutting and chipping, while trying to get to sound concrete for a necessary repair.

As technology improves and changes, so too will the capabilities of the ROV. Operators are constantly pushing for longer umbilicals to provide for greater inspection distances. As electronics continue to become smaller and more powerful, the ability to make watertight enclosures to house them will continue to improve ROV capabilities.

ROV inspections are a useful tool for programmed inspections when operational, safety, and budgetary constraints are a concern. They cannot always replace manned inspections but can be an excellent supplement that allow for inspections to be performed more regularly and on an emergency basis.

10. REFERENCES

Jacobs Associates (JA). 2011. Great Hill Tunnel Condition Assessment. Prepared for South Central Connecticut Regional Water Authority.

McMillen Jacobs Associates (MJA). 2017. ROV Inspection of the Great Hill Tunnel. Prepared for South Central Connecticut Regional Water Authority.

SeaView Systems, Inc. 2011. Regional Water Authority Great Hill Tunnel Investigation Report. Prepared for South Central Connecticut Regional Water Authority.

SeaView Systems, Inc. 2017. Regional Water Authority Great Hill Tunnel Investigation Report. Prepared for South Central Connecticut Regional Water Authority.

Occupational Safety and Health Administration (OSHA). 2011. Timeline of OSHA's 40 Year History. Retrieved from https://www.osha.gov/osha40/OSHATimeline.pdf

ANOTHER GILBOA DAM MILESTONE:

Completion of Schoharie Low Level Outlet Tunnel Project Includes Wet Retrieval of MTBM Unit

By: John Arciszewski, Southland/Renda Joint Venture
Patrick Hoosier PE, AECOM

INTRODUCTION

Managed by the New York City Department of Environmental Protection (NYCDEP) Gilboa Dam, in upstate New York, impounds Schoharie Creek to form the Schoharie Reservoir providing 15% of the water supply for New York City. Under a dam stabilization Capital Improvement Program, a 108-inch Low Level Outlet (LLO) was constructed to allow NYCDEP to drain the reservoir and meet proposed water conservation releases.

MTBM DEPLOYMENT

Southland/Renda Joint Venture (SRJV), general contractor for the Gilboa LLO Tunnel Project, selected and deployed a Herrenknecht AVN2200B microtunnel boring machine (MTBM) to excavate the approximately 2,176 LF of 108-inch tunnel for the LLO from the reservoir to the Valve Chamber portal downstream of the dam at Schoharie Creek (Figure 1).

Because the Contract classified the proposed shaft and Gilboa LLO tunnel excavation as "potentially gassy" in accordance with OSHA hazardous classifications, the MTBM

is the first of its kind manufactured by Herrenknecht with explosion-proof (Class I Division II) electrical components, and with tunnel support accessories designed to mine in "gassy" environments. Replacement parts were not shelf-stocked as they were one of a kind with this classification. So, defective component parts not serviceable or repairable on-site required a long lead time for fabrication and delivery.

The MTBM diameter and the depth of the shaft posed unique challenges to the project. Being one of the largest microtunnel machines in existence (with a 9.5-foot excavated diameter and total weight of more than 80 tons) as well as being configured for hyperbaric interventions and wet retrieval made this a one-of-a-kind microtunnel boring machine.

The microtunneling system was initially designed to have only two return pumps on the slurry circuit, one behind the machine and one mounted 30 feet up the shaft wall on a platform; however, it was determined early on that a third pump would need to be installed to lift the slurry from the shaft and into the separation plant. A non-explosion proof pump was sourced and located on the surface where it proved to be beneficial.

Figure 1: The Herrenknecht AVN2200B MTBM "Miss Diane" lowered to the land leg tunnel launching site. The first of its kind manufactured in accordance with OSHA Class I Division II classification

Figure 2: Low Level outlet tunnel alignment

Figure 3: MTBM pushed through Valve Chamber portal to complete the land leg tunnel

Figure 4: Commemorative last pipe to complete the LLO water leg tunnel

LOW LEVEL OUTLET: SHAFT AND MTBM TUNNEL CONSTRUCTION

The water leg of the microtunneling alignment proceeds southeast from outside of the dam footprint at the Intake Structure, to the Gate Shaft at the right abutment. The land leg of the LLO projects northeasterly from the Gate Shaft towards Schoharie Creek, downstream of the dam, and terminates at the portal face of a steep slope, where the Valve Chamber for the LLO discharge system is located. (Figure 2)

The circular Gate Shaft, which served as the jacking shaft from where both the land and water leg tunnels were excavated, was the first of the LLO features to be constructed. It was excavated through 30 feet of overburden soil and approximately 150 feet of bedrock using drill-and-blast techniques to a size 40 feet in diameter, 180 feet deep.

Initially, it was planned that, for the land leg tunnel receiving site (located at the Valve Chamber), the MTBM would pass through the Valve Chamber portal with the grout plug located within a soil nailed wall with ground stabilization. However, as the soil nails progressed it was determined that four soil nails encroached into the tunnel horizon, presenting obstruction hazards to the advancement of the MTBM as it neared the final 75 foot of the land leg tunnel. To mitigate the risk of obstruction and damage to the MTBM, a 12-foot horseshoe-shaped tunnel was hand-mined for 80 feet centered on the alignment to remove the drifted soil nails within the tunnel horizon. With the end reach of the land leg hand-mined to remove drifted soil nails, the MTBM excavated the land leg tunnel entirely in the bedrock from the Gate Shaft into the hand-mined tunnel and jacked through to the portal platform (Figures 3 and 4).

The receiving site for the water leg at the Intake Structure location, under the reservoir, was dredged and the Intake Structure foundation prepared. A circular 35-foot-diameter cofferdam constructed with steel liner plates was installed at the Intake Structure location and acted as the MTBM receiving structure. It was fitted with an 11-foot by 11-foot fiberglass soft-eye target to allow the MTBM to break into the cofferdam (Figure 5). The cofferdam was then locked in position by placing tremie concrete around it and for 75 feet over the top of the tunnel

Figure 5: Water leg cofferdam structure with fiberglass soft eye

Figure 6: The MTBM unit was retrieved from a depth of approximately 153 feet on July 10, 2019

alignment to provide ballast in the low cover area.

For the water leg, the MTBM excavated 500 LF in rock and 450 LF in soft ground, transitioning through decomposed rock into glacial till, fine sand, and marine deposits before grinding through the tremie concrete around the cofferdam to hole through the fiberglass soft-eye target into the cofferdam on January 19, 2019.

MTBM WET RETRIEVAL

Once the water leg tunnel was completed, the annulus was grouted. Then the remaining utilities, hydraulic sled, pump, and airlock were removed from the tunnel and the two bulkheads reinstalled near the Gate Shaft.

The MTBM was retrieved from the reservoir at a depth of approximately 153 feet, and the adaptor piece was then removed by divers from the first joint of pipe installed. Several major steps were required in order to disconnect the MTBM from the Permalok jacking pipe and prepare it for retrieval. These steps required careful coordination between the contractor tunnel crews and the Ballard Marine divers. The MTBM was sealed, pressure tested with compressed air for 48 hours, and then the tunnel crews closed and bolted the bulkheads. The dive team used an external hydraulic power unit to extend and retract the cylinders in order to push off the MTBM and ready it for pick. The MTBM was raised to the surface on July 10, 2019 after all preparations and testing were complete.

(Figure 6)

Following MTBM retrieval, divers cut the adaptor piece from the Permalok® pipe, and flooded the water leg tunnel back to the bulkhead near the Gate Shaft. The 108-inch elbow was set into position and welded to the tunnel pipe

Figure 7: 108-inch elbow for the intake. In foreground is removable plug/bulkhead used for dewatering water leg tunnel

underwater, then encased with tremie concrete. A removable plug/bulkhead was installed into the top of the elbow bellmouth (Figure 7) so that the water leg tunnel could be dewatered during final concreting and mechanical installations for the Gate Shaft. This plug/bulkhead can also be used for any future shutdowns that may be required to dewater the water leg tunnel. Finally, the stainless steel Intake Structure was lowered and tremie concreted in place (Figures 8 & 9).

GATE SHAFT LINING COMPLETION

To facilitate the mining operations and the subsequent concrete lining of the shaft, the bottom 16 feet of the shaft was belled out to approximately 48 feet to accommodate the launching of the machine and installation of 20-foot sections of Permalok pipe. By belling it out, the thrust and launch walls were outside of the A-line and could remain in place after tunnel construction was complete.

Completion of the final concrete work in the Gate Shaft required close coordination between Contractor, Engineer and Designer of the Roller Gates, and encompassed the overall constructability for the initial and final concrete work connecting the water leg and land leg tunnels. (Figure 10)

Concrete work in the Gate Shaft began with the placement of the 5.5-foot thick reinforced base slab, followed by a 14-foot tall liner pour with mounts for the roller

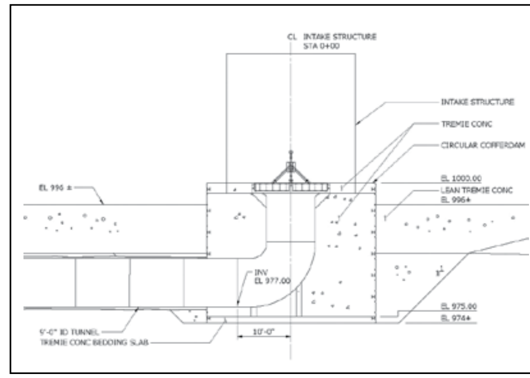


Figure 8: Section showing Intake Foundation and Structure

Figure 9: The stainless steel Intake Structure was lowered into place and tremie concreted

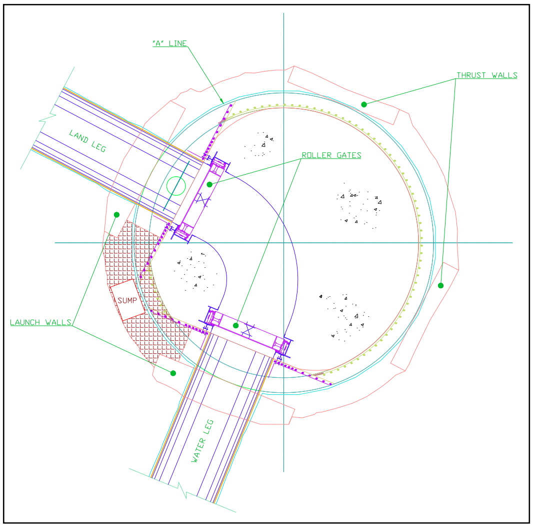


Figure 10: Final concrete work in Gate Shaft connected water and land leg tunnels

gates and a blockout for a temporary sump. A custom built compression form was than lowered into position and rested on top of the previously placed 14-foot concrete liner. A zone of the work shaft with high groundwater inflow required significant panning prior to being encased in concrete. A concrete turning structure between the two tunnels will be formed prior to setting the shoring towers for the maintenance slab 120 feet above. A second slab will be shored from this slab to set and receive the hoists for the roller gates.

The above grade concrete work and mechanical fit-out and testing will complete the work on the Gate Shaft structure by July, 2020.

VALVE CHAMBER COMPLETION

At the portal, the 108-inch hydro stub (for potential future works) and the bifurcation and reducers to 78 inches were installed and welded. The three story Valve Chamber structure sits on 110 caissons and tiedowns and is protected by O-piles driven 40 feet below the bottom of the base slab. Concrete work is underway with the base slabs placed and half of the walls on the lower level complete.

The roller compacted berm adjacent to the existing spillway is complete with majority of the earthwork required. All marine equipment has been demobilized and work for the public East Overlook Visitors Center area is near completion.

ABOUT THE AUTHORS:

John Arciszewski *is the Project Manager with Southland/Renda Joint Venture responsible for the construction delivery of the CAT-212C contract. For the last 20 years he has worked on underground projects for transportation, water, and wastewater across the United States including the Lake Mead Intake No. 3, East Side Access and, most recently, the Jollyville Transmission Main.*

Patrick Hoosier PE, *is the Resident Engineer with AECOM NY Metro - Water responsible for Construction Management of the CAT-212C Schoharie Reservoir Low-Level Outlet Project. He has over 10 years of experience delivering major construction projects for the public sector. Since 2011, Patrick has been working in Gilboa, NY for NYC-DEP on the Gilboa Dam Reconstruction Projects.*

CIPP SEWER REHABILITATION IN THE ENVIRONMENTALLY SENSITIVE COMMUNITY OF WAREHAM, MA

Protecting Marshes, Waterways & Coastline

By: Robert Drake, PE, BETA Group, Inc.
Guy Campinha, Town of Wareham, MA

Wareham's aging sanitary sewer system is comprised of clay, ductile iron, and RCP, running 15-16 feet deep through sandy soil with a tidally influenced groundwater level at six to eight-foot depth. The sewer system runs directly underneath beaches, sensitive bays, salt marshes, cranberry bogs, and fish farms that are typical of the Massachusetts coastline. With 54 miles of sandy beach coast, this beautiful seaside community was faced with the challenge of rehabilitating a sewer system situated within a sensitive coastal ecosystem.

Wareham is a densely populated beachfront community with narrow streets

Serious structural integrity issues were found within an 18/21-inch reinforced concrete pipe (RCP) interceptor that carries flow from the western side of the Town around marshes and water ways within the Town boundaries. The deteriorated sections of RCP showed visible spalling, deposited aggregate from infiltration, root infiltrations, and exposed structural reinforcement. These sections of interceptor were clearly weakened and urgently needed repair. Additionally, manholes along this 1.8-mile interceptor were structurally compromised, showing signs of infiltration and also needed immediate rehabilitation.

There was urgency because exfiltration from the deteriorating pipe would entail costly cleanup and negatively affect the wildlife of the marshland and estuaries, also damaging the commercial and recreational fishery. (*NASTT-NE Journal, Spring/2019*).

The location of this interceptor in environmentally sensitive areas made open trench cut construction cost prohibitive and permitting a challenge. In addition to ensuring the marshlands and waterways within the town were protected, it was also vitally necessary to reduce disruption from the construction work to local residents. Wareham is densely populated with narrow streets, so any underground construction work required a very compact site footprint.

These factors prompted Town officials to select a construction method that would ensure minimal disruption to the community and also protect the marshes,

The 1.8 mile segment of 18/21-inch RCP interceptor was structurally compromised and urgently needed repair

Protection of the marshes and waterways was of vital importance

> **"A TRENCHLESS METHOD WAS THE ONLY OPTION THAT MADE SENSE."**
>
> **–Guy Campinha, Director, Wareham Sewer Department**

waterways, and coastline. Wareham Sewer Department Director, Guy Campinha, and the Wareham Sewer Board, were determined to execute rehabilitation of the interceptor without disrupting neighborhoods or damaging the delicate ecology of the ocean area. "One of our main concerns was the impact to the community affected by the need to rehabilitate the 21-inch RCP. A trenchless method was the only option that made sense," said Campinha.

Trenchless technology had already proven to be beneficial to this seaside community, when a 1,600 LF eight-inch AC gravity main running at 17 feet below grade under the coastline near Swifts Beach was repaired in 2017 using the trenchless epoxy CIPP method. Valuable experience was gained during this project using CIPP to reestablish a pipe's structural integrity when the pipe is at a depth completely below the town's six to eight-foot-deep tidally fluctuating water table. These depths also make the dewatering necessary for open excavation sewer replacement work difficult and cost prohibitive, thus favoring the use of trenchless applications. (*NASTT-NE Journal, Fall/2017*).

This time around, with assistance from Robert Drake, PE, Vice President of BETA Group, Inc, and his team, the Town again chose a trenchless solution to rehabilitate the deteriorated pipe without digging it up. The team opted for a CIPP repair method, using only specified products which had passed rigorous standardized laboratory testing proving them to be low toxicity, aquatic-safe for fragile aquatic life.

A low toxicity aquatic safe epoxy CIPP lining technology supplied by Warren Environmental was selected, along with a structural glass and felt liner which had passed third-party ASTM testing. The epoxy resin selected was zero VOC, 100 percent solids, non-toxic, solvent free, laminar system, and moisture insensitive with superior strength and chemical resistant properties.

Compact site footprint during liner installation minimized impact on the community

The 39 manholes along the 1.8 mile segment were coated with an aquatic-safe epoxy

The CIPP system chosen would guarantee the protection of the local ecology, especially in the places where pipe was submerged in the ocean. Work began in early March of 2019, with completion in May. To further minimize disruption and reduce traffic concerns, night work was scheduled when installing CIPP liner in the downtown area of Wareham. The knowledge gained from the Town's previous trenchless projects was helpful, however the tidal influence and high water table again presented monumental challenges during construction.

Locally approved Warren Environmental, A&W Maintenance, and subcontractor SAK Construction, overcame tremendous challenges during installation of the liner, including managing major infiltration leaks at several pipe locations. Prior to installation, grouting was applied to these areas in order to stop the leakage.

To reduce traffic disruption in downtown Wareham, CIPP liner was installed at night

Bypass setup pumped over 110,000 gallons average daily flow

In order to protect the surrounding environment from erosion runoff coming from the construction site, straw wattles were installed around the salt marshes, cranberry bogs, and ecologically sensitive bays.

While the liner was being installed, use of residential sump pumps was another major concern. If a sump pump activated during the installation process, the force or pressure of the sewer flow could potentially cause the liner to deform, or even collapse, at the location of the service lateral. To prevent this from happening, mail-outs were sent to residents requesting them not to flush their toilets or take showers during the liner installation in front of their homes. Additionally, on the morning of installation in the neighborhood, crews went from house to house reminding residents not to flush their toilets or take showers.

During construction, there were three pump stations connected to the 1.8 mile section of gravity 18/21-inch RCP being rehabilitated. The total average daily sanitary flows to the work zone from these three pump stations was 113,445 gallons. Each of these pump stations had to be individually bypassed using pumper trucks. The pumper trucks remained on-site 24/7 until the lining work proceeded past each pump station connection point. After that, individual pipe segments were bypassed with six-inch pumps during liner installation and curing. Flows were picked up from a manhole located upstream of the segment being lined, to a manhole located downstream from it.

As graduation for local high school approached in May, the bypass setup made it very difficult for students to go from the school onto the field. Though this created some anxiety, close and regular communication with both the school superintendent and principal helped graduation to go off without a hitch. Construction work was suspended during the graduation ceremony to accommodate this important event in so many young lives. This ability to accommodate the needs of the community through flexibility, collaboration, and teamwork was exemplary throughout the entire project. According to Campinha,"Various town departments, the engineers, and the contractors had daily conversations to address issues that came up as the project proceeded."

At completion in May 2019, local contractor A&W Maintenance, along with subcontractor SAK Construction, had successfully installed a host bonded structural CIPP system along all 35 lined pipe segments which passed acute marine toxicology testing. Following installation and steam curing of the liner, A&W Maintenance went on to coat each of the 39 manholes along the entire 1.8 mile section with an aquatic-safe epoxy system that is also manufactured by Warren Environmental.

With the constant support and collaboration of the local authorities and Conservation and Sewer Department, A&W Maintenance and SAK were able to complete the project on time at the end of June with no impact on the sensitive marshlands, waterways, and coastline, along with minimal disruption to the lives

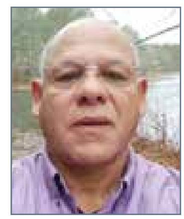
Selection of the aquatic-safe CIPP system guaranteed protection of the local ecology

of local residents. By rehabilitating this critical length of interceptor, the Town of Wareham, in collaboration with BETA Group, Inc., A&W Maintenance, SAK Construction, and Warren Environmental, was able to create an ecologically harmless monolithic lining system which will protect the Town's sanitary sewer system and surrounding environment for many years to come.

Trenchless technology applications have proven to be very beneficial for the beautiful seaside community of Wareham, helping preserve its valuable coastline resources for future generations. Driven by the goal of leaving the earth better than how it was inherited, the Town of Wareham chose to do what was best for all of its stakeholders, including those who do not have a voice.

ABOUT THE AUTHOR:

Robert Drake, PE *is Vice President of BETA Group, Inc. He has over 36 years of experience in the water and environmental fields overseeing the planning, scheduling, and execution of the environmental projects. Bob specializes in the planning and design of water distribution systems, sewer and drainage collection systems including installation/rehabilitation of main pipe by trenchless technology methods.*



Guy Campinha Sr. *is Director of Water Pollution Control for the Town of Wareham. He has spent the past 20 years managing Wastewater facilities and was also Past Chair of the Wareham Board of Health. Guy is a NASSCO: LACP, MACP, PACP certified Member, and is a Certified Grade 7 Wastewater Operator in Massachusetts. He is a currently serving member of the NASTT-NE Board of Directors.*

PIGGING RESTORES INTAKE FLOW CAPACITY FROM QUAGGA MUSSEL FOULING IN GREAT LAKES

By: Rex Murphey, Montauk Services Inc.

QUAGGA MUSSEL INVASION

During the fall of 2018 the City of Toronto initiated a project to clean all three (3) sixty-inch diameter HDPE raw water intakes at the Island Water Treatment Plant, restore intake flow to its original design specification, and reduce plant operating costs. The Island WTP is vital to the City of Toronto and serves as the only source providing year-round deep lake cooling water for Enwave Energy Corporation, a private utility generating electricity. The hydraulic capacity of each deep-water intake as determined by Hazen-Williams "C-Factor" rating was markedly reduced during the 14 years of service since commissioning of these deep-water pipelines.

Figure 1.ROV pictures showing quagga mussel build up prior to pigging

Quagga mussels, an invasive species of mollusk native to the Ukraine, arrived in the ballast water of ships navigating into the Great Lakes. Quaggas adhere to any submerged surface, and then feed off plankton in the water as they grow. This species creates catastrophic environmental impact as it invades new ecosystems, and rapid mussel infestation concurrently affects the maintenance costs for water treatment facilities and power plants by increasing aquatic fouling growth.

Tom Nalepa, emeritus research biologist at the National Oceanic and Atmospheric Administration Great Lakes Environmental Research Laboratory, has stated "*Without question, the quagga mussel represents the greatest threat to the Great Lakes of any invasive species.*"

Quagga mussels propagate at such a massive rate that they alter the natural food chain and displace native species, which dramatically disrupts the ecosystem, and ultimately reduces populations of both game and commercial fish. The quagga mussel may well present a greater immediate danger to lake ecology than the more famous zebra mussel. Neither chlorine nor other chemical procedures have proven effective as a control mechanism.

In 2014 Remotely Operated Vehicle (ROV) inspections of the deep-water intakes extending from Island WTP into Lake Ontario documented quagga mussel infestation. Fouling was heaviest in deep water (250 ffw) at the mouth of the intakes, and the mussels adhering to the interior wall of the HDPE pipe created flow turbulence which diminished the volume of water delivered to the WTP facility, and also increased the pumping cost.

SCOPE OF WORK

Large diameter hydraulic pipeline cleaning is a somewhat unique specialty and particularly so under deep water conditions as encountered off Toronto Island. In summer 2017, Engineers with the City of Toronto Water Division contacted Montauk Services because previously Montauk had successfully pigged Cornell University's 60-inch HDPE deep water Lake Cayuga intake. The Engineers reviewed the criteria, specifications, and budget for hydraulic pigging to restore flow capacity at the Toronto Island WTP in relation to the procedures and results which had been demonstrated at Cornell University.

In June 2018, the City of Toronto finalized project specifications and bid requirements. Montauk teamed with Galcon Marine Ltd., a Toronto-based contractor with marine equipment, local offshore expertise, and previous experience with the City. Galcon provided island transport, support, and overall control for multiple Subcontractor specialists, in addition to undertaking the General Contractor tasks required to handle barge delivery, on-shore piping, hydraulic water supply pumping, ROV services, and the marine operations for pig retrieval.

"Completing the project in the tight timeframe was a challenge due to poor weather conditions," said Ryan Vogt, Senior Project Manager at Galcon. "From a marine standpoint, the prevailing winds during Fall are from a predominantly bad direction making retrieval of the pigs, ROV operations, and drawing water for the operation very difficult." Vogt said the timeframe chosen

PIPELINE RESTORED TO A HYDRAULIC CONDITION BETTER THAN ORIGINALLY INSTALLED. CLEANING FROM THREE PIG RUNS COMPLETELY CLEARED THE QUAGGA MUSSELS AND ANY OTHER BUILD UP

Figure 2.60-inch launcher being moved from one intake to another

Figure 3.60-inch durafoam style pig being placed in launcher

for the project was optimal for the City of Toronto because it was the lowest usage time for its clients.

The specified Scope-of-Work included:

- Design and fabricate a pig launcher and structural supports capable of mating with the Intake Valve Chamber and WTP piping system
- Develop, document, and provide a process, design and procedure for hydraulic pigging of the three WTP intakes consistent with the timing and utilization requirements imposed by the City. The movement of vehicles and personnel along Lakeshore Avenue on Toronto Island was not to be delayed significantly or disrupted.
- Obtain necessary regulatory permits and approvals
- Perform an ROV inspection throughout complete length of each intake before pigging
- Pigging at three deep water intakes, including salvage of used pigs which, in view of environmental considerations, could not be "lost at sea"
- Manual cleaning of the Raw Water Suction Well and the Common Inlet Pipe

Montauk Services handled the overall hydraulic layout, launcher design, and hardware designation as well as pig design, sequence determination, tracking, and recovery procedures. Each pig was tracked leaving the Intake Valve Chamber, entering Lake Ontario, and at the offshore mouth of the intake.

HYDRAULIC PIGGING PROCEDURES

Pigging pipelines is simple in concept, but success usually determined by the experience, planning, and preparation prior to the actual pig runs. In Toronto, cleaning time was very limited because removing even a single intake from service imposed major constraints upon the system, and there were immense operational consequences from any significant disruption such as a "stuck pig".

The proper pig sequence is important because pipe cleaning usually must be completed as quickly as possible, but the procedures must also be conservative enough to avoid any damaging pressure surges in the line or the delays associated with a "stuck pig".

Pigs clean through compression of the foam body as they pass along the pipe propelled forward from hydraulic pressure created by pumps discharging into the line behind the pig. Pigs used for cleaning are often larger in diameter than the ID of the pipe, much like pulling a very large sponge through a pipeline and scrubbing the wall surface as it moves along. The Toronto WTP lines were almost 61 inches ID, however the first pig deployed was a soft foam material and only 58-inch diameter. The intention was to create enough bypass flow to perform initial cleaning, but not have the pig adhere to the wall of the pipe or restrict its movement through the intake.

Figure 4.Each pig is tracked as it leaves the shoreline

Figure 5.60-inch brush pig being readied for tow back to shore

One significant concern when cleaning mussels or removing any similar hard pipeline debris is that a mass of material can accumulate and shoal up ahead of the pig, which may slow down or potentially stop forward pig movement. During the first 58-inch pig shot, submerged video cameras aboard an ROV stationed at the intake mouth monitored in real time the volume of Quagga mussels displaced from the intake ahead of the pig. The amount of discharged material and the documented pressure profile measured by instrumentation behind the pig provided the information needed to determine the specific characteristics of the next pig launched.

Based on experience, the contractor will select and keep available onsite an array of alternative pigs for cleaning, however the actual results of each pig run determines the selection of each subsequent pig from this inventory. Generally, foam density and pig diameter increases after each run with the final pig larger in diameter than the ID of the pipeline. The last pig shot through each of the three Toronto intakes was a full sized pig with embedded plastic bristles to ensure complete cleaning of the pipe wall. The beauty of foam pigs (to a pigging Contractor), is that they can be designed to channel approximately 10% of the propelling water around the pig. This flow thereby displaces the volume of mussels or debris scoured off the pipe wall, suspending it in the flow ahead of the moving pig.

About 5-10 minutes before the pig discharges from the pipe, observations at the intake mouth become exciting, particularly in conditions with very good submerged visibility such as in Toronto. A flow of murky water comes first, followed by a trickle of mussels dropping onto the lakebed from the invert of the intake mouth. The trickle of mussel shell becomes a flow creating a pile on the bottom, followed by a surge of black water, mussels, debris, and finally, the pig. Depending upon the time of day and particulars of the pig run, sometimes creating back lighting above the intake even at depth, the pig itself can be observed by the ROV video. If obscured by a cloud of debris, the pig is tracked and located using sonar. Each pig is fitted with an acoustic transponder, which then is tracked at long distance by a receiver aboard the ROV to allow pig recovery even if it is shifted across the lakebed by bottom currents.

TORONTO INTAKE CLEANING OPERATION

Because contract specifications would not allow any interruption of intake flow before October15, 2018, fieldwork for the project commenced in the Fall. Completion was required by December 14.

For improved cleaning results, the launcher was designed and fabricated to accept oversized pigs at the upstream end. It had a reduced diameter on the downstream end, in order to fit the ID of pipe in the Intake Valve Chamber. Each of the intake lines had an independent connection for the pig launcher so that cooling water supply from two lines was kept in service while the third line was cleaned. The pig was propelled with water pumped from the shore side of Toronto Island passing beneath a temporary bridge installed by Galcon to maintain traffic along Lakeshore Avenue. The pumps were controlled to maintain uniform flow ranging between 18,000 and 20,000 gallons per minute. The three intake pipelines extended from approximately 16,500 LF to 17,300 LF between the Valve Chamber and intake mouth installed at 270 feet of water depth in Lake Ontario. Pig run times for each of the three intakes varied from 75 to 90 minutes. Each of the three intakes, (West, Center and East), were cleaned by three successive pig runs.

With the surface support vessel and ROV stationed at the intake mouth, a pig would be loaded and launched. The pig was tracked as it left the launcher, and again as it crossed the beach into Lake Ontario. If any problem developed during pig transit, gauges and data-loggers would indicate a pressure surge, providing data on the estimated location of the pig. Pigging time was recorded and documented for each run. Just before the pig discharged, a slight change in pressure accompanied the opening of the pipeline.

DEEP WATER & WEATHER CONCERNS

Cleaning at both the West and Center Intakes progressed like clockwork with each pig. All three pigs for both these intakes retrieved without issue. The good luck ran out during the East Intake cleaning when the second pig did not exit the intake mouth. The November weather turned foul with high winds and sea state, which precluded continued offshore operations. The surface support vessel could not safely leave the dock for a week

to track and retrieve this stranded pig, which was the size of a minivan, lost somewhere in the depths of Lake Ontario.

After a week of delay, the winds and the wave height subsided to the point the surface support vessel could maintain station above the East Intake mouth and deploy the ROV in order to locate the "lost" pig. It was discovered sitting happily in the truncated mouth of the intake structure at the end of the HPDE pipeline. It was a simple procedure for the ROV manipulator to attach a haul line so an auxiliary boat could pull the pig clear of the truncated intake section.

INTAKE CLEANING RESULTS

Other than the predictable weather challenges previously described, the pigging operations progressed flawlessly. Immediately after the first intake cleaning, Montauk Services and Galcon stood by while the City engineers verified the resultant Hazen Williams C-Factor rating achieved for the first intake by the three pig runs. This would also determine if an optional fourth pig run would offer any significant benefit. The City engineers were pleased by the initial (three pigs) results yielding a C-Factor indicating the pipeline was restored to a hydraulic condition better than when it was originally installed. The cleaning from three pig runs completely cleared the quagga mussels and any other build up reducing water flow.

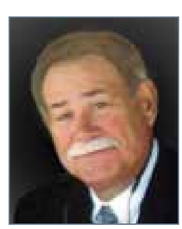
All three intakes were cleaned with It took only three pig runs to clean each intake. C-Factor analyses performed by the City on each intake after cleaning demonstrated better water flow conditions than when the pipelines were new. A perfect C-Factor for this type of pipe is 150+. Built in 2004, the original C-Factors for these pipes were calculated as 137 to 140. Prior to cleaning, quagga mussel buildup had reduced the C-Factor to approximately 110. After the pigging operation, all three intakes at the Island WTP had C-Factors of 149 to 152 as calculated by City engineers.

Figure 6.60-inch brush pig after being towed to shore

This project validated the use of hydraulic pigging for pipeline cleaning and restoration, with results exceeding expectations. Work completed on time and on budget while fulfilling a critical obligation that the Island WTP remain in operation at all times during the work.

This method of pipeline remediation is worthy of consideration for situations on the Great Lakes or in other areas with pipeline flow restricted due to quagga mussels, zebra mussels, or other species of biofouling.

ABOUT THE AUTHOR:



Rex Murphey *has been leading pigging and testing projects across multiple industries since 1986. He is Founder and CEO of Montauk Services, specializing in pipeline pigging services and equipment for pressure pipeline cleaning, focusing on water and wastewater. Rex is relied on among municipalities and utilities for his institutional knowledge and 37 years leading complex projects.*

UNDERSTANDING GEOLOGICAL HISTORY WHEN SELECTING TRENCHLESS INSTALLATION METHODS:

PART 3: EFFECTS OF NEW ENGLAND GLACIAL LAKES ON MICROTUNNELING

By: Bradford A. Miller, P.G., Haley & Aldrich
Dennis J. Doherty, P.E., F. ASCE, Haley & Aldrich

INTRODUCTION

When it comes to engineers and contractors undertaking new trenchless installation work, it is all about understanding how the ground may behave in response to a given trenchless method. The anticipated behavior considers several complex elements: real-world experience, a fundamental understanding of resultant ground behavior when a specific soil matrix is removed from the ground, strength of the ground to support equipment, a means to stabilize the borehole, and sufficient soil strength to prevent inadvertent returns ("frac-out"). Terms from the Tunnel-Man's Ground Classification Guide like "raveling" (slow and fast), "squeezing," and "running" are used to describe the ground and emphasize a potential level of concern.

For trenchless projects that are closer to the surface, designers are concerned with: weak overburden soils, weight-of-hammer (WOH) material, nested cobbles, gravel with little fines, running ground, and squeezing or swelling ground. All suggest unfavorable ground conditions. For large-dollar and complex trenchless projects, extensive ground characterization is typically performed. For small-dollar trenchless projects, however, adequate ground characterization is often overlooked, either due to lack of budget, a perception of low value for the upfront project cost, or unfamiliarity and limited experience with trenchless installations and their possible risks. Part 3 of this three-part series looks closely at the complications associated with the use of microtunnel boring machines (MTBM) in glacial lake-bed deposits in the Hartford, CT area.

UNDERSTANDING GEOLOGIC SETTINGS

To many owners a new installation project is "just a line on a piece of paper" - but there is much more to it. It requires understanding construction risk, how to manage that risk, and anticipating how the ground will behave in response to a specific trenchless method. Thus, understanding regional and local geology, and characteristics of the geologic conditions, can provide clues that an informed designer will use to anticipate the resulting ground behavior. For some projects, the ground changes can be hidden or unexpected, resulting in drastic and significant risk impacts.

One consideration often overlooked is fully understanding the geological history of an area. On large, engineered trenchless installations, it is imperative for the engineer to understand the geological setting of the project, and determine the possible consequences and controlling effects the geology has on the proposed crossing. We will briefly examine how deciphering the geologic history (and its anomalies) drives the selection and control of the trenchless method. In this case study, a very soft, water-bearing varved clay deposited in a freshwater glacial lake of regional extent created the challenging geology encountered by several large-diameter microtunnel projects in the Hartford, CT basin.

NORTHEASTERN GLACIAL LAKES

During the retreat of the last glacial sheet across southwest New England (estimated to be between 19,000 to 16,000 years ago), meltwater streams from the decaying glacial ice masses discharged significant volumes of sand and gravel in the New Britain/ Rocky Hill, CT area. Coupled with the formation of a retreat moraine, these deposits created a temporary debris dam. Upstream meltwater was trapped and ponded in a regional depression behind this sediment dam, forming Glacial Lake Hitchcock. Over the course of about 4,000 years, Lake Hitchcock extended back up the ancestral Connecticut River drainage as far north as West Burke, VT, a distance of roughly 250 miles (Ref. 1). In places, the lake spanned as much as 20 miles in width. Eventually, the debris dam broke, the lake waters drained southward towards Long Island Sound, and the modern Connecticut River was established on the drained lakebed of Glacial Lake Hitchcock (see Figure 1)

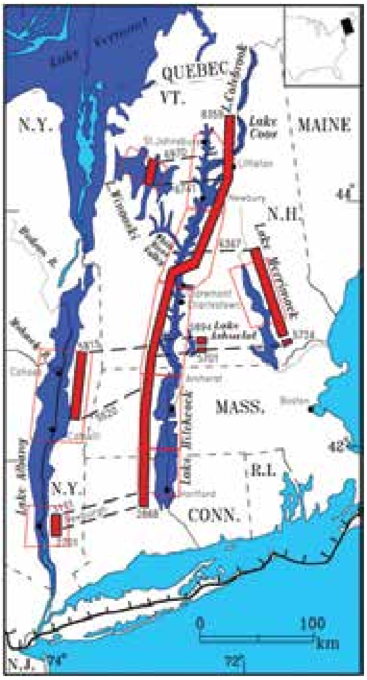


Figure 1- Estimated extent of major regional Glacial Lakes Hitchcock, Albany, Winooski, Coos, Ashuelot and Merrimack with chronology of varved clay deposits in New England shown in red. Deposits from the glacial lakes and associated delta complexes are significant landscape features in New England. Regional limit of the Last Glacial Maximum (LGM) is demarcated by black hatch line. Map is from the North American Glacial Varve Project, Tufts University (Ref. 2)

Controlled by the New Britain, CT spillway at an elevation of 75 feet above sea level, Lake Hitchcock extended from Rocky Hill, CT (elevation 223 feet) past St. Johnsbury, VT (elevation 614 feet) (Ref. 1). But how can a lake have a tilted shoreline? As described in Geocaching (Ref. 1), the tilt of this once-horizontal shoreline plane was due to uplift (land rebound) following ice loading by the continental ice sheet that depressed the crust beneath. With the melting and retreat of the ice, the newly-exposed land rebounded from its depressed position. This rising shift in the land surface due to the addition and removal of the weight of the ice is called isostatic adjustment, or "glacial rebound." Isostatic adjustment in New England appears to have been delayed but continues to occur over the past 2,000 years and appears to exhibit oscillating effects rather than reflecting a straight-line rebound.

CONNECTICUT VALLEY GLACIAL LAKE HITCHCOCK

For trenchless construction, the relevant deposits of Glacial Lake Hitchcock relate both to the granular deltaic deposits (found around the glacial lake perimeter) where meltwater streams delivered sand and gravel into the standing water body, and the fine sediments (silt and clay) forming characteristic glacial lake-bed sediments in the deeper portions of the water body.

On the lake-bed floor, deposits of repeating fine sediment layers reflect a seasonal cycle. During "warmer" periods of the glacial year, ice-free open water allowed fine sands and silts to be deposited, yet during ice-covered freezing "winter" cycles, only thin, darker cohesive clays were deposited. Each of these seasonal, cyclic pairs is termed an annual "couplet" or "varve," and much like tree rings reflecting an annual growth year, varves can be used to date the duration of the glacial lake's existence and regional extent.

Logically, at the perimeter of the glacial lake, the finer lake

IT IS IMPERATIVE FOR THE ENGINEER TO UNDERSTAND THE GEOLOGICAL SETTING OF THE PROJECT

bottom sediments also laterally onlap the paleo-shorelines where harder mixed geology (glacial till and bedrock) may lead to the threat of a difficult "mixed-face" condition to trenchless construction, especially to microtunneling. Therefore, knowledge of the regional geology and knowing which landforms may create problems allows a trenchless designer to tailor the MTBM design and MTBM route to best accommodate the ground conditions.

HARTFORD, CT ENGINEERING CHALLENGES

Of interest to microtunneling design and MTBM performance in the Hartford Basin, the very soft and deep varved sediments found in the vicinity of the city and close-in suburbs appear interbedded with sands that allowed water to flow laterally between the less-permeable layers of clay, indicative of the strong horizontal anisotropy of the deposits (see Figure 2). Rather than a perceived "uniform" deposit of lean clay, the varved glacial sediments behaved as a stack of alternating thin sand layers with interbedded clay horizons.

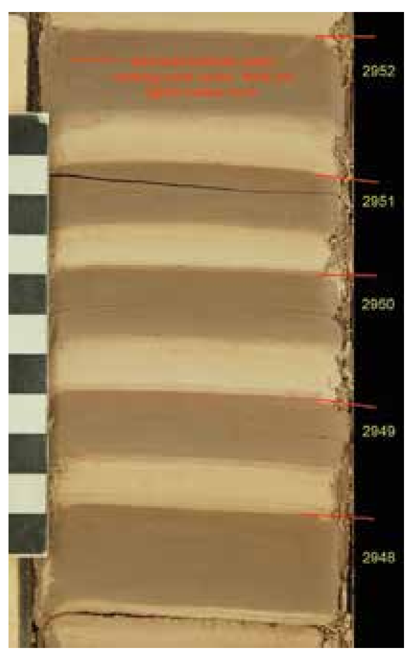


Figure 2- Varves of the former Glacial Lake Hitchcock, retrieved from Glastonbury, CT as part of the North American Glacial Varve Chronology project (John Ridge, Director). Bar scale on left is in centimeters. Red lines indicate start of varve-year "summer" deposits and also the sand layers described in text.

This situation affected several recent municipal wastewater projects constructed in Hartford that were sited within the geographic limits of the former Glacial Lake Hitchcock. During construction, the loss of effective buoyancy created by lateral water migration along the sand layers, combined with the weak/low bearing capacity of the clays, posed problems for wastewater conduit construction, primarily in keeping the microtunnel machines on-line and on-grade, especially upon launching and retrieval from the sheeted shaft excavations. The MTBM would often "dive" or drop below design elevations due to these unfavorable ground conditions. The low-strength varved clays also resulted in a number of shaft stability issues, including ground settlement/ground loss outside of the sheeted shaft walls.

In response to these ground effects and challenges, one specialty contractor opted to install a large mass of low strength concrete in front of the jacking shaft launch portal to stabilize the launch of the 48-inch MTBM out from the shaft and into the soft ground ahead of the drive (see Figure 3).

Figure 3- Photograph of MTBM launching shaft depicting the use of concrete mass ground stabilization in front of launch portal to stabilize weak soils.

On another Hartford-area microtunnel project the contractor elected to use a different method known as a "guillotine" for launch control. A guillotine method involves two walls on the launch or receiving side that helps control launch under certain ground types. However, the varved clay is not one of these types. This resulted in lost ground in front of the shaft, leading to the aforementioned surface settlements.

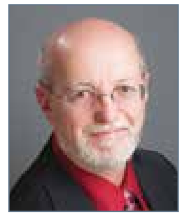
An industry lesson-learned arose based on the performance of the larger, heavier MTBMs that settled in the alignment due to their own weight in the soft material. In these examples, MTBM alignment control could not meet overly strict contract tolerances, demonstrating that the "one-size-fits-all" tolerance of 1.0-inch of maximum settlement was an unachievable criterion.

In hindsight, different approaches to MTBM launch and retrieval control, and other types of alignment control, may have solved some of these issues. For this reason, the latest American Society of Civil Engineers (ASCE) Design and Construction Guidelines for Microtunneling Standards were revised, leading to more realistic allowable vertical misalignment tolerances to account for larger and heavier MTBMs working in soft ground.

REFERENCES:

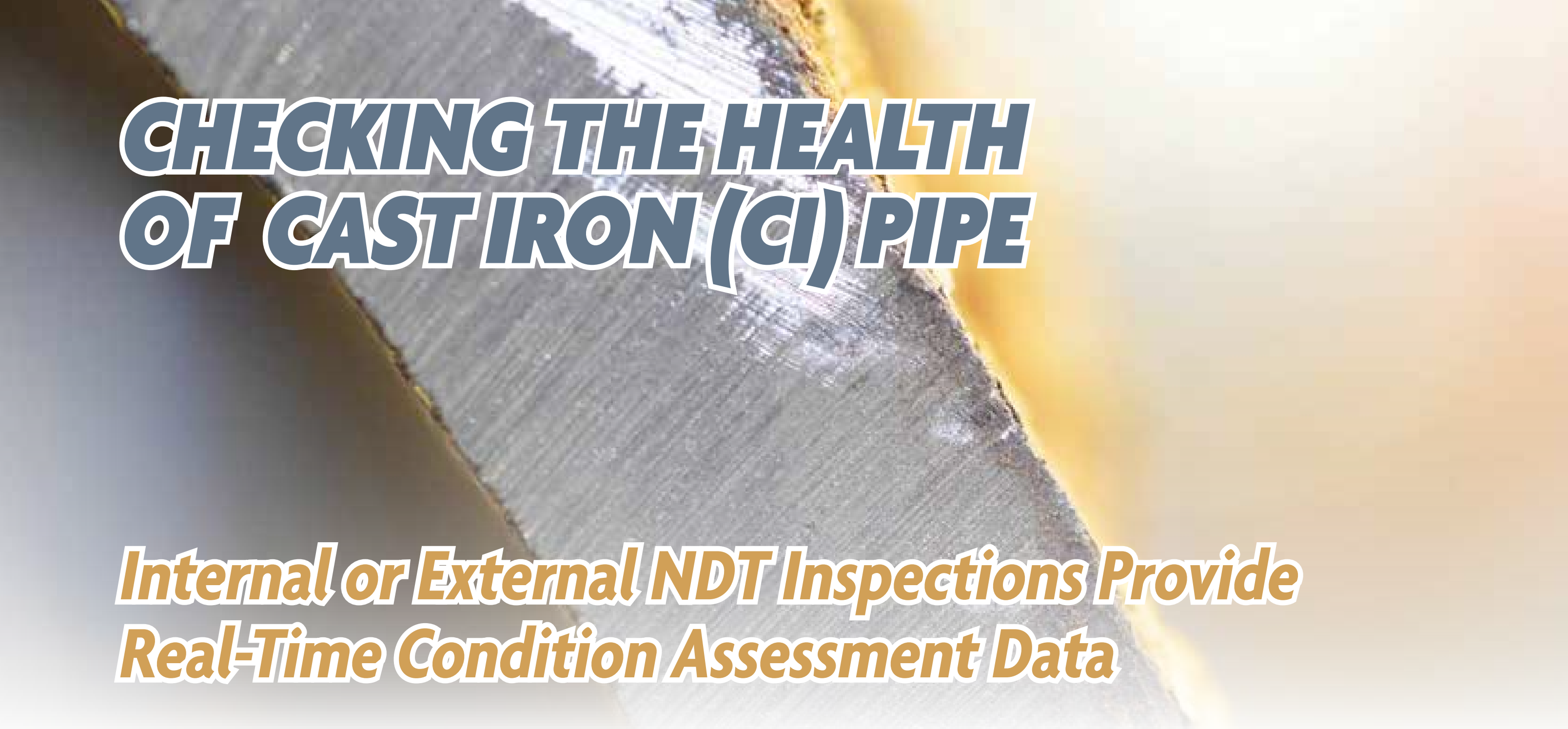
1. www.geocaching.com/geocache/lake_hitchcock-an-introduction
2. Ref 2. https://eos.tufts.edu/varves/NAVC/navctoday.asp

ABOUT THE AUTHORS:



Dennis J. Doherty *is a Senior Consultant and the National Practice Leader for Trenchless Technologies at Haley & Aldrich, applying a total trenchless approach on microtunneling, HDD and other trenchless method projects for private sector energy clients. An ardent proponent of the benefits and value of trenchless methods, Dennis has a unique understanding of risk management as it relates to trenchless design, having worked on a number of innovative projects across the US. He serves on the NASTT No-Dig Show Program Committee and is an instructor for NASTT's HDD Good Practices Course. Dennis is proud to be Past-Chair of the NASTT-NE Chapter.*

Bradford A. Miller *is Senior Geologist at Haley & Aldrich, whose expertise is the geologic interpretation of complex soil, rock and groundwater conditions as they influence a broad variety of geotechnical projects, including trenchless utility construction, pipelines, linear energy corridors, highway rock slopes and foundation construction. He currently serves as Chair of the New England Chapter of the Association of Engineering and Environmental Geologists (AEG).*



CHECKING THE HEALTH OF CAST IRON (CI) PIPE

Internal or External NDT Inspections Provide Real-Time Condition Assessment Data

By: George Ragula, Public Service Electric & Gas

PASSAIC RIVER

Back in 2002, Public Service Electric & Gas (PSE&G was the first utility in the US to utilize broadband electromagnetic non-destructive testing (NDT) technology for condition assessment on cast iron (CI) pipe. The NDT inspections were performed on two critical 30-inch high pressure CI underwater crossings, installed in 1914, located in a tunnel breached with water under the Passaic River in Newark, NJ. Extensive construction work along the river front was planned as part of a development project. There was a significant need therefore to confirm the integrity of these two critical feeds due to all the surrounding planned construction activity.

At the time, the broadband electromagnetic technique was the only NDT technology available to detect wall loss, graphitization and cracks in CI pipe. The scans can identify pipe anomalies without having to remove external coatings or internal linings. Applied both internally and externally, broadband electromagnetic inspections provides real-time condition assessments of all types and diameters of ferrous pipe, detecting metal loss as small as 1mm. Inspecting all types of ferrous pipe was an added benefit which provided flexibility in being able to also utilize this technique to evaluate several shorter sections of steel pipe in the same area.

The two CI lines under the river were abandoned temporarily so that an internal pig probe with multiple broadband electromagnetic sensors could run through each pipeline and perform the inspection. This resulted in a comprehensive report containing a complete assessment of the condition of the mains. Overall, the inspection confirmed the integrity of the two mains, showing both lengths of CI pipe in reasonable condition with some minor wall loss at the horizontal legs towards the center of the river and vertical legs at the mid sections.

External NDT inspection of exposed CI pipe

Internal pig probe with multiple sensors

SOUTH ORANGE

Fast forward to 2018, and there was an immediate need to NDT a 2,500 foot section of 30-inch diameter high pressure CI main situated under a heavily trafficked roadway in South Orange, NJ, and located only a mile west of the 2017 world record diameter CIPL renewal of this same gas main in an area where it opens up to a 36-inch diameter. This 2,500 foot section had a long prior history of repaired leaks and presently contained several active leaks needing immediate attention.

Local field reports indicated graphitization might also be involved, affecting the decision to repair, replace or preferably renew using CIPL technology. If the degree of graphitization was too severe, the integrity of the host pipe would be compromised making it an unsuitable candidate for CIPL renewal. Real time data from broadband electromagnetic inspections would provide the ability to make an informed decision on the best option for this leaking segment of pipe moving forwards.

Due to the costs associated with temporarily abandoning the pipe to perform an internal inspection, similar to what was done on the two Passaic River crossings in 2002, this time around the broadband electromagnetic inspection was performed externally.

NDT INSPECTION

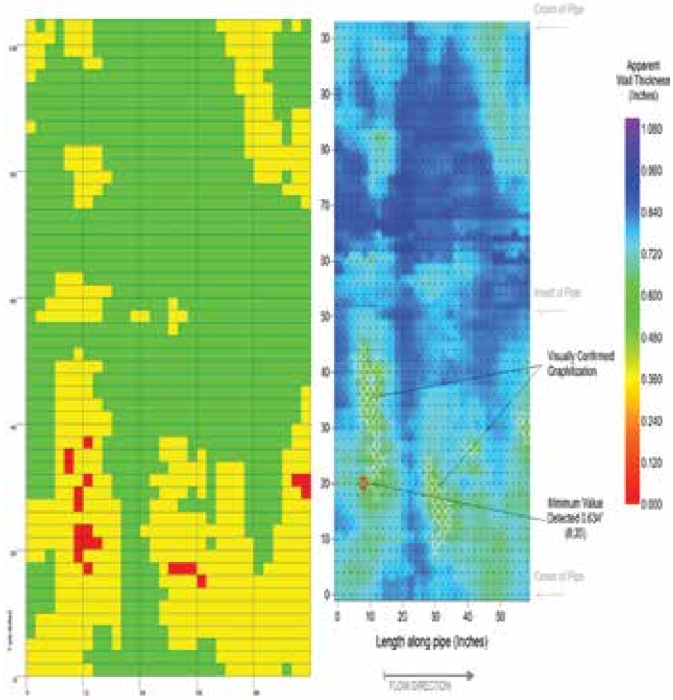
A total of 5 inspection sites were excavated at strategic locations over the 2,500 foot run. The NDT inspection work was performed over a 1 week period in summer 2018 by Rock Solid Group out of Australia working alongside its North American licensee from New Jersey, Progressive Pipeline Management. While immediate results were obtained in real-time on site, PSE&G elected to post-process all the data which generated color-coded topographical images of the pipe containing the absolute magnitude of actual pipe wall thickness remaining at each of the five specific pipe locations, including any graphitization or cracks.

At Site 3 for example the real-time display indicated a specific area contained less than 70 per cent wall thickness. Upon closer examination a small area of

Graphitization South Orange NJ

Site 3 - South Orange

Nominal Thickness – 0.920
Minimum Measured – 0.634
Maximum Measured – 0.969
Average Measured – 0.788



Real time display and color-coded topographical image showing graphitization

graphitization was discovered. Subsequent post-processing of that data indicated that the wall thickness was actually 0.630 inches in that location compared with an original pipe wall thickness of 0.920 inches.

After careful analysis of all the data collected, it was determined overall that graphitization was not a major factor which would negatively impact renewing the pipe with CIPL. The general over-design of the pipe in terms of its operating pressure and wall thickness meant that its structural integrity as host pipe would be adequate for liner installation and ongoing safe operation. Furthermore, any

Leak at CI coupling

weak locations found outside of ASTM F2207 allowable requirements could be strengthened internally during the lining process through the installation prior to lining of internal structural reinforcement sleeves usually constructed of carbon fiber.

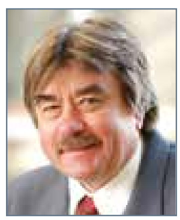
CI PIPELINE INTEGRITY

Fortunately, due to overall favorable soil conditions in the northeast, graphitization of CI mains is a very isolated condition, however an aging CI inventory requires careful ongoing monitoring of pipeline integrity. Broadband electromagnetic inspections allow for condition assessments on CI pipeline health to be done in conjunction with other construction projects when segments of pipe are exposed, for example road or rail bridge widenings, tapping projects and emergency repairs. This NDT pipe inspection technology gives a utility the ability to make decisions based upon actual real time data on pipe conditions, and is a valuable tool when considering pipeline repair, replacement or CIPL renewal options for large diameter high pressure CI mains.

FORTUNATELY, DUE TO OVERALL FAVORABLE SOIL CONDITIONS IN THE NORTHEAST, GRAPHITIZATION OF CI MAINS IS A VERY ISOLATED CONDITION...

Graphitization cross section

ABOUT THE AUTHOR:



George Ragula *is the Distribution Technology Manager at Public Service Electric & Gas (PSE&G) with over 42 years of experience in gas industry engineering, operations, construction, research/development/deployment and management. George is a noted authority on trenchless applications for the gas industry having spent 32 years specifically focused on trenchless. He received his B.S. in Mechanical Engineering from Polytechnic Institute of Brooklyn in New York. George is a past Chair of NASTT and serves on the NASTT No-Dig Show Program Committee. He also teaches several NASTT courses on various trenchless technology topics, including CIPL for the Gas Industry.*

APPLICATIONS SUMMARIZED

As a direct result of PSE&G's work with broadband electromagnetic NDT pipeline inspection technology, key applications involving its use are evident as follows:

1. CI Condition Assessment:

a. Providing additional data points for developing a replacement main priority matrix
b. More informed decisions relative to pipeline repair, replace or renew options
c. Characterizing pipeline integrity
d. Pipeline failure prediction
e. Locating suitable areas for tie-in to existing CI pipe.

2. Lining Applications:

a. Pre-lining host pipe integrity assessment
b. Periodic post-lining host pipe integrity monitoring, since coatings/liners do not need to be removed using this technology

3. Major Application Areas:

a. RR crossings
b. Large diameter CI mains
i. Costly to replace
ii. Congested subsurface conditions
iii. Capacity issues

SLIPLINING OF A 102-INCH AQUEDUCT

UMass Lowell NASTT Student Chapter Report

By: Jorge Calmo, Dylan Shaffer, and Dr. Raj Kumar Gondle (Faculty Advisor)

Students posing in a large-diameter pipe

HOBAS custom FRP pipe fittings

Members of the UMass Lowell NASTT Student Chapter had a great opportunity to witness Providence Water's 102-inch Aqueduct Sliplining Project in Cranston, Rhode Island on May 21, 2019. Ian Mead, Chair of NASTT Northeast Regional Chapter and Prof. Raj Kumar Gondle, faculty advisor for our student chapter, joined the field trip along with representatives from Providence Water.

Arriving at the construction site, the Student Chapter teamed up with contractors and onsite engineers from Providence Water who walked students through the project as it was in action. It was interesting to see sections of large-diameter fiberglass-reinforced pipes that were near the construction site ready to install. The challenge of the construction project was to replace an aging 102-inch Prestressed Concrete Cylinder Pipe (PCCP) aqueduct in-place underneath a major highway in the Cranston area, with minimal traffic disruptions and without diminishing the water supply.

Due to these constraints, the contractors and project engineers proceeded with rehabilitation of the existing pipe using a sliplining method to cause minimal surface disruptions. Sliplining involves joining a series of smaller-diameter pipe sections on the job site and inserting them into the damaged host pipe. A 90-inch diameter HOBAS Fiberglass-Reinforced Pipe (FRP) was used for the project, which was slightly smaller when compared to existing 102-inch PCCP host pipe. Whenever a smaller-diameter carrier pipe is considered for replacement of an existing pipeline, flow capacity can be a concern. In this case, flow capacity was minimally impacted since the slipliner had a smoother inner surface than the existing concrete pipe. The flow capacity due to

Placement of a new slipliner

Lifting of a pipe section using an excavator onsite

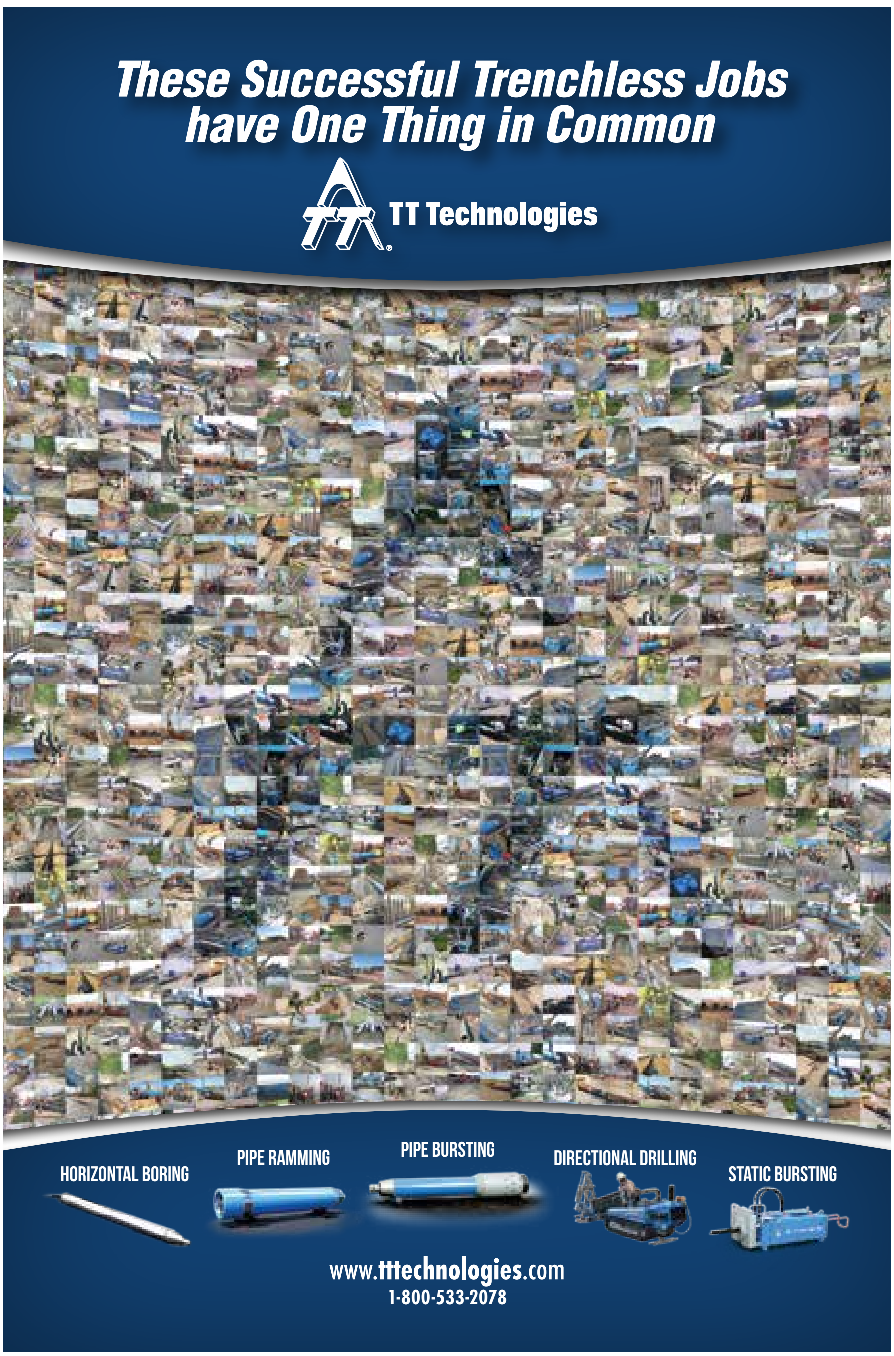
the smaller-diameter pipe was balanced by improved hydraulic coefficients of the new pipe. From student's perspective, it was remarkable to see how fundamentals of fluid mechanics are directly applied in the field. In addition, engineers informed students about a series of state-of-the-art trenchless technologies used at the site for assessing and monitoring the condition of PCCP.

On the day of the site visit, contractors and engineer's onsite were prepared to reline the pipe. A section of deteriorated PCCP pipe was removed in order to insert and slipline the new pipe. An excavator was deployed on the site to lift a new section of pipe, insert it into the excavated pit, and push the FRP slipliner into the existing PCCP. In addition, a pipe pusher custom-2 designed for the project site was used to apply a large force which was required to push the FRP slipliner.

During the installation process, frictional forces developed on the surface

Installation of a slipliner into an excavated pit

New pipe in-place



Field crew observing FRP slipliner getting pushed with one excavator and pipe pusher

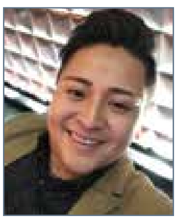
of the new pipe became so large due to the amount and weight of slipliner already installed that the sliplining was temporarily stopped until the process could be adjusted to overcome these frictional forces. After several discussions, the contractors and engineers agreed upon using another excavator to lift and push the pipe as it was sliplined into the existing one, overcoming the amount of friction imposed. Since there was only one excavator onsite on the day of the visit, the slipling operation was halted.

When field operations were resumed the next day, the onsite field engineers pushed and pulled the FRP slipliner with two excavators in tandem to successfully advance the pipe. Even though such an incident is something that engineers in these projects do not want to happen, it was a great moment for the student chapter to observe how engineers came together to develop a solution to a construction site challenge.

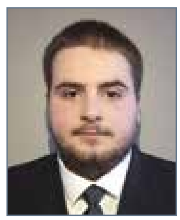
Problem solving skills are critical for engineers as it teaches how essential tackling, developing and executing solutions for real-life problems are for the field of Engineering. It is important that such projects are shown to upcoming engineers because this type of essential learning outside the classroom allows students to get a feeling of how different engineering principles are applied in real-life projects. In addition, it benefits student's academic and professional growth, as they develop a unique skill set that they can apply in order to successfully complete any given tasks. The NASTT Student Chapter at UMass Lowell is very grateful to Providence Water and the NASTT Northeast Regional Chapter for the opportunities provided for students to explore in the trenchless community and is always looking forward to participating in future events or projects with the goal of making the world a better, and more trenchless environment.

IT WAS REMARKABLE TO SEE HOW FUNDAMENTALS OF FLUID MECHANICS ARE DIRECTLY APPLIED IN THE FIELD.

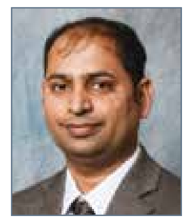
ABOUT THE AUTHORS:



Jorge Calmo *is a junior in the Department of Civil and Environmental Engineering at UMass Lowell. Jorge has recently become the new Treasurer for the UMass Lowell NASTT Student Chapter and is the Public Relations Chair of the Society of Hispanic Professional Engineers (SHPE) at the university.*



Dylan Shaffer *is a 2nd Semester Senior in the Department of Civil and Environmental Engineering at UMass Lowell. The former President of the NASTT Student Chapter, Dylan is currently searching for long-term employment while continuing his education as a Masters in Geoenvironmental Engineering.*



Dr. Raj K. Gondle *is an Assistant Teaching Professor in the Department of Civil and Environmental Engineering at the University of Massachusetts Lowell (UMass Lowell). He serves as a faculty advisor for North American Society for Trenchless Technology (NASTT) Student Chapter.*

INDEX TO ADVERTISERS

ADVERTISER	WEBSITE	PAGE
Akkerman Inc.	www.akkerman.com	30
AP/M Permaform	www.centripipe.com	16
Barton & Loguidice, D.P.C.	www.bartonandloguidice.com	8
BETA Group, Inc.	www.beta-inc.com	36
Bradshaw Construction Corporation	www.bradshawcc.com	53
Green Mountain Pipeline Services	www.greenmountainpipe.com	45
Haley & Aldrich, Inc.	www.haleyaldrich.com	51
Hallen Construction Co., Inc.	www.hallen.com	48
Henniker Directional Drilling LLC	www.hddbore.com	47
Herrenknecht AG	www.herrenknecht.de	31
JESCO, Inc.	www.jescoditchwitch.us.	4
LMK Technologies LLC	www.lmktechnologies.com	37
Logiball, Inc.	www.logiball.com/en	55
McMillen Jacobs Associates	www.mcmjac.com	42
Montauk Services	www.montaukservices.net	41
National Water Main Cleaning Company	www.nwmcc.com	Inside Front Cover
Progressive Pipeline Management	www.progressivepipe.com	Outside Back Cover
Southland Holdings Renda JV	www.southlandholdings.com	33
Tighe & Bond	www.tighebond.com	32
TT Technologies Inc.	www.tttechnologies.com	52
Vermeer Northeast	www.vermeernortheast.com	6