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TRENCHLESS NORTH AMERICA



The Official Magazine of the North American Society for Trenchless Technology



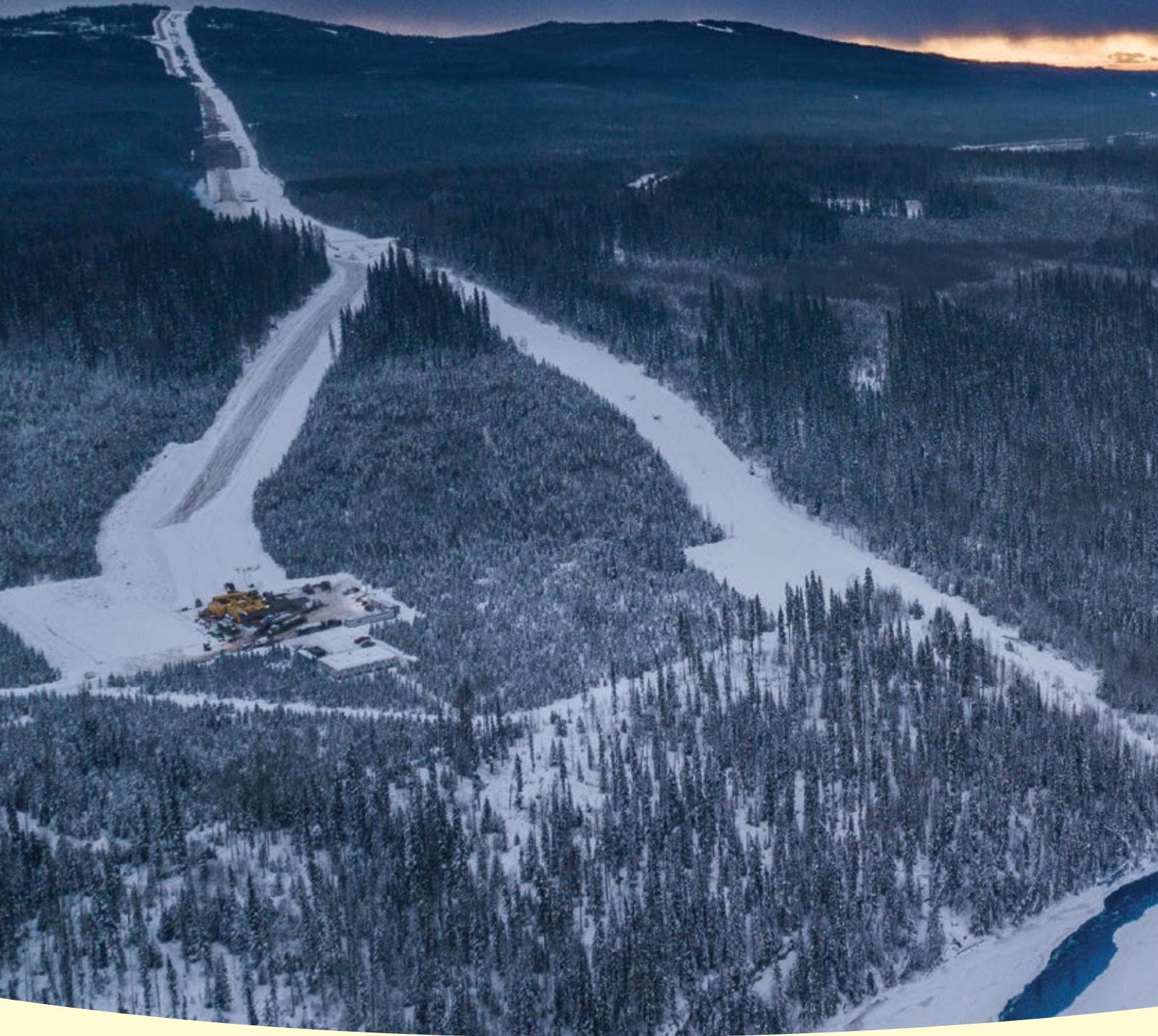
NASTT 2022 NO-DIG NORTH

OCTOBER 17-19, 2022 | TORONTO, ONTARIO

Corporate Member Listings Inside

FALL 2022
Volume 12 • Issue 3

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TRENCHLESS NORTH AMERICA



The Official Magazine of the North American Society for Trenchless Technology

FALL 2022 – VOLUME 12, ISSUE NO. 3

JOIN US AT THE 3RD ANNUAL NASTT NO-DIG NORTH CONFERENCE IN TORONTO!

The 2022 No-Dig North Show October 17 – 18 at the Beanfield Centre in Toronto will feature two full days and four tracks of sessions as well as Good Practice Courses on the first day of the conference. The conference will also include an exhibit hall with nearly 100 exhibitors. Join us for this unparalleled in-person networking opportunity!



12

FEATURES

14 Q&A: David Rosenberg

With a lifelong interest in construction and innovative technologies, David Rosenberg recently retired after a distinguished 50-year career involved in underground infrastructure. Having served as Chair of the Board for the Metropolitan St. Louis Sewer District, David offers a well-rounded perspective on the current state of trenchless technology in this interview.

20 Trenchless Travelogue: Josh Bentley, Wessex Water

A firsthand account of his North American trenchless adventures, by Josh Bentley of Wessex Water in the UK. As winner of the prestigious UKSTT “Young Professional” Award, Josh received a grant funding a trip to the USA to learn more about new trenchless installations. Details of his travels and work with the team from Staheli Trenchless.

28 NASTT 2022-2023 Corporate Membership Listings

NASTT offers special recognition to its Corporate and Government, Utility and Education members in appreciation of their ongoing promotion of NASTT and the industry. The member lists are as of September 2022. The NASTT Corporate, Government & Education Members are highlighted here, along with key contacts, websites and corporate logos – the NASTT community!

48 Comparison of Observed and Predicted Settlements: Dubuque IA

Selected as the Outstanding Paper – New Installations at the 2022 NASTT No-Dig Show in Minneapolis, this paper compares the predicted versus observed settlements over a substantial time period from six parallel 101-inch 200-foot long microtunneled storm drains constructed underneath 5 sets of railroad tracks adjacent to the Mississippi River in Dubuque Iowa.



DEPARTMENTS

- 6 Executive Director’s Message
- 8 Welcome from NASTT Chair
- 10 NASTT 2023 Municipal Scholarships
- 16 Morty’s Trenchless Academy
- 25 NASTT Celebrate Trenchless Awards
- 26 NASTT Membership Benefits
- 38 Eye on Industry
- 58 NASTT Regional Chapters
- 60 NASTT Student Chapters
- 61 Events Calendar
- 63 Index of Advertisers

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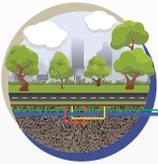
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A large, circular tunnel under construction. The walls are lined with vertical wooden planks and reinforced with horizontal metal rings. A large, white, flexible pipe runs vertically down the center. The floor is cluttered with construction materials, tools, and a red ladder on the right side.

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**GREEN ABOVE.
GREEN BELOW.**

“Our collective contributions to the growth and development of trenchless technology continue to create the conditions for sustainable environment, people, and profit.”

WELCOME TO THE FALL 2022 EDITION OF TRENCHLESS NORTH AMERICA!

This issue includes our Membership Directory and focuses on No-Dig North, Toronto - Canada's annual trenchless technology event.

Active membership through volunteer activity enables NASTT to deliver its substantial training and education courses that form an important part of our outreach program. This willing engagement to develop understanding and encourage the suitable application of trenchless technologies personifies NASTT's mission and vision through your actions.

A great example of this is No-Dig North. Starting in 2019 (where does the time go!) we are delighted to be back in Toronto, returning to a favorite for NASTT as the host city of 1995 No-Dig Show and the 2009 International No-Dig Show. Those involved in 2009 may remember the Program Chair that year was Joe Loiacono, and for many years was our best attended conference – until which? (*Answer below!*)

The event resulted from the growth of the successful conferences by our three Canadian Chapters - British Columbia, Great Lakes, and Northwest - and the hard work of many volunteers combining to become the 'must-attend' trenchless event in the Canadian utilities & pipeline sector. I would like to recognize David Crowder's leadership this year in Chairing the Program committee, supported by all exhibitors, sponsors and attendees in continuing the strong demand to grow and deliver another exceptional event. Thank you all for your contribution.

Many of our members find local networking more suitable through one of their 12 Regional Chapters, perhaps for specific projects or providing career opportunities through our 18 Student Chapters, affiliated to engineering academic institutions. Engagement with owners and decision makers to provide knowledge on trenchless technology is generated through re-investing your revenue directly into the NASTT Municipal & Public Works Scholarship. Since 2013 over 1,500 places have been awarded to directors and project managers of utility owners throughout North America to attend the No-Dig Show full technical conference. This program has now been extended to No-Dig North through the support of the Canadian Chapters, and we are delighted that over 50 representatives from various Regions and Cities across the Provinces have embraced the opportunity to engage with attending engineers, contractors, manufacturers and suppliers in Toronto.

Recognition for No-Dig North is subsequently drawing more international awareness with increasing visitors each year. As a result, many of our members are benefitting from the import and export opportunities created by attending, presenting technical papers, and creating business links that are formed as part of our global community.

Let our collective contributions to the growth and development of trenchless technology continue to create the conditions for sustainable environment, people, and profit to collectively flourish.

Enjoy your read!

Matthew Izzard, Executive Director

North American Society for Trenchless Technology (NASTT)

mizzard@nastt.org

(Denver, 2015)

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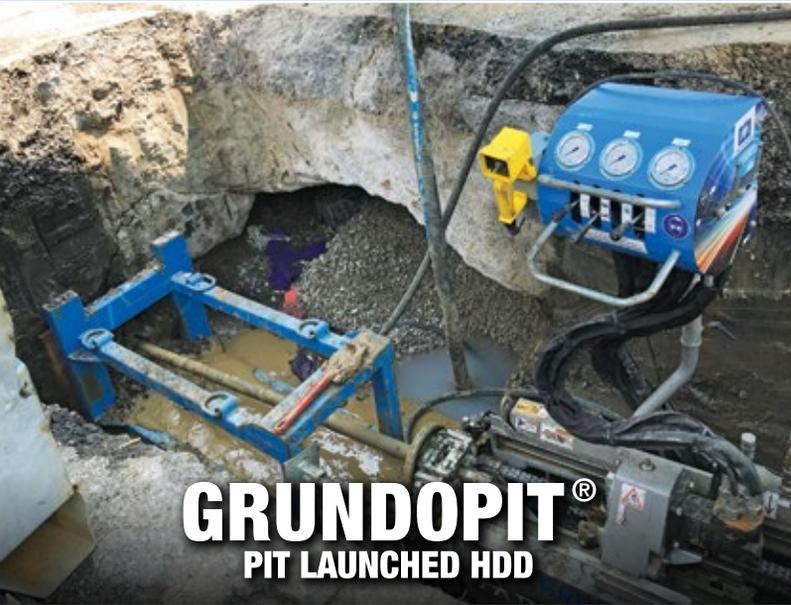
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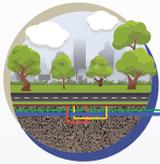
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THE DIVERSITY IN OUR MEMBERS AND VOLUNTEERS MAKE US WHO WE ARE

As we enter the fourth quarter with more projects and work, many companies are on pace to set another record year in 2022. This is proof that the trenchless industry shows no signs of slowing down. Our training programs and Regional Chapters are busier than ever. We had our in-person No-Dig Show in Minneapolis this past Spring and it was an amazing turnout for new attendees in the Midwest. It was great to see so many of our colleagues and friends that had not been able to travel to Orlando in 2021! Many of our Regional Chapters are holding in-person conferences and networking events this quarter. If you are unaware of your local regional chapter conferences, the national conferences, or events; then go to our website and get more information to register. The value of networking with NASTT members is truly priceless. Our members and volunteers are innovative and creative thinkers, always looking for ways to improve technology and infrastructure and protect our environment.



**GREEN ABOVE.
GREEN BELOW.**

“NASTT’s mission and vision are 'to continuously improve infrastructure management through trenchless technology.'”

The Fall issue of **Trenchless North America** is dedicated to our members and volunteers. This organization is able to grow and thrive because of you and for that reason, it is important to us to recognize our members and volunteers for their support. I want to personally thank all of you that have taken an interest in joining one of our 40 plus committees. We now have good representation of municipalities, gas utilities, manufacturers, contractors, and engineering firms on these committees to contribute up to date good practice courses and publications. If you or your company are involved with CIPP, Pipe Bursting, HDD, Gas, Laterals, or Grouting, then I recommend that you get involved with that committee and represent the technology within the courses and publications. With our membership and committee growth, NASTT will continue to provide the most relevant and up to date publications and courses for all industries. NASTT is the primary source for all education on Trenchless Technology throughout North America.

NASTT’s mission and vision are “to continuously improve infrastructure management through trenchless technology” and “to be the premier resource for knowledge, education, and training in trenchless technology.”

We are all anticipating the upcoming No-Dig North conference in Toronto October 17-19. The exhibition is sold out and we all will benefit from this opportunity. This is the third annual No-Dig North that Canadian Chapters have put together, which consists of two days of technical paper presentations and industry exhibits in the trenchless technology field. We are extremely proud of the quality and work that has been put into the papers and presentations. Pre-event Good Practices courses will also be available, so visit www.nodignorth.ca for all the details.

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

We look forward to seeing you at a regional or national conference or training event soon!

Alan Goodman

North American Society for Trenchless Technology (NASTT)

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NASTT 2023 No-Dig Show Scholarships Available for Municipal & Public Utilities

Municipal and public utility scholarship opportunities are still available to attend the NASTT 2023 No-Dig Show, April 30 – May 4 in Portland, Oregon!

In 2013, NASTT established the No-Dig Show Municipal & Public Utility Scholarship Award Program to provide education and training for employees of North American municipalities, government agencies and utility owners who have limited or no training funds due to economic challenges.

In past years, over 100 applicants were awarded the scholarship annually. NASTT's Municipal & Public Utility Scholarships have gone to over 1350 people since the inception of the scholarship program, and it continues to build momentum. With an entire conference dedicated to trenchless technology, this scholarship offers public agencies the opportunity to participate, and experience, the world of trenchless. It's an opportunity perhaps entirely missed were it not for the award directly impacting an agency's bottom line. Submit your application today - this is a chance public agency representatives shouldn't pass up!

Selected scholarship winners will be awarded Full Conference and Exhibition registration to the NASTT 2023 No-Dig Show. Also available are one day conference registrations which include full access to all exhibits and technical paper sessions. Selected applicants will also be eligible to receive complimentary overnight accommodations for three nights at the host hotel. The scholarship applications are reviewed by a committee of NASTT volunteers and awarded based upon the supplied responses.

To apply for the scholarship, complete the application online at nastt.org/no-dig-show/municipal-scholarships on or before November 1, 2022. Applicants are not required to be NASTT members. For more information about the NASTT No-Dig Show visit www.nodigshow.com and www.nastt.org.

“The show provided many opportunities to network with contractors, consultants, and decision makers within municipalities and utilities across the United States and Canada.”

– Joseph Barnes, Johnson County Wastewater

“This event allows you to meet and talk with manufacturers, installers and end users who are not normally the case at other shows.

Thank you for the opportunity.”

– Joe Devito, Beaufort Jasper Water and Sewer Authority



Each year NASTT hosts a reception for the Municipal Scholarship recipients to network with each other and kick off the conference

Who Do You Want to Meet at No-Dig 2023?

Doing business with municipal agencies and public utilities is crucial to the trenchless industry. NASTT's Municipal & Public Utility Scholarship brings hundreds of decision maker agency representatives in-person to the No-Dig Show. Since its inception, over 2,000 delegates have been onsite looking for solutions to their infrastructure challenges that you can provide.

Register today to secure these future customers!
Join us at the Oregon Convention Center, April 30 – May 4, 2023.



Municipal and public utility scholarship applicants from all over North America are planning to be at the NASTT 2023 No-Dig Show. Visit www.nodigshow.com to register today.

“I found the sessions interesting and gained a lot of useful information to bring back to my community. I had such a narrow view of Trenchless Technology before the show, and now see it in a clearer fashion and in a larger light. The exhibits were interesting and I found many products or ideas that directly related to what I deal with on a day to day basis.”

– Matt Overeem, Village of Wilmette

“I was blown away by the magnitude of the conference and all of the information provided at each track session. So many professionals with similar problems and alternative solutions to learn from and network with. I am looking forward to attending another No Dig show!”

– R.J. Kakach, E.I.T.

Municipal & Public Utility Scholarship Program

The NASTT No-Dig Show Municipal & Public Utility Scholarship Award includes:

- Complimentary full conference registration
- Full access to all exhibits and technical paper sessions
- Overnight accommodations



Apply for the scholarship by **NOVEMBER 1** to attend the No-Dig Show **FREE** of charge!

APPLY TODAY!



Join us at the
Third Annual NASTT No-Dig North October 17-19, 2022!
Beanfield Centre • Toronto, Ontario

The 2022 No-Dig North will feature two full days and four tracks of sessions as well as Good Practice Courses on the first day of the conference. The conference will also include an exhibit hall with nearly 100 exhibitors.

Networking events at the 2022 No-Dig North will include an Opening Reception on Monday, October 17 inside the exhibit hall. All full conference attendees and exhibitors are invited to enjoy drinks and appetizers. On Tuesday, October 18, the conference will begin with a Kick-Off Breakfast featuring a welcome speech from Lou Di Gironimo, General Manager of Toronto Water. The breakfast is complimentary but limited to the first 400 attendees who sign up to attend at registration.



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No-Dig North is owned by the North American Society of Trenchless Technology (NASTT).
For more information about NASTT or other NASTT events, please visit nastt.org.



with

David Rosenberg

With a lifelong interest in construction and innovative technologies, David Rosenberg has recently retired after a distinguished 50-year career involved primarily in underground infrastructure. He has a well-rounded perspective on trenchless technology, serving as Chairman on the Board of the Metropolitan St. Louis Sewer District. David was elected to the NASTT Midwest Chapter Board in 2018, and has been long-standing member of the NASTT Program Committee. He was a NASTT Regional Ambassador in 2021.



What first inspired you to become interested in the construction & engineering fields, particularly underground construction?

Growing up in St. Louis, MO I was always fascinated with construction. Whether watching a grading operation, building houses, or any other type of construction I knew I wanted to work in the construction industry. I initially attended a technical trade school to learn drafting and was fortunate to be hired by a local civil engineering firm. There were several individuals who mentored me in the aspects of laying out subdivisions and what was involved in taking an undeveloped parcel to turn it into a subdivision. I worked for contractors and developers who knew I was interested in construction. I was able to use this experience to take on the roles of site development manager, project manager, and vice presidents of development for numerous projects including land development, single-family homes, large scale office and industrial projects, and infrastructure.

Having lived in St. Louis I met several individuals from Insituform Technologies and learned about their various pipe rehab technologies and gained a better understanding of the rehab market. At the time Insituform was looking to expand their business development group for their water market technologies and offered me a position to grow this market segment. This turned out to be a great move as it once again allowed me to use my experience and knowledge to enter a new market on the ground floor.

Over my 50-year career I earned a BA in Human Resource Management and raised 2 daughters with my wife of 50 years.

Although never working in HR, it taught me the importance of listening and guiding people. Over my career I volunteered with the AGC, Home Builders Association, United Way, and other organizations to mentor individuals and help them realize careers in the construction industry via working in the trades and pursuing a college degree.

Outline your experience of first being introduced to trenchless technology methods and applications.

I was appointed to the Board of Trustees for Metropolitan St. Louis Sewer District and later became Chairman. MSD spent a large portion of their annual operating budget on improving and rehabilitating the sewer system. During my time as a trustee, I became more interested in not only CIPP technology, but also other industry solutions. Insituform was expanding their product line for the CIPP industry with a new technology for the drinking water market. I became interested in this new technology as well as their gravity products. As my term was ending, I began discussions with them and was offered a position to bring their pressure pipe product to market. I was fortunate to be in on the “ground floor” of pressure pipes not only for drinking water, but also to expand the gravity market.

After spending 7-years with Insituform I went to work for Michels Corporation in Wisconsin for more than 8 years. Working for Michels Pipe Services I assisted in growing this business unit to become one of the largest installers of CIPP gravity and pressure pipe lining systems. Michels installs not only CIPP lining systems, but is a leader in installing several other trenchless technologies including Geopolymer Spray-on, cement mortar lining, slip-lining, manhole rehab, and

continues to evaluate new technologies for the industry. Today, Michels is an industry leader in the trenchless industry. I retired from Michels in February 2022.

How did you first get involved with NASTT? What are some of the goals and initiatives you would like to see NASTT pursue?

When I joined Insituform, I attended my first NASTT conference and worked in their trade show booth. I attended several educational presentations and spent hours learning more about the industry from other industry leaders. Meeting these industry leaders provided me with a platform to become involved as a volunteer. I represented Insituform at various NASTT national and regional conferences by presenting technical papers on projects.

I continued my volunteering while working for Michels. I attended annual industry conferences, regional and local conferences in the US and Canada. Michels supported my volunteer efforts with NASTT and I continued building my relationships with NASTT and its members. I became a member of the Program Committee to evaluate papers for upcoming NASTT conferences. Additionally, I was elected to the NASTT Midwest Chapter board, and served on the committee to evaluate new technologies for the industry. I found this to be valuable in growing my knowledge within the industry and make numerous contacts in the private and public sector promoting the trenchless industry.

Going forward, I would expect NASTT to continue to be the voice for the trenchless industry providing guidance in setting policy to assist the industry with growth. NASTT should continue to represent engineering professionals, owners of utilities, contractors, suppliers and others on the merits of trenchless technologies. NASTT's leadership has grown beyond North America and has become the face for international organizations as they expand their efforts using trenchless solutions in their markets.

What are your thoughts on the current state of the trenchless industry? What areas do you see evolving in STEM – (science, technology, engineering, and mathematics) education and post-secondary academics?

The trenchless technology industry will continue to grow based on the aging infrastructure throughout the world. Owners and community leaders want to use a technology, friendly to the environment and with less disruption to surrounding neighborhoods and traffic. New technologies are being developed for the industry to assist in lowering costs to rehab existing infrastructure instead of digging and replacing.

“My 50-year career... taught me the importance of listening and guiding people. Going forward, I would expect NASTT to continue to be the voice for the trenchless industry

STEM programs for education and training must continue to evolve as the trenchless industry grows. New methods for pipe assessment, installation, equipment, materials, and labor will be required to handle continued growth while not sacrificing safety. NASTT will need to assist in helping to deliver this message for the industry by recruiting academia to not only understand the trenchless industry and career opportunities, but to assist in further research and development to improve upon new solutions for the industry.

Is the trenchless industry generally doing a good job of attracting young professionals? What do you think can be done to better engage students and young professional in the trenchless industry?

NASTT and its members must continue to provide internships for engineering students to become familiar with the trenchless industry. The promotion of the trenchless industry is larger than just pipe rehabilitation. All aspects and scopes of work must be represented to individuals looking to enter the fields of engineering and construction. Field personnel will be some of the most difficult positions to fill. Workers will need to be trained in safety and using specialized equipment, handling materials, working with other team members, and learning the mechanics of construction. This effort will become more important as work continues to grow.

NASTT and their members must recognize we are competing for valuable resources, mainly people. As the current workforce is aging, our members must dedicate themselves to attract talented people to consider the trenchless industry as a viable industry for a career.



B-Tech Connections™ for Infrastructure Piping Applications

Evolution of an Innovation

By: Sam Boyd, Boyd Tech Inc.

A Simple Question

Our journey began with a simple question. "Why is there no pullable HDPE threaded segment system on the North American market?" We learned quickly that no current manufactured HDPE connection in existence would guarantee pipe pull-ability over 2,000 US Pounds! The result of our research and exploration became the basis for **B-Tech Connections™**. We simply couldn't stop until we found a way to solve this problem!

Our preliminary experiments with common threads revealed why previous efforts had likely fallen short. HDPE is a very soft and supple material, it expands over itself, so traditional threads don't hold. Then our out-of-the-box thinking took over, and the brainstorming began. Ultimately, we developed a way to use the suppleness of HDPE pipe almost against itself – a negative positive force configuration for positive output. Our new product **B-Tech Connections™** solved the problem, and can withstand literally tons of pulling force for trenchless pipe rehabilitation and confined space pipe rehabilitation.

A means to mechanically connect HDPE piping for pulling, pushing and transitions, **B-Tech Connections™** provides a pipe-to-pipe connection wherein ID & OD remain the same. Either permanently locked or

temporarily installed, connections are water-tight with a broad range of applications in trenchless and non-trenchless applications. In confined space applications, work crews save time and resources when compared to other, time-consuming connection techniques or bulky mechanical methods. Connections can be supplied in short spools up to 36 inches, or pre-fused to any length of pipe to produce custom length spools. Long life span and fast assembly times, make this connection method, time efficient and cost-effective for any HDPE project or application.

Evolution of the Innovation – Rotational Threaded Connection (RTC)

Two patented mechanical connections were developed for joining HDPE:

- **Locking Pull Thread (LPT)** - is a proprietary thread that is machined onto short sections of HDPE and fused onto longer sections on location.
- **Locking Push Conn Tapered (LPCT)** - is a proprietary stepped locking profile that is machined onto short sections of HDPE and fused onto longer sections on location.

By combining these two patented connections, the LPT and LPCT, into



B-Tech Connections™ was winner of the NASTT Abbott Award – New Installation at the NASTT 2022 NO-DIG SHOW in Minneapolis. The product also recently won the New Technology Award at the ASTT No-Dig DownUnder Show in Australia, and is on the short list for the UCT Innovative Product Award in Orlando, February 2023

This connection method, time efficient and cost-effective for any HDPE project or application.

Quickly becoming recognized as a game-changer in the industry. The response has been incredible!

The Most Advanced Steering Tool in the HDD Industry



Brownline's Drillguide GST is the original, standalone Gyro Steering Tool specifically designed for HDD operations used as the primary survey and reporting system. The industry leading technology consists of highly accurate components and software which provide a proven accuracy of 0.01° in pitch and 0.04° in azimuth. The Drill-guide GST provides real time, highly accurate navigational information which allows for a smoother bore trajectory and has proven to reduce drag and stress during installation.

To complement the GST, Brownline has developed a comprehensive selection of Steering Systems for a multitude of HDD projects; For Intersecting Projects, Brownline has developed the Drillguide Radar System. As the bore paths reach the point of intersect, the RADAR Systems are activated and the two systems Actively communicate with each other to establish their relative position. Unlike the passive magnetic systems, the RADAR System has proven to be more accurate and allows HDD Intersects to be completed faster and seamlessly. For Secondary Tracking, Brownline has developed the Drillguide GPS Tracking System. Based upon the proven RADAR System, this portable unit can be placed in any position along the bore path to confirm the location of the GST. This system has proven to be essential to tight tolerance windows along the bore trajectory and provides on target Punch-Outs.

Having been deployed on thousands of projects since 2004, the Drillguide Gyro Systems have a well-documented record for providing a safe and cost-efficient pilot hole. 4,300,000 feet drilling with over 700,000 feet of intersect drills successfully completed. Contact Brownline to discuss how we can assist with your project.



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Brownline's Drillguide Gyro Steering Systems allows for HDD projects to be executed with extreme accuracy, in a safe and cost efficient manner.

The Drillguide GST is the original, and only, GST specifically designed for HDD operations and consists of highly accurate components and software that has a well-documented record, having been deployed on thousands of projects since 2004.

The Drillguide RADAR System uses Active Ranging to allow HDD Intersects to be completed faster and with greater accuracy.

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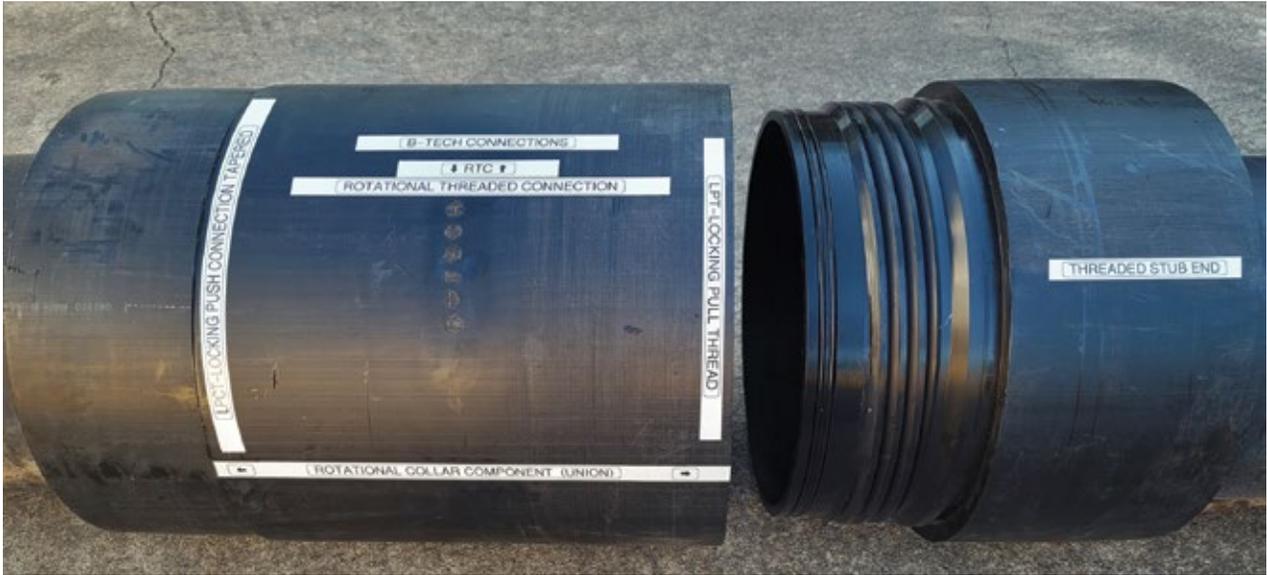
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Morty's Trenchless Academy



The B-Tech Connections™ product is a game changer for Trenchless Technology Engineers, Designers and Contractors

one multipart connection, we created the **Rotational Threaded Connection (RTC)**, which is a time saving and practical mechanical approach to joining long lengths of pipe together with minimal effort and equipment.

This hybrid connection was designed for long length spools where rotating the entire length of pipe would not be possible, or, where rotational alignment is critical. Especially, when using pipes with large diameters and/or heavy wall thicknesses. An end-user can make-up connections with fewer resources. Simply line up the threads and rotate the Collar component of our connection until the thread locks into place. The Collar, or 'union' of the connection rotates freely and independently of the fused sections of pipe allowing threads to make-up without either pipe having to rotate.

The B-Tech Rotational Threaded Connection is preferred by many industry professionals who deal with long length spools found in farm irrigation, dredging, mining, dewatering, by-pass, and all types of temporary conveyance systems. It allows contractors to quickly dis-assemble and re-assemble multiple times and/or locations, with very little assembly equipment.

A Game-Changer

B-Tech Connections™ is quickly becoming recognized as a game-changer in the industry. We set out to assist the trenchless industry in the best way possible, and the response has been incredible. It has been professionally invigorating and rewarding to be able to take **B-Tech Connections™** across multiple industries solving countless different operational issues. Complex bypass systems can be set up within a day, rather than a week, yielding huge cost savings. **B-Tech Connections™** innovative design features make these patented connections completely customizable, providing time and cost benefits to industries such as water, wastewater, telecom, electrical, irrigation and petro-chemical applications. **B-Tech Connections™** are specially designed & tested to be extremely pullable, thus eliminating Trenchless Technology connection issues for engineers, designers & contractors.

Our ground-breaking product, **B-Tech Connections™** was winner of the NASTT Abbott Award – New Installation at the NASTT 2022 NO-DIG SHOW in Minneapolis. Our leading edge product also recently won the New Technology

Award at the ASTT No-Dig DownUnder Show in Australia, and is on the short list for the UCT Innovative Product Award in Orlando, February 2023, showing the positive impact we've had on the industry so far.

For more information, contact Sam Boyd, President at samboyd@boydtech.us or visit us on LinkedIn: [linkedin.com/in/sam-boyd-99b3b712](https://www.linkedin.com/in/sam-boyd-99b3b712)



(L to R) Rollin Boyd with 40 Years of Trenchless and HDD, Sam Boyd with 44 years of General Construction and Consulting are the Architects of B-Tech Connections™. Their collaboration and out of the box designing have produced something that will likely benefit multiple industries! We set out to assist one HDD Contractor and ended up changing an Industry



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Josh Bentley UKSTT Young Engineer Winner – Trip to Seattle

By: Josh Bentley, Wessex Water

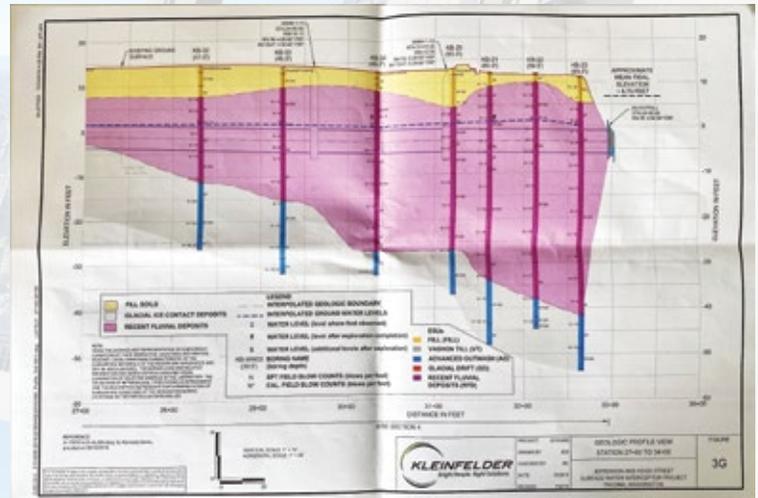


Winning the ‘Young Professional’ award

On September 15th 2021, my colleagues and I from Wessex Water attended the United Kingdom Society of Trenchless Technologies (UKSTT) road show and award ceremony. It was a great day and it allowed us to explore new technologies and kit being used in the industry. As a company, we won three awards, two of them being the ‘Application of Digital Technology’ and ‘Innovative Product’ for our involvement with the ‘Telesto’ 3D LiDAR Modelling of Tunnels in Semi-Turbulent Flow, along with Headlight AI Limited and Bright Innovations Group Ltd.

I was nominated for the ‘Young Professional’ award after writing a paper based on my experiences and contributions made to the industry since joining Wessex Water in September 2017. The main focus of my paper highlighted my contribution and involvement towards the rollout of a new product from Australia called the ‘Latseal’ by Ibtech. As of today, we have now successfully completed some of our first installations to help reduce infiltration on the direct area of the lateral connection.

As I was one of the winners for the ‘Young Professional’ award, I received a grant which helped me fund my trip to the USA to learn even more about the industry; this being for new trenchless installations, as opposed to trenchless renovations work, which is the usual area I focus on in my role. My plans commenced for the trip to Seattle to work with Kim Staheli’s team from Staheli Trenchless.



Geotechnical profile

An Introduction to Staheli Trenchless and the USA!

I arrived in Seattle on June 18, 2022. This was my first time back in America since 2001 when I was 3 years old! I had a hotel booked for 2 weeks and I used the first couple of days to explore Lynwood which is where I was staying. Travelling for the first time alone is a surreal experience, especially when you are somewhere that you have never been before. Some nerves were present but overall, excitement took over quickly. Trying to catch up on sleep was the first task on the Saturday but the Sunday was a fresh day to explore. A trip to the shopping mall in the morning and hearing nothing but American accents gave me that feel of ‘I’m a long way from home’, but in an exciting way. After grabbing some lunch and heading back to the hotel, I got in contact with Kim Staheli and Matt Izzard. Matt was kind enough to pick me up from my hotel and give me a brief tour of Lynwood in his ‘truck’ (one of the many new terms I had to get used to). We stopped at Rory’s Bar & Grill for some more food and that’s when it really hit me that I was in America. Sitting in a classic American bar, chatting with Matt, just looking around and taking everything in, it felt like a different world. It was a perfect taster of America to start the trip, and I was ready to meet Kim at her office the next day.

Before work could start on the Monday, we had to do something which felt very important, and that was to get a Starbucks! Which

With Seattle being a 10-hour flight from the UK, I had to make the most of what it had to offer!

Some nerves were present but overall, excitement took over quickly.



Seattle sight-seeing



First Starbucks!

for anyone that doesn't know, originated from Seattle. I then got the chance to chat with Kim about Staheli Trenchless and the overall processes of the water industry in America.

Staheli Trenchless Ltd are a consultancy based in Lynwood just north of Seattle. They design projects for their customers and tender the work out to contractors on an array of trenchless construction projects ranging from;

- HDD
- Pipe bursting
- Pipe ramming
- Pipe jacking
- Augor boring/ Guided augor boring
- Tunnelling

Over the two weeks, I was able to learn and get involved in a few of the projects they had running. I'll get into that later. One of the main differences I noticed was the process of the project throughout the design and installation. Back home in the UK at Wessex Water, I had been used to working a lot with internal teams. It felt more separated in the US, and it seemed the litigation side of things were more present. However, with limited knowledge on trenchless installations, I knew it was going to be a great opportunity to learn. This started

with auger boring, and Kim explained some of the main considerations to make when designing a project.

Design – Learning about trenchless installations and what to consider

As I started to learn about the different methods of trenchless installations, it came apparent that each method had its own characteristics and limitations. Therefore, the site-specific factors had to be considered throughout design to ensure the best solution was being used. One of the main factors to consider was Seattle's geology. Different but similar in the sense that they have specific soils which can cause problems. In the Wessex region for example, we suffer with high levels of CaCO_3 (calcium carbonate) causing calcite build up within our pipes suffering from infiltration. Seattle's geology ranged from Vashon Till to Glacial Till. Vashon Till was the more common substance geologically, with dense grey silty/gravelly characteristics that included cobbles and boulders. Glacial Till was a trickier substance to determine, as it included a variety of materials that had been carried in the ice of a glacier. When designing a project for trenchless installation, the geology was an important factor to determine the most appropriate solution.

Trenchless Travelogue



Kayaking on Lake Washington

We also touched base on the other important factors to consider, such as the entry and receiving angles, the length, size, and depths of the tunnel required, and locations. It was interesting to learn and see how the projects were designed, and how the technical calculations would be used when designing a project. One topic in particular was how a hydrofracture or better known as a 'frac out' would occur. This being the potential risk that can occur during HDD when the down-hole mud pressure exceeds that of the 'earth' pressure (vertical pressure/load of the soils and existing ground above the drilling route).

It's been great having the chance to go into further detail and it has given me a better understanding of the capabilities of each of the drilling units; knowledge I have been able taken home with me. This also including an understanding of hydrokinetic pressures, bore path profile trajectories and different formulas.



Mariners Game!

As well as learning a lot from Kim, I also attended an ASTT masterclass online, which again was greatly beneficial. This focussed on pipe bursting. A technique which I was more familiar with but again, did not know too much about.

Site visits

It wasn't just office work during my two weeks in Seattle. I attended some site visits to see more of the action. Myself and Jake Andresen, from Staheli Trenchless, went to visit a site further up north of Lynwood which was called Lyndon. It was a small town right next to the Canadian border. There was an ongoing auger boring project that we wanted to see, so I was able to see the site set up and I also listened in on a site meeting involving the client, designer, and contractor to discuss the progress.



Lateral Lining

Jake and I visited another project which was of a much larger scale. It was located in Tacoma where they were installing a 1200mm storm main across a busy main road and railway crossing. The method used for this project was micro tunnelling with a jacking frame used to insert to the pipe sections. This was a job that you could really see the scale and usefulness for trenchless installation. Within the area, you had busy roads, railway lines and even an art museum. For the section they were drilling, they only required one road closure for the receiving pit and the entry pit was located off of the highway. There was minimal disruption and it did not affect the main 705 highway or any of the nearby trainlines.

Some familiarity

As well as conducting site visits on the larger drilling projects, I also got the chance to visit a site in Lynwood where they were carrying out some CIPP works. It was nice to see some familiarity with a trenchless renovation project. I think I may have been lucky with this site as well as it was located on a lovely quiet road surrounded by hundreds of tall pine trees. Something you don't see every day in the UK! This leads on to one other benefit I could notice is the US, which were the size of the roads. Compared to the UK, there was plenty of space for set up and installation. I've worked on multiple schemes in the UK and most of them consist of busy main roads or

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Trenchless Travelogue



Site visit!

small country lanes that normally require a closure, so I was slightly jealous of the room that was on offer for the team to operate in.

There was a lot of common ground in terms of the kit that was required, method of installation etc for the CIPP, although it seems UV cure was the chosen method for curing. We usually use a steam or water cure method. Again though, it was nice to see another method in practice.

Sight-seeing and time to relax

With Seattle being a 10-hour flight from the UK, I had to make the most of what it had to offer. As soon as the weekend came, Kim and Matt made sure I had plenty of things to do and see. They were kind enough to take me to a 'soccer' game (one term I definitely won't be keeping as a Brit!) and my first ever baseball game. I even managed to perfectly time one of my videos of the 'soccer' game to catch one of the Seattle Sounders goals. Once the game was over, I went on my own to have a look around Seattle to do some sight-seeing. As the coffee culture is massive over there the first stop had to be the Starbucks Reserve and the first ever Starbucks store. The smell of the coffee at the reserve was incredible! I also went up the Sky View observatory which offered an amazing view of the whole city, including the Space Needle and Mount St. Helens which I could even see from my hotel in Lynwood.

The Sunday consisted of more chill time, kayaking on Lake Washington in the morning and then having a leisurely

I'd recommend this experience to anyone, especially other young engineers!



Special thanks to Kim Staheli and everyone at Staheli Trenchless (l-r: Josh Bentley, Jake Andresen, Kim Staheli)

lunch in Bellevue. Anywhere you go, the views are always memorable. I also managed to squeeze in an extra trip to Kingston via a short ferry ride from Edmonds. Apart from one of the ferries breaking down and nearly missing the baseball game, it was another enjoyable experience and another part of Seattle which was just as good as the rest.

The whole experience was amazing and I'm grateful I had the chance to do it. I was able to take so much from my time in Seattle and I'm thankful for the support I've had from the UKSTT and Wessex Water to make this trip possible. Not forgetting all the bits in between that Kim Staheli and Matt Izzard did for me, whether it was going out for breakfast, or playing a round of golf before work.

I'd also like to say a special thanks to Kim Staheli and everyone at Staheli Trenchless for their time and support during my time there to make it a memorable one. I'd recommend this experience to anyone, especially other young engineers who are looking to learn more and have fun in the process. Until next time Seattle!

NASTT Celebrate Trenchless Awards



NASTT Celebrate Trenchless Awards recognize the multitude of ways that individuals and companies contribute significant time, energy and intellect to developing trenchless technology and fostering its success. The awards celebrate innovators, champions, volunteers and emerging leaders who have made a substantial impact in the industry.

Why nominate yourself or a colleague?

- **Sales.** Awards are an opportunity to stand out from your competitors.
- **Attract talent.** Motivated employees want to work for the best companies. Awards increase your stature among new recruits.
- **Build name recognition.** Even if you don't win, you or your organization will become familiar names known for excellence, initiative and ingenuity.
- **Growth.** Awards should be an essential part of your growth strategy for your career, corporate funding, succession planning and revenue.

The application window is open now for several awards.

Nominate a Standout Young Professional for the Ralston Young Trenchless Achievement Award

Applauding savvy NASTT members under 36 who have demonstrated excellence early in their career by making valuable contributions to the trenchless technology industry, the Ralston Young Trenchless Achievement Award recognizes members whose talent and ability are the future of trenchless.

You do not have to be a NASTT member to nominate; but, only NASTT members are eligible for the award. Self-nominations are allowed. *Student members are not eligible.*

Read more at: www.nastt.org/awards and apply by November 30, 2022.

NASTT No-Dig Show 2023: Focus on INNOVATION

The **Abbott Innovative Products & Services Award** celebrates the NASTT 2023 No-Dig Show exhibiting and sponsoring companies with state-of-the-art product or services making a significant impact in advancing the trenchless industry in the areas of rehabilitation or new installation. Applicants can apply in one or both categories.

Applicants must be an exhibitor or sponsor *who will be on site* in Minneapolis. There is no separate fee to enter.

Apply by January 31, 2023 online at www.nastt.org/awards.



Finalists and winners receive:

- Top-tier exposure in person and online;
- International recognition throughout the US, Canada and Mexico;
- Industry affirmation from a panel of NASTT judges and members;
- Team inspiration through nationwide validation of their hard work; and
- Elevated brand identity that attracts the finest talent.

That means...

- Winners and finalists are featured in NASTT distributed press release and NASTT publications.
- Winners are honored with an exhibit booth banner and personalized award at the NASTT No-Dig Show.
- Winners receive winner logos to use on company websites and sales and promotional materials.
- Winner and finalist presentation recordings posted on NASTT YouTube channel following the No-Dig Show
- Winner's photos will be shared across NASTT social media channels.

If you have any questions, contact Carolyn Hook at chook@nastt.org

NASTT Membership

“NASTT has been the most significant vehicle relative to the industry-specific connections I’ve made and cultivated throughout my career.”

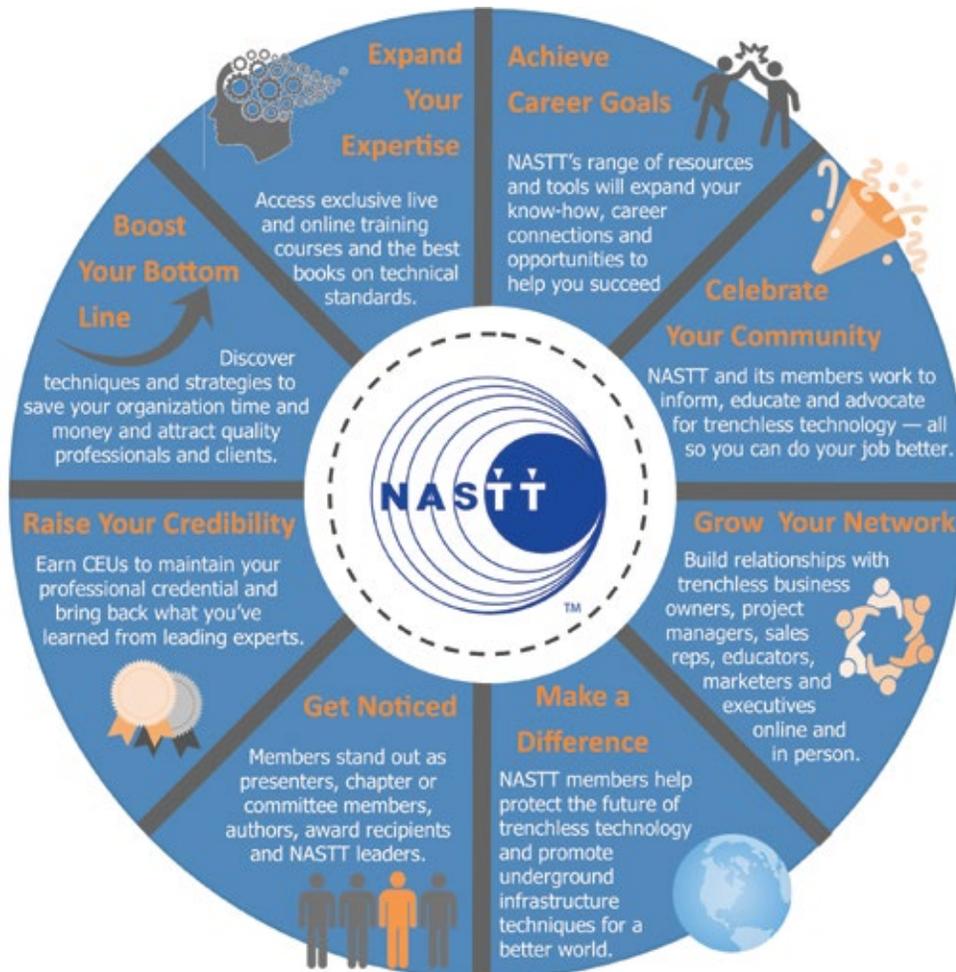
– Cindy Preuss, PE Water Conveyance Discipline Leader, CDM Smith

Who are NASTT Members?

As a trenchless technology professional, your ongoing success sometimes depends on factors that go beyond your own hard work and expertise. Now more than ever, your membership more relevant and valuable. The North American Society for Trenchless Professionals (NASTT) offers more of what you need to succeed.

Whether you’re a sales professional, engineer, skilled laborer, business development expert, business owner or executive, or project manager who works in contracting, construction, manufacturing, gas, water, planning and development or transportation, NASTT is the platform you can build your career upon.

NASTT has something for everyone connected to the trenchless profession: from small businesses to global enterprises and entry-level, young and future professionals to CEOs and presidents. Across Canada, the United States and Mexico, NASTT members are connecting over trenchless technology and its related industries.



“Value. That’s the reason I renew year after year. The interactions with trenchless professionals and NASTT No-Dig Show proceedings, are just a few of the resources that broaden my knowledge and enrich my career and, in turn, the future of the profession.”

– Dr. Kalyan R. Piratla, Associate Professor of Civil Engineering, Clemson University

TOP 5 MEMBER ROLES BY TITLE



NASTT is stronger than ever with new and improved programs, services and tools to help expand your know-how, career connections and opportunities. A dynamic range of career content, online member interaction, job resources, educational courses, expertise-building publications, give-back opportunities, career building recognition and networking events are designed to support your specialty area, role and career stage.

NASTT Group Membership

Corporations, government organizations, utilities, colleges, universities and training centers can join as a group and be recognized as premier supporters of NASTT and for their commitment to advancing trenchless technology. Group membership includes:

- Group rate pricing on membership
- Bulk purchase rates on books
- Recognition online, at events and in various publications
- Exclusive member-only exhibitor rates at NASTT No-Dig Show.
- Member priced registration at NASTT No-Dig, No-Dig North and select events.
- NASTT Elite monthly industry news, business development tips and management insights.

“I joined because with municipalities’ underground infrastructure coming to its end of design life during a time when municipalities are consolidating and have limited capital budgets, the only solution to keep things flowing is via trenchless methodologies. NASTT is the place to be – the place to obtain the knowledge necessary to support our municipalities into the future.”

– Greg Tippett, Stantec Consulting Ltd.

NASTT Elite
Exclusive headlines for NASTT group Corporate and Government/Education/Utility Members
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June 2022

Less Work...Same Money
Instance rates continue to take a toll on new infrastructure projects. Rising costs, project postponements and re-evaluations of project priorities and needs are making an impact – partially due to the diminished value of the US dollar. These 1 trillion dollars are disappearing. [Read our article](#)

Engineering & Construction Outlook
Material and labor shortages, risk of recession, energy costs, international turmoil, and increased living expenses were factors in FMI's April 2022 economic assessment for the U.S. and Canadian engineering and construction (E&C) industry. [Read our article](#)

Regenerating Canada's Energy
Canada's east coast energy construction sector is being revived with the restart of two major oil production projects which were delayed due to the pandemic and financial set backs. Find out [more](#) about who will be creating jobs and supporting renewable energy initiatives.

Bringing Direct Steerable Pipe Thrusting to Municipal Markets
As Direct Steerable Pipe Thrusting (DSPT) transitions into the municipal market, there is some confusion regarding its capabilities, the parameters influencing its success, and when to choose DSPT. NASTT Trenchless North America focuses on what you need to know in the spring and upcoming summer issues. [Read](#)

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– Alan Goodman, HammerHead Trenchless Equipment



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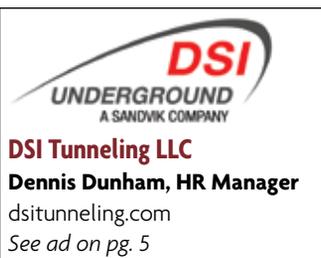
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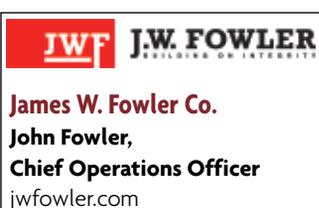
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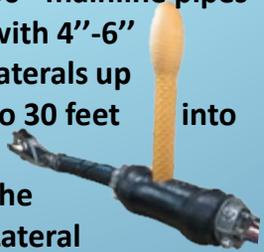
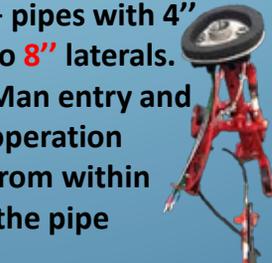
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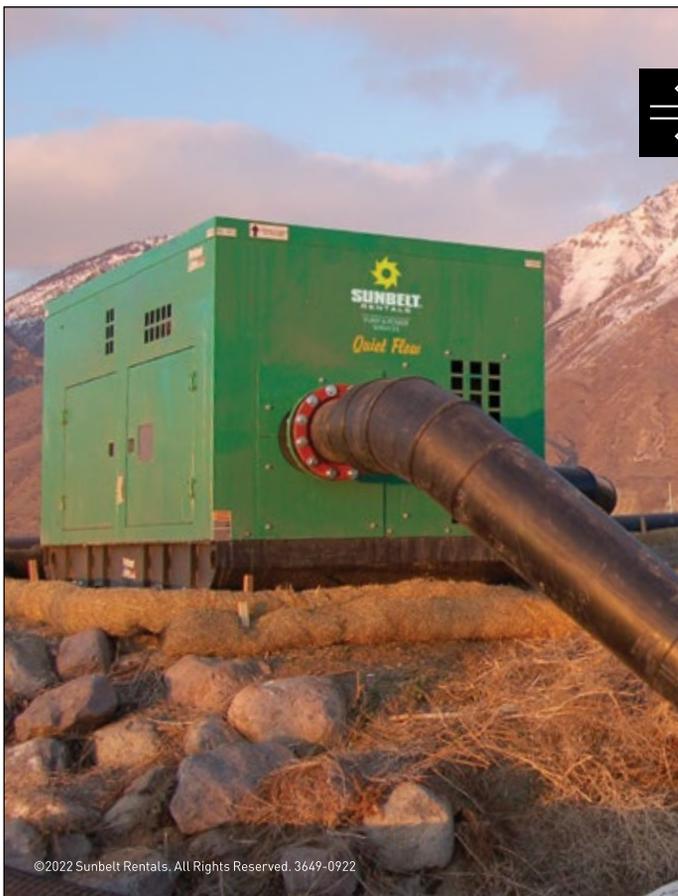
ARA Forecast Remains Bullish on Equipment Rental Revenue Growth Despite Headwinds

Today's economic indicators are mixed and uncertain, but all continue to point toward significant growth for equipment rental revenue in the U.S. according to the latest quarterly update of the five-year forecast released by the American Rental Association (ARA).

The update, released Aug. 3, projects equipment rental revenue, including the construction and general tool segments, to grow 11.2 percent to nearly reach \$55.9 billion in 2022. ARA expects growth of 6.2 percent in 2023, 2.5 percent in 2024, 3.3 percent in 2025 and 3.7 percent in 2026 to total more than \$65.1 billion.

“Rental revenue continues to experience significant growth, despite some headwinds in 2022. The longer-term forecast, while showing slower growth than this year, remains bullish. It is generally a good time to be in the equipment rental industry,” says Tom Doyle, ARA vice president for program development,

“In these times of higher uncertainty, it is prudent to closely watch the driving factors to the forecast for changes that will affect build schedules for original equipment manufacturers (OEMs) or demand for rental companies. Depending on how long we have high inflation, supply chain constraints, labor



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shortages and climbing interest rates, those econometric drivers can have an impact on the rest of 2022 and the outlook for 2023,” Doyle says.

For construction equipment rental revenue, the forecast calls for a 12.5 percent increase in 2022 to surpass \$41.6 billion, with growth slowing to 7 percent in 2023, 2 percent in 2024, 3 percent in 2025 and 3 percent in 2026.

General tool growth is expected to be 7.4 percent in 2022 and then remain fairly steady with 5 percent growth in 2023, 3 percent in 2024, 5 percent in 2025 and 5 percent in 2026.

The ARA forecast for equipment rental revenue in Canada, combining construction and general tool revenue, closely mirrors the outlook for the U.S., projecting growth of 14.4 percent in

2022 to \$4.7 billion, 6 percent in 2023, 2 percent in 2024, 3.4 percent in 2025 and 3.3 percent in 2026 to exceed \$5.4 billion.

About ARA (www.ARArental.org)

The American Rental Association, Moline, Ill., is an international trade association for owners of equipment and event rental businesses and the manufacturers and suppliers of construction/industrial, general tool and party/event rental equipment. ARA members, which include more than 11,500 rental businesses and more than 1,000 manufacturers and suppliers, are located in every U.S. state and more than 44 countries worldwide. Founded in 1955, ARA is the source for information, advocacy, education, networking and marketplace opportunities for the equipment and event rental industry throughout the world.

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The *MAB Generic Electrofusion Procedure for Field Joining of 12 Inch and Smaller Polyethylene (PE) Pipe (MAB-01-2022)* guide has been updated by the Municipal Advisory Board (MAB) and is available as a free download from the MAB website. The updates focus on HDPE water piping systems that include new sections on Electrofusion, Safety and Cleaning; the new requirement to use a minimum of 90 percent isopropyl alcohol; new tables on peel depth and cooling times for couplers and saddle fittings; improved questions in the sample test; emphasis on the use of peelers (instead of scrapers) in most locations; plus, new inspection check lists have been added.

MAB serves as an independent, non-commercial adviser to the Municipal & Industrial Division of the Plastics Pipe Institute, Inc. (PPI), the major North American trade association representing all segments of the plastic pipe industry.

The document provides the proper procedures, equipment, installers' training, testing, inspection and qualification for electrofusing HDPE pipe up to 12 inches. For larger HDPE pipes, refer to MAB-2. In addition to joining HDPE pipe sections with couplers, the document provides a field guide for electrofusion of saddles.

The direct link to download MAB-01-2022 is:
 chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/
[https://plasticpipe.org/common/Uploaded%20files/
 Technical/MAB-01.pdf](https://plasticpipe.org/common/Uploaded%20files/Technical/MAB-01.pdf)

"The information in MAB-01-2022 is highly important to the successful installation of HDPE water piping systems," stated Camille George Rubeiz, P.E., F. ASCE, co-chair, Municipal Advisory Board and senior director of engineering, Municipal and Industrial Division of PPI. "HDPE fused joints create leak-free, self-restraint, monolithic piping systems, and eliminates infiltration into the pipe as well as exfiltration into the environment.



Information about electrofusing polyethylene pipe procedures can be found in the updated MAB Generic Electrofusion Procedure for Field Joining of 12 Inch and Smaller Polyethylene (PE) Pipe (MAB-01-2022), one of two electrofusion documents available for free on the PPI MAB website: www.plasticpipe.org/municipaladvisoryboard.

"This second edition contains more valuable contributions from the MAB Electrofusion Task Group. These updates have been reviewed and approved the members of the Municipal Advisory Board that included Jacob Nakanoof City Utilities, Springfield, MO; Eric Shaffer, P.E., City of Duluth, MN; Andrew Schipper, P.E., City of Ft. Wayne, IN; Greg Scoby, P.E. formerly of the City of Palo Alto, CA and now with Crossbore Consultants, CA, Task Group Chair; Masa Niiya, P.E., MUD, Omaha, NE; David Freireich, P.E., City of Round Rock, TX and myself. Plus, we would like to acknowledge the electrofusion equipment and fittings manufacturers who contributed and endorsed MAB-01-2022 as listed in Appendix A.

For additional information, go to the Municipal Advisory Board's website: MAB Publications (plasticpipe.org)www.plasticpipe.org.



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No Man's Land: Crossing the Savannah River



With a few techniques borrowed from oil diggers, Martin Cherrington may very well be the first contractor to bore under a river, and he did so without any electronic guidance. Cherrington and his crew did the unthinkable when they crossed the Pajaro River, drilling approximately 500 ft in one month. Jobs such as this paved the way for generations of HDD contractors to come. Fortunately, boring under a river is no longer considered "no man's land" and the introduction of electronic guidance systems like HDD locators as well as

advancements in drilling equipment have made jobs like this more practical and efficient.

In July 2022, Sirman's Underground, out of Homerville, Georgia, was contracted to bore approximately 1800 ft across the Savannah River. Due to the reconstruction of the Houlihan Bridge in Port Wentworth, a new fiber line was required and going under the river was the best option. Faron, of Sirman's Underground, chose to use a combination of the Ditch Witch JT40 and the Underground Magnetics Mag 9 locating system paired with the Echo 90 transmitter to tackle the project. With that, they were able to locate to depths of 65 ft, while also using the Underground Magnetics' "drill-to" function to track and guide the drill head from the receiver 90 ft out in front of the head.

Coupled with the expertise of Sirman's crew, the Mag 9 locating system played a pivotal role in ensuring the accuracy and completion of this project. It enabled them to not only locate, but also adjust as needed to ensure a straight and efficient bore path. Trusting the capabilities of your equipment is one of the key components when considering taking on a project like

this. While accuracy is a requirement, efficiency is what enables your business and the horizontal directional drilling industry as a whole, to grow.

With today's advancements, Sirman's drilled approximately 1800 ft and located to depths of 65 ft. The Savannah River crossing took roughly one week to drill and pull back a 2" steel pipe. We appreciate the opportunity to provide hard-working contractors like Sirman's Underground with state-of-the-art equipment and congratulate their crew on a job well done!



Job Details Total length of bore: 1800 feet (1500 ft of water) Product pulled back: 2" steel	Deepest depth: 60ft Furthest distance out in front of drill to: 90ft Drill: JT40	Locator: Mag 9 Transmitter: Echo 90 Company: Sirmans Underground Contact: Faron Sirmans
--	---	--



Municipal Sewer Grout School: Registration Now Open

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COST:

\$585 (\$485 for each additional employee from the same company) when registering before October 3rd.
Standard pricing: \$609 (\$509 for each additional employee).

To Register, and for more information, visit:

Municipal Sewer Grout School
(constantcontact.com)



Michael Byrne Mfg. Names Dave Kauffman as Manufacturing Engineer

Michael Byrne Mfg. names Dave Kauffman as Manufacturing Engineer. Dave has a B.S. in Business Administration/ Management and brings over 25 years of experience in the Trenchless Industry. He received extensive training in fluid power at The Ohio State University's - ATI. Dave began his career at American Augers; working his way up from saw operator, fabricator, assembler, Lead man, CIP manager, and manufacturing manager. He was then employed at Underground Professionals Inc., specializing in HDD repair, refurbishing, and parts sales.

Prior to joining the Michael Byrne Mfg., Dave & a partner started D&L Underground Solutions, which specialized in parts sales, service, HDD repair, modernization & refurbishments. Dave supplies a wealth of knowledge with hydraulic and can

bus systems relating to the Mobile Construction industry. Dave brings a hands-on approach to implementing incremental improvements and problem solving for HDD and Auger boring equipment. Michael Byrne Mfg President Jim Weist adds, "Dave's addition to the Michael Byrne Team brings another perspective from a respected industry leader with experiences hard to find today".



For more information on Michael Byrne Manufacturing, visit their website at byrnegroup.com.

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HammerHead opens CIPP ‘Order Fulfillment Center’ in Greencastle, Pennsylvania

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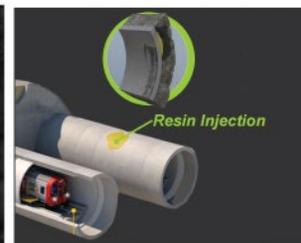
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HammerHead® Trenchless has announced the opening of its first U.S. Order Fulfillment Center (OFC) for cured-in-place pipe (CIPP) consumables. The Greencastle, Pennsylvania, location will help customers from Ohio to Massachusetts and south to North Carolina receive their CIPP consumable shipments in as little as one day. The OFC also offers same-day pickup to those who prefer to collect their orders at the facility.

The Greencastle OFC has been made possible through a partnership with transportation and logistics provider A. Duie Pyle. A. Duie Pyle is an award-winning, Less-Than-Truckload (LTL) transportation and logistics provider whose Northeast service capabilities have been expanded through its own established partnerships into the Southeast, Midwest, West Coast and Canada.

Paul Waskow, Inventory Control Manager at HammerHead Trenchless, explained how the OFC concept benefits CIPP installers. One is reliable, quick delivery. The OFC shortens

shipping routes, reducing exposure to potential mid-route failures and crises that can delay delivery. A prime example is weather.

Waskow said, “A snowstorm in Ohio could delay a shipment from our Wisconsin facilities to a customer in New York. Yet the same storm would not impact delivery from Pennsylvania.”

Perhaps even more importantly, Waskow said, the OFC concept is a “forward deployment of consumables” that enables more CIPP installers to confidently take on new jobs as they come up. “A lot of installers just can’t keep a large enough supply of product on hand to ensure they always have what they need.” The OFC improves product availability for them.

Customers within the Greencastle service area will notice minimal change in their ordering experience. “They’ll simply place their order same as always,” Waskow said. “All that’s different is quicker availability, knowing they’ll have the products they need as quickly as they need them.”



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Landmark Breakthrough for Robbins TBM ‘Big Tex’

Main Beam Holes Through to Fanfare after Changing Diameters

On July 25, 2022, a crowd gathered as a large Robbins Main Beam TBM, dubbed ‘Big Tex’, broke through in Dallas, Texas, USA. The machine and its continuous conveyor system, for the Mill Creek Drainage Relief Tunnel, successfully bored 8 km (5 mi) in chalk and shale at up to 498 m (1,634 ft) advance in one month. “I think when you step back and look at what was accomplished by this team as whole...the overall length and size of this tunnel, the TBM conversion, the everyday grind to keep moving forward...it truly is something to be proud of, professionally and personally. No single individual could reach this milestone. It took a great team of skilled individuals. I am fortunate to be a part of it,” said Nick Jencopale, Sr. Project Manager for contractor JV Southland/Mole.

Good advance rates were not the only cause for celebration: the unique project required a planned in-tunnel diameter change of the TBM from its original 11.6 m (38 ft) to a more compact 9.9 m (32.5 ft). The first-of-its-kind conversion process was undertaken 2.8 km (1.7 mi) into the bore and was not done inside a shaft or pre-excavated portal. “The



The Robbins Main Beam TBM, dubbed ‘Big Tex’, broke through on July 25, 2022 in Dallas, Texas, USA

TBM conversion was a unique challenge that we were excited about, and ultimately provided a more efficient method for the desired product compared to the alternative options. Hopefully the successful conversion proved that this option can be considered for future tunnel projects,” said Jencopale.

While there were many detailed steps to the conversion process, precision design of the machine was a key aspect. “We started with a smaller machine, then we made a kit or second skin that was slightly larger. And then when the time came, we just took that skin off. It was essentially that simple,” said Evan Brinkerhoff, Robbins Field Service Manager. The conversion took about four months and was completed in April 2021.

“The Robbins Main Beam TBM (‘Big Tex’) performed consistently throughout the duration of the tunnel excavation. There were very minor issues and little overall downtime as a result of the TBM itself,” said Jencopale. Due to the relatively favorable ground conditions in much of the tunnel, including low rock strength and low abrasivity, only eight disc cutters were changed during the length of tunnel bored at the larger diameter. At the time of diameter change the full dress of cutters was changed, and since



The view of the breakthrough shaft from overhead: The Mill Creek tunnel is a designated critical infrastructure project for the City of Dallas, providing 100-year flood protection for areas of East Dallas that have experienced severe flooding in the past



The 9.9 m (32.5 ft) Robbins TBM bored up to 498 m (1,634 ft) in one month for JV contractor Southland/Mole



A crowd gathers as the Robbins TBM breaks through into a shaft at the Mill Creek Drainage Relief Tunnel in Dallas, Texas, USA

that change only 14 cutters have needed replacing. Crews did encounter some fault zones, and installed rock bolts and wire mesh in the tunnel crown as needed. With the TBM-driven portion of the tunnel now complete, work can commence to remove the machine from the tunnel

and install a final lining. The tunnel is a designated critical infrastructure project for the City of Dallas, providing 100-year flood protection for areas of East Dallas that have experienced severe flooding in the past. Construction work is expected to be complete in late 2024/early 2025.



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**Comparison of Observed and Predicted Settlements:
 City of Dubuque Bee Branch Parallel 101" Microtunnels
 under Canadian Pacific Railyard**

David Bennett, PhD, PE, Bennett Trenchless Engineers, Folsom, CA
 Sandie Dudley, PE, Bennett Trenchless Engineers, Folsom, CA

I. ABSTRACT

Six parallel 101" outer diameter by 200' long microtunneled storm drains were constructed adjacent to the Mississippi River in Dubuque, the "Masterpiece on the Mississippi." The Permalok jacking pipe was 1.50" thick by 101.0" OD. The microtunnels crossed beneath 5 sets of Canadian Pacific tracks, with only 10 to 14 feet of loose to very loose silty sand fill above the tunnels. The loose sand fill contained variable amounts of debris including wood, metal rail spikes, flood debris, concrete, rocks, plastic pipe remnants, and even cow bones. Beneath the loose sand fill, a layer of soft to firm clay coincided with the tunnel. The loose to very loose fill and debris posed significant settlement risks to overlying RR tracks.

The City undertook extensive analyses and mitigation measures, including a thorough geotechnical investigation, settlement risk calculations, contract provisions to mitigate risks, including continuous injection of bentonite lubricant in the annulus, grouting the annulus of each tunnel soon after completion of each drive, and an extensive settlement monitoring program.

The project demonstrated that microtunneling could be successful in adverse ground conditions with minimal earth

**COMPARISON OF
 OBSERVED AND
 PREDICTED SETTLEMENTS:
 CITY OF DUBUQUE BEE BRANCH
 PARALLEL 101-INCH MICROTUNNELS
 UNDER CANADIAN PACIFIC RAILYARD**

AUTHORS



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 Bennett Trenchless Engineers,
 Folsom, CA



Sandie Dudley, PE,
 Bennett Trenchless Engineers,
 Folsom, CA

1. ABSTRACT

Six parallel 101-inch outer diameter by 200-foot long microtunneled storm drains were constructed adjacent to the Mississippi River in Dubuque, the "Masterpiece on the Mississippi." The Permalok jacking pipe was 1.50 inches thick by 101.0 inches OD. The microtunnels crossed beneath 5 sets of Canadian Pacific tracks, with only 10 to 14 feet of loose to very loose silty sand fill above the tunnels. The loose sand fill contained variable amounts of debris including wood, metal rail spikes, flood debris, concrete, rocks, plastic pipe remnants, and even cow bones. Beneath the loose sand fill, a layer of soft to firm clay coincided with the tunnel. The loose to very loose fill and debris posed significant settlement risks to overlying RR tracks.

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This paper was selected as the Outstanding Paper – New Installations at the 2022 NASTT No-Dig Show in Minneapolis. NASTT No-Dig Papers are available for download, free to members, at www.nastt.org

earth cover while protecting highly-sensitive railroad facilities. The project allowed forensic analysis of settlement data collected during construction. This paper documents and compares the results of the predicted systematic settlements from the calculations with the observed settlements over a substantial time period. Questions explored included:

1. Were observed settlements in agreement with predicted settlements?
2. Were settlements above adjacent microtunnels influenced by loosening of ground from previously constructed microtunnels? The parallel microtunnels were separated by 8 feet edge to edge, with 10 to 14 feet of earth cover between crown and rails.
3. Were settlements time-dependent? Observed settlements at completion of each drive were compared to settlements after several weeks to months.

Comparison of Observed and Predicted Settlements

2. INTRODUCTION AND BACKGROUND

The Bee Branch Tunnel project required construction of 6 each 101-inch OD by approximately 200-foot long parallel storm drains, installed using microtunneling. The project was adjacent to the Mississippi River in the City of Dubuque, also known as “the Masterpiece on the Mississippi.” The jacking pipe was 1.50 inches thick by 101.0 inches OD steel, supplied by Permalok Pipe in 20-foot-long sections. The MTBM was an Iseki Unclemole, with 102.4-inch OD. Figure 1 is a photograph of the Iseki Unclemole MTBM.

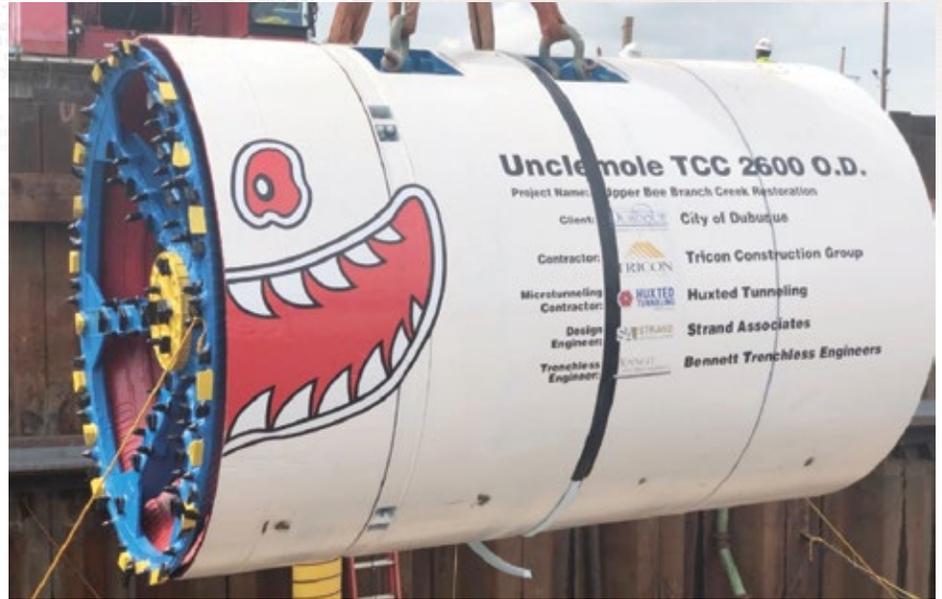


Figure 1. Iseki Unclemole TCC 2600 mm OD (102.4 inches) MTBM used to construct storm drains beneath CP railyard and tracks. Radial undercut was 0.75 inches, measured between MTBM OD and pipe OD. Note that gage teeth and eccentric cutterhead rotation provide small additional undercut, resulting in total radial undercut of approximately 1.0 inch. Both values of radial undercut were used in design analyses to bracket predicted settlements

The parallel microtunnels were driven west to east beneath 5 sets of Canadian Pacific tracks in the CP rail yard. Earth cover above pipe crown was 10 to 14 feet. Aerial views of the project site are shown in Figures 2 and 3.

A thorough geotechnical investigation was conducted during design, including desktop studies, numerous closely-spaced deep borings, laboratory testing, and 5 small diameter HDD bores, which were conducted to explore potential for fill debris/obstructions. The boring logs and a generalized interpretative profile are shown in Figure 4.

Ground conditions can be generalized as a relatively uniform 3-layer system, consisting of a surficial fill layer of loose to very loose silty sand, from ground surface to approximately 10-12 feet below ground surface (bgs). The loose sand fill contained variable amounts of debris including wood, metal rail spikes, flood debris, concrete, rocks, plastic

pipe remnants, and even cow bones. The microtunnels encountered minor amounts of fill debris on 4 of the 6 drives.

Beneath the surficial loose sand fill, a layer of soft to firm clay coincided with the tunnel horizon. The clay consisted of 2 distinct layers, an upper reddish-



Figure 2. Aerial (drone) view of Bee Branch project site, looking east with Permalok jacking pipes in foreground, jacking shaft near center of photo, CP tracks and reception shaft in upper background



Figure 3. Aerial view of project site, looking SE across jacking shaft toward CP tracks and reception shaft. Note separation plant in upper right portion of photo, and existing storm drain culvert to right of jacking shaft

Comparison of Observed and Predicted Settlements

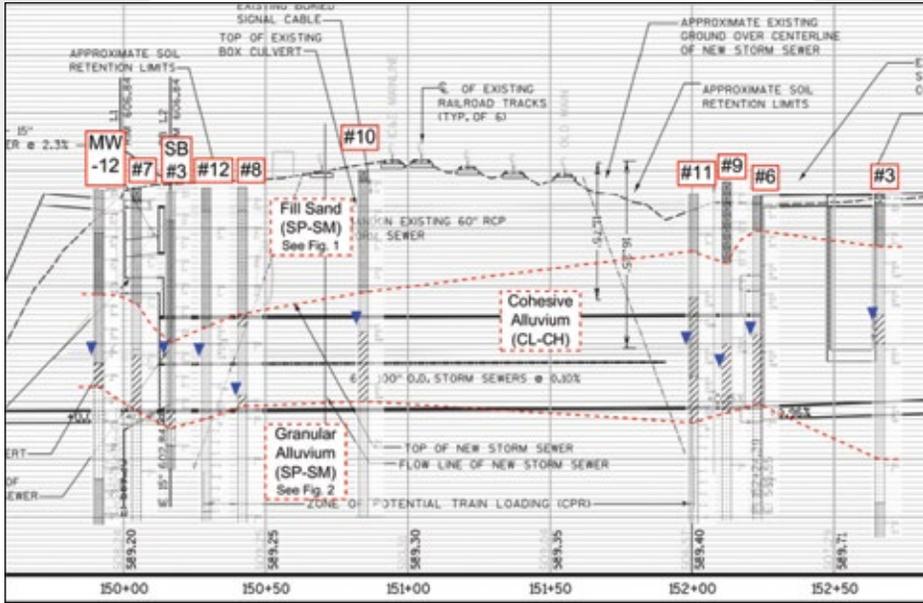


Figure 4. Profile view of parallel microtunnel pipeline crossings, with geotechnical boring logs and interpretative geological profile superimposed. The interpretative profile consisted of an upper 10-12-foot layer of loose to very loose silty sand fill, underlain by 8 to 12 feet of reddish-maroon clay and gray silty clay at tunnel horizon, underlain by loose to medium dense silty sand to or below the depths explored by borings

maroon high plasticity clay and a lower gray medium plasticity silty clay. The upper reddish-maroon clay extended generally from approximately 0 to 1.5 feet above crown to 2 to 3 feet above springline, although the reddish-maroon clay sometimes was thinner or absent for parts of drives. The gray lower plasticity silty clay extended from about 2-3 feet above springline to just below invert in general. A layer of loose to medium dense silty sand extended from the bottom of the gray clay to at least the bottom depths explored by borings.

The loose to very loose silty sand fill and fill debris posed significant challenges for controlling and limiting settlement of the overlying RR tracks. Since the steel culverts were designed to transmit flood flows, pipe elevation was fixed, so earth cover could not be increased to reduce risks. Additionally, the 98.0-inch pipe inner diameter was required to pass design flood flows through the 6 parallel pipes and could not be reduced. These constraints created substantial design, permitting, and construction challenges

for the City and its design and contractor teams.

Canadian Pacific, and its engineering consultant were rightfully insistent on protecting its facilities against settlement risks. To address these concerns and protect the CP facilities, the City and its consultants undertook extensive analyses and mitigation measures. Measures included conducting a thorough geotechnical investigation, conducting settlement risk calculations to predict magnitudes and aerial extent of settlement associated with the tunnel construction, incorporating provisions into the contract documents to mitigate risks, including requiring continuous injection of bentonite based lubricant to fill the annulus created by the MTBM overcut, grouting the annulus of each tunnel soon after completion of each drive, and an extensive settlement monitoring program consisting of multiple subsurface and surface settlement monitoring points in a grid that spanned the full length of each tunnel from jacking to receiving shaft

and spanned from the first to last tunnel in width.

This project presented a great opportunity to demonstrate that microtunneling could be successfully used in adverse ground conditions with minimal earth cover while protecting highly-sensitive railroad facilities. The project also presented an uncommon opportunity for in-depth forensic analysis of the voluminous settlement data collected during construction, including evaluating the time-dependent behavior and adverse synergistic impacts of closely spaced parallel tunnels, i.e. the loosening and disturbance of the ground caused by a preceding tunnel impacting the subsequent tunnel, and the overlap of settlement troughs resulting from the close spacing of parallel tunnels.

This paper documents and compares the results of the predicted systematic settlements from the calculations with the observed settlements over a substantial time period, including construction of each tunnel and for a significant period of time afterward. The comparative analysis clearly demonstrates the efficacy of the empirical predictive model first developed over 50 years ago for larger shield driven tunnels (Peck, 1969; Schmidt, 1969; Cording and Hansmire, 1977) and more recently extended to microtunnels and other trenchless methods (Bennett, 1998; Bennett and Cording, 1999, 2000; and Wallin, Wallin, and Bennett, 2008).

3. EVALUATION AND MITIGATION OF SETTLEMENT RISKS

The inherent settlement risks and challenges associated with multiple parallel large diameter pipelines installed beneath multiple railroad tracks with loose sand fill earth cover of less than 1.5 times the pipe OD were recognized by the City and its design consultants from inception of design. The City and its prime design consultant, Strand

Comparison of Observed and Predicted Settlements

Associates, contacted Bennett Trenchless Engineers to discuss risk evaluation and potential mitigation measures. For any trenchless pipeline installation with high risks of settlement and significant potential consequences, the potential mitigation measures are generally recognized and include:

1. Consider alternative trenchless construction methods which may present lower settlement risks, such as pipe ramming.
2. Specify and enforce continuous pressurized lubrication to completely fill annulus and reduce annular volume contributing to settlement.
3. Specify and enforce timely grouting of annulus of tunnel upon completion to reduce annular volume contributing to settlement.
4. Reduce radial overcut between tunnel machine and pipe OD within reasonable limits to reduce annular volume contributing to settlement.

5. Install pipelines at deeper elevation to increase earth cover and ratio of earth cover to pipe OD.
6. Reduce pipe diameter to increase earth cover and increase ratio of earth cover to pipe OD.
7. Increase horizontal clearance between parallel pipes to reduce ground disturbance and weakening of soils for subsequent tunnels. Increasing horizontal clearance also reduces the overlap between adjacent settlement troughs, thereby reducing settlements between adjacent tunnels.
8. Use ground improvement to reduce settlement risk. This option typically requires surface access to the area above the proposed tunnels, which would have been quite disruptive to operation of the rail yard.

As is true for most trenchless projects, project performance criteria limit the options that can be practically implemented. The storm water flows

that had to be accommodated and available project staging footprint limited the option of reducing diameter and increasing horizontal clearance between pipes. The City and its prime consultant desired to specify a sufficiently large diameter pipe to safely accommodate calculated storm water flows. Pipe nominal diameter was initially set at 138 inches, but the nominal diameter selected for final design was 100 inches, after several iterations of calculations and meetings. The pipe selected by the Contractor for installation was 101.0 inches OD, with a 1.5-inch wall. The gravity flow design essentially eliminated the option of going deeper. The radial overcut could be reduced within reasonable ranges, but adequate overcut is necessary to manage and control jacking forces exerted on the pipe and thrust block, to avoid overstressing the pipe and avoid excessive ground deformations



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Comparison of Observed and Predicted Settlements

behind the thrust block. Various radial overcuts between 0.5 and 1.5 inches were evaluated during preliminary design analyses to gauge potential impacts on settlement and jacking forces. The actual radial overcut between the Iseki Unclemole MTBM OD and pipe OD was 0.75 inches. The upset gauge teeth and eccentric rotation of the Unclemole cutterhead conceivably could have increased the maximum overcut to about 1.0 inches, so the settlement analyses bracketed this range of overcuts.

4. CALCULATION OF ANTICIPATED SYSTEMATIC SETTLEMENTS

Figure 5 illustrates the proportional relationships between trenchless pipeline geometry parameters and relative settlement risks. Figure 5 also presents the general approach used to evaluate anticipated systematic settlements. The approach assumes that the shape of the settlement trough can be approximated by an inverted normal probability distribution (bell) curve. Figure 5 illustrates the empirical relationship of settlement versus horizontal distance from tunnel centerline and settlement trough width, in addition to the maximum settlement directly above crown. While there is no theoretical basis in soil mechanics for

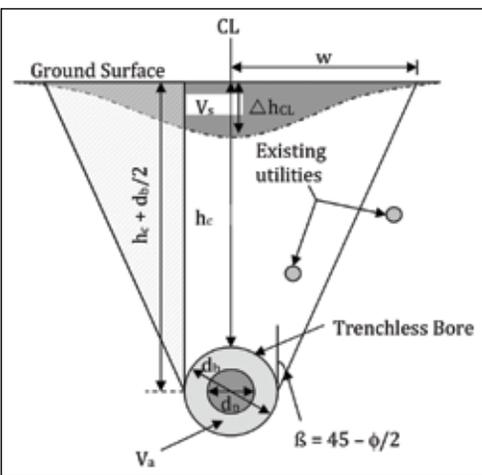


Figure 5. Schematic of settlement trough, illustrating relationship between microtunnel geometry (diameter, radial overcut, depth of earth cover), and systematic settlements

Where the variables are as follows:

- CL = Centerline of pipe
 - w = Settlement trough half-width
 - Δh_{CL} = Settlement trough depth at centerline (maximum settlement)
 - V_s = Settlement trough volume per unit of bore length
 - h_c = Depth of clearance above crown of the bore (not the pipe)
 - d_b = Diameter of the bore
 - d_p = Diameter of the product pipe
 - V_a = Volume of the annulus per unit of bore length, $\pi/4 (d_b^2 - d_p^2)$
 - ϕ = Friction angle of the soil
- [1]

To calculate the settlement at the centerline, Δh_{CL} , the maximum settlement above the pipeline, the equation is:

$$\Delta h_{CL} = V_s/w \quad [2]$$

Where it is assumed that the volume of the annulus is translated directly to the surface and is equal to the settlement trough volume, ($V_a = V_s$), and w is defined as half the trough width, or as:

$$w = \frac{d_b}{2} + (h_c + \frac{d_b}{2}) \cdot \tan(45 - \frac{\phi}{2}) \quad [3]$$

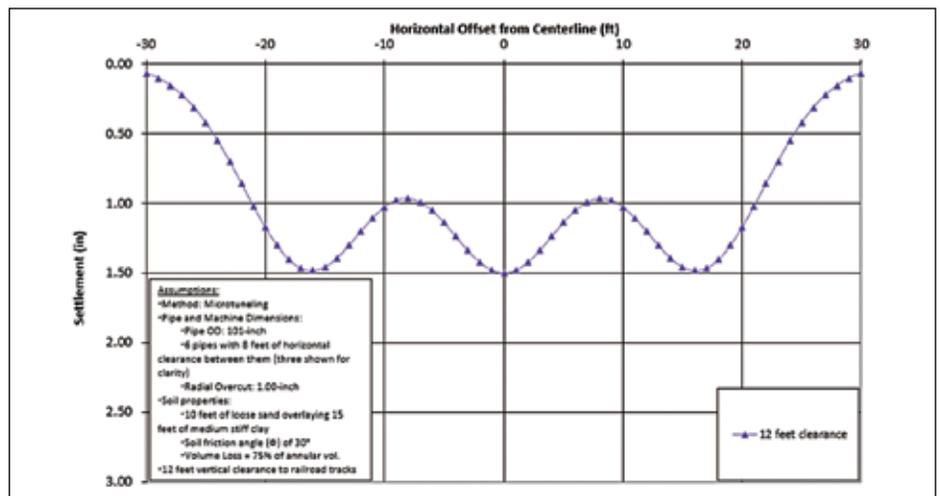


Figure 6. Graph depicting calculated settlements for parallel microtunnels. Note that for 1.0-inch radial overcut and other assumptions listed on graph, maximum estimated settlements above tunnel crown were 1.5 inches, with 1.0-inch settlements predicted halfway between tunnels

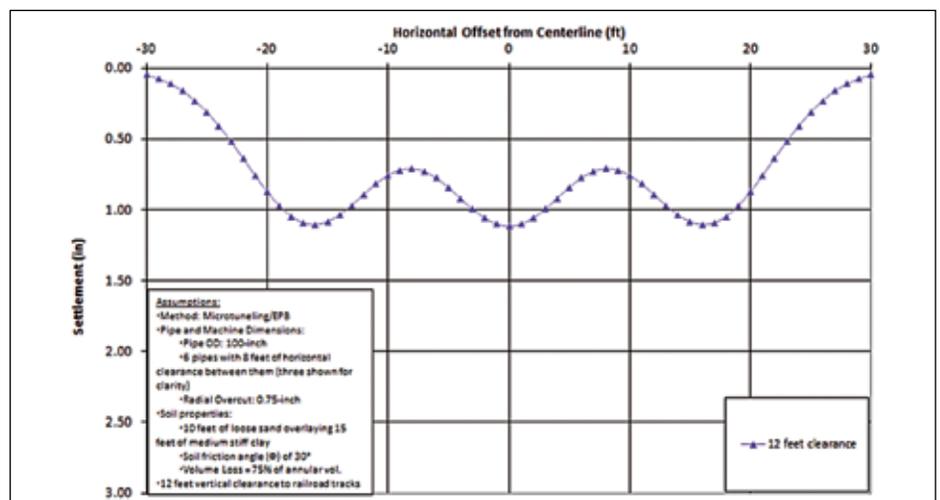


Figure 7. Graph depicting calculated settlements for parallel microtunnels and actual 0.75-inch radial overcut used by Contractor. All assumptions unchanged from previous graph. Maximum calculated settlements were 1.1 inches above pipe crown, and 0.7 inches halfway between tunnels

Comparison of Observed and Predicted Settlements

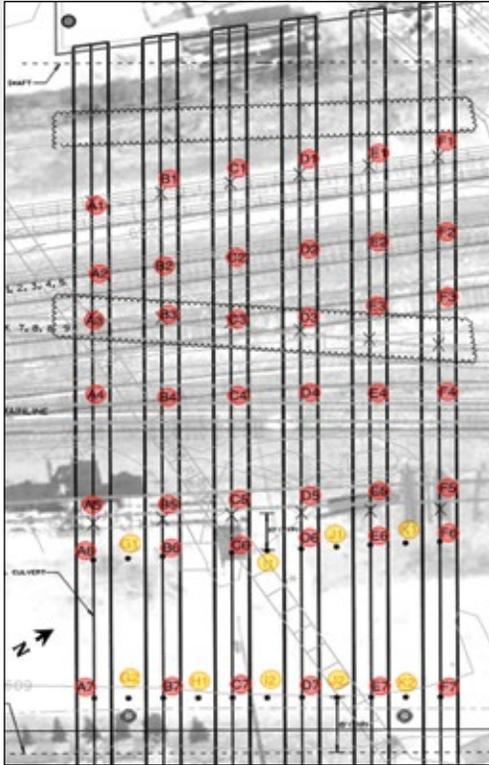


Figure 8. Grid of surface and subsurface settlement monitoring points in CP railyard above 6 parallel 101-inch microtunnels. Note "A" refers to Microtunnel A; "F" refers to Microtunnel F. The reception shaft was at the top of the figure; the jacking shaft was at the bottom

the use of this approach, the growing body of empirical evidence generally supports the model and assumptions. Obviously, the correct geometry and representative soil property values must be selected to yield reasonably accurate results. The analysis presented in this paper is based on only one case history, albeit a case history with extensive monitoring program data.

The anticipated systematic settlements were evaluated during design. Figures 6 and 7 bracket the anticipated settlement for 1.0-inch and 0.75-inch radial overcuts. The actual overcut used by the Contractor was 0.75 inches so Figure 7 is more representative of construction operations. However, the gauge teeth and eccentric motion of the Iseki cutterhead produced a slightly larger bore diameter, which Figure 6

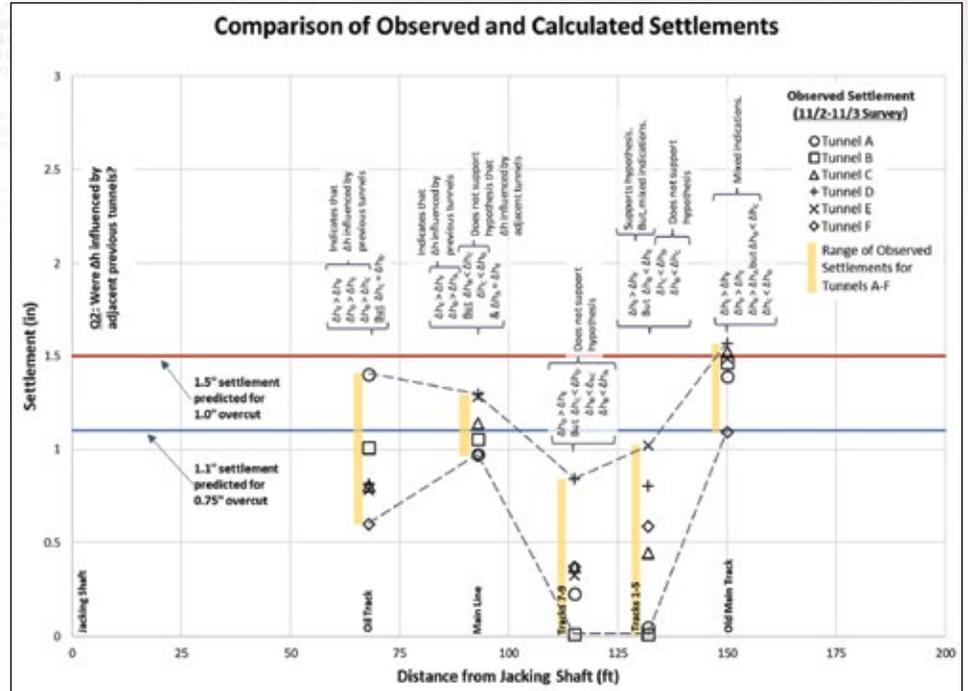


Figure 9. Comparison of calculated and observed settlements (from 2 Nov 2020 survey) above crowns of microtunnels A-F from surface points on tracks. Note the sequence of microtunnel construction was A, E, F, D, C, then B

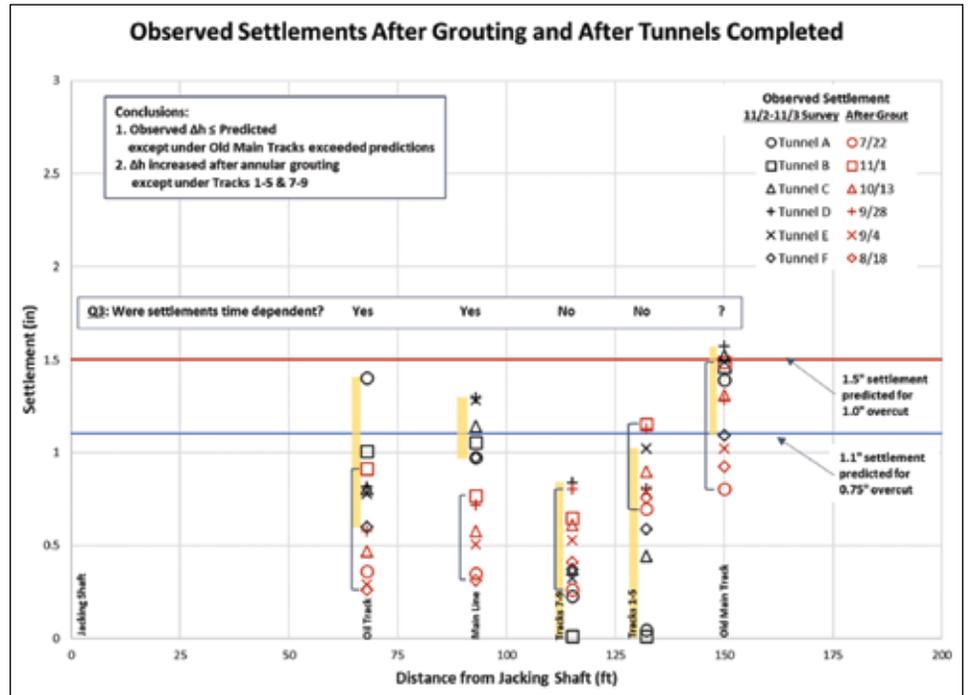


Figure 10. Observed settlements after grouting annulus and after all tunnels completed

models. Settlement trough volume was assumed to be 75 percent of the annular volume, based on continuous pressurized injection of lubricant, and the anticipated arching of the thin veneer of clay above the tunnels. The bracketed settlements

predicted for the two overcuts were 1.1 to 1.5 inches, as can be seen in the figures. Note also that the figures depict settlement troughs for only 3 of the 6 tunnels, since the layout of the 6 parallel tunnels was symmetrical.

Comparison of Observed and Predicted Settlements

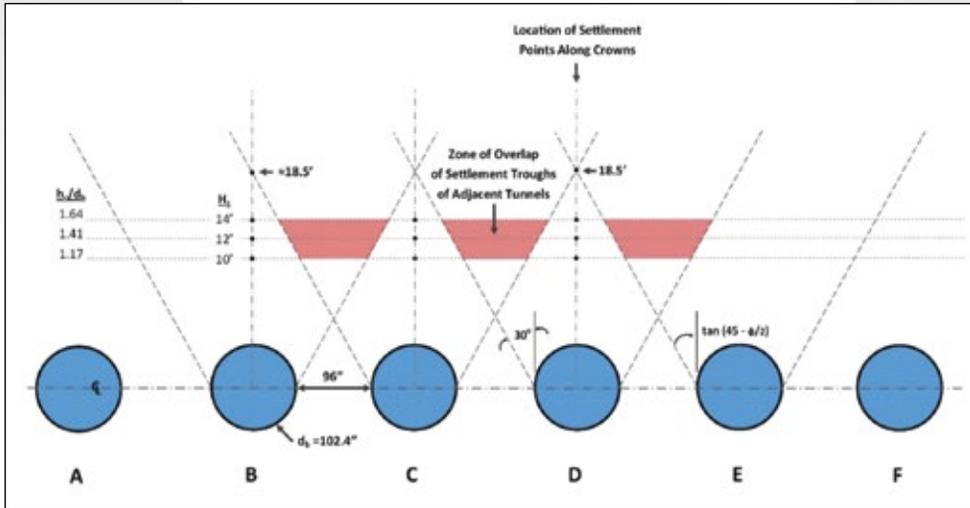


Figure 11. Geometry of adjacent 102.4-inch microtunnels and ratio of earth cover to bore diameter indicates that settlement troughs do overlap. However, overlap does not encompass centerlines above tunnels. 18.5-foot earth cover would have been required for overlap to encompass centerlines. Note: Homogeneous geotechnical conditions (loose silty sand) were assumed above tunnel crowns, which is not strictly accurate, as 1 to 2 feet of soft clay existed above portions of some tunnels. (Overlap only shaded for center 3 microtunnels in figure)

5. OBSERVED SETTLEMENTS AND COMPARISON WITH CALCULATED SETTLEMENTS

An extensive grid of settlement monitoring points was installed above each parallel tunnel and frequently surveyed. The monitoring program

was intended to provide CP with the information it needed to manage rail traffic in the yard and implement any needed rail remediation (track levelling) measures. The monitoring program also provided an opportunity to conduct a forensic evaluation of settlement magnitudes, time-dependent soil

behavior, and synergistic effects of adjacent parallel tunnels. The grid of monitoring points is shown along with tunnel and track locations in plan view in Figure 8.

The extensive settlement monitoring program allowed the 3 questions posed earlier to be evaluated. That is:

1. Were observed maximum settlements above microtunnel crowns in agreement with predicted settlements?
2. Were settlements above adjacent microtunnels influenced by loosening of ground from previously constructed microtunnels? The parallel microtunnels were separated by 8 feet edge to edge, with 10 to 14 feet of earth cover between crown and rails. Construction sequence was Microtunnel A, then F at opposite end, then E, D, C, and B, moving back towards A.
3. Were settlements time-dependent? Observed settlements at completion of each drive were compared to settlements after several days to months.

Were observed settlements above tunnel centerlines in reasonable agreement with predicted values? The observed systematic settlements for all microtunnels are shown in Figures 9 and 10 and were compared with calculated settlements. As the figures indicate, the observed settlements were in good to excellent agreement with predicted settlements calculated during final design. Almost all of the observed settlements fell within or below the calculated settlements bracketed by the 0.75-inch and 1.0-inch radial overcut predictions. The very few exceptions where observed settlements slightly exceeded calculated settlements may be ascribed to one or a combination of more adverse ground conditions than indicated by the geotechnical investigation, particularly the existence of debris in the fill. The loose to very loose silty

Comparison of Observed and Predicted Settlements

sand fill extended from ground surface to just above or at tunnel crown. The randomly encountered fill debris likely exacerbated ground disturbance during tunneling. In addition, groundwater drawdown near shafts and ground disturbances during pulling of jacking shaft guillotine sheets at the beginning of each drive likely exacerbated settlements near the shafts.

Were settlements above adjacent microtunnels influenced by previously installed microtunnels? The geometry of the parallel microtunnels and ratio of earth cover above crown to tunnel bore diameter does produce some overlap between adjacent settlement troughs, as indicated by Figure 11. However, the overlap between adjacent troughs does not encompass the centerlines of the tunnels and troughs, because of the low ratio of earth cover to bore diameter. Approximately 18.5 feet of earth cover would have been necessary for the troughs to overlap centerlines. In fact, the 8-foot clear spacing between adjacent tunnels was selected to avoid synergistic settlement impacts. Unfortunately, the settlement point array did not include intermediate settlement points between tunnels. Rather, only settlements above centerlines were measured.

The graphed data yield a mixed interpretation, depending on location along parallel microtunnel alignments. The relative settlements of the "Oil Line track" indicate that centerline settlements were larger and may have been exacerbated on subsequent tunnels by ground loosening from construction of adjacent previous tunnels. The data from tracks 7, 8, and 9 do not indicate any influence of loosening. The data from the "Main Line tracks", the "Old Main Line", and tracks 1-5 yield mixed indications. The data do not provide strong evidence that previously constructed tunnels resulted in loosening of ground that

influenced subsequent adjacent tunnels; the graphed data do support the selection of 8-foot spacing to minimize impacts from adjacent tunnels.

Were settlements time-dependent?

The soils above tunnel crowns were predominantly loose to very loose sand and silty sand. As much as 1 to 2 feet of soft clay existed above tunnel crowns near the jacking shaft but clay

was sometimes absent above crowns as the tunnels advanced beneath the rail yard. Therefore, settlements would be expected to occur rapidly, with little to no time-dependent behavior.

To evaluate whether settlements were time-dependent, observed settlements were graphed at end of construction and several days to several months after construction. The resulting graphs



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are captured in Figure 10. The data yield different interpretations depending on location. Settlements observed above tunnels at the locations of the “Oil Track line” and “Main Line” do indicate that settlements increased between end of construction and end of monitoring. However, the increases were inconsistent and not proportional to elapsed time between end of construction and end of monitoring. For example, Tunnel A was constructed first and showed a relatively large increase of 0.35 to 1.4 inches over a period of about 3.5 months at the location of the “Oil Line tracks”. Tunnel B was constructed last and showed an increase of only 0.1 inch over a period of only 3 days at the Oil Line tracks. This comparison tends to support the hypothesis of time-dependent settlement. Similar trends were observed at the location of the Main Line. However, at the location of tracks 7, 8, and 9, the differences between settlements at end of construction and end of monitoring

were quite small, and do not support the time-dependent settlement hypothesis.

6. SUMMARY AND CONCLUSIONS

1. The forensic analysis summarized in this paper clearly supports the efficacy of the empirical predictive model developed for evaluating settlement risks on trenchless projects.
2. Maximum settlements measured above microtunnel crowns were in good to excellent with settlement values predicted using the empirical inverted normal probability distribution curve and representative soil properties.
3. The 8 feet clear spacing between adjacent tunnels was selected to try to minimize impacts of ground loosening resulting from construction of previous tunnels which could exacerbate settlements of subsequent tunnels. The measured settlements indicate that this goal was achieved.

Settlements of subsequent tunnels were slightly larger than previous tunnels in some but not all cases, and differences were generally small to insignificant.

4. The data did not provide clear indications of time dependent settlements in the overlying loose to very loose sands. Settlements would be expected to occur rapidly and not exhibit time dependent behavior in loose to very loose sands. However, settlements did increase over time at some but not all locations. Observed settlements actually decreased over time at other locations.
5. The successful completion of the six 101-inch parallel microtunnels demonstrates that settlements associated with microtunneling can be managed and controlled through good design practices, including settlement risk evaluation and mitigation measures, accompanied by good microtunneling construction

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practices by a skillful, competent contractor, and thorough geotechnical investigation.

7. ACKNOWLEDGEMENTS

The success of this challenging project was achieved through the extensive collaboration and cooperation of the project owner and its design and contractor team. The authors wish to express their appreciation to the City of Dubuque, and its design consultants, Strand Associates, Origin Design, formerly IIW, Allender Butzke Engineers (Geotechnical subconsultant), and Bennett Trenchless Engineers. We also appreciate the cooperative efforts and professionalism demonstrated by the General Contractor, Tricon, its microtunneling subcontractor, Huxted Tunneling, and Michels, the shaft subcontractor. Canadian Pacific Railroad and its consultant, HDR, are also commended for their professionalism and constructive comments during design and construction.

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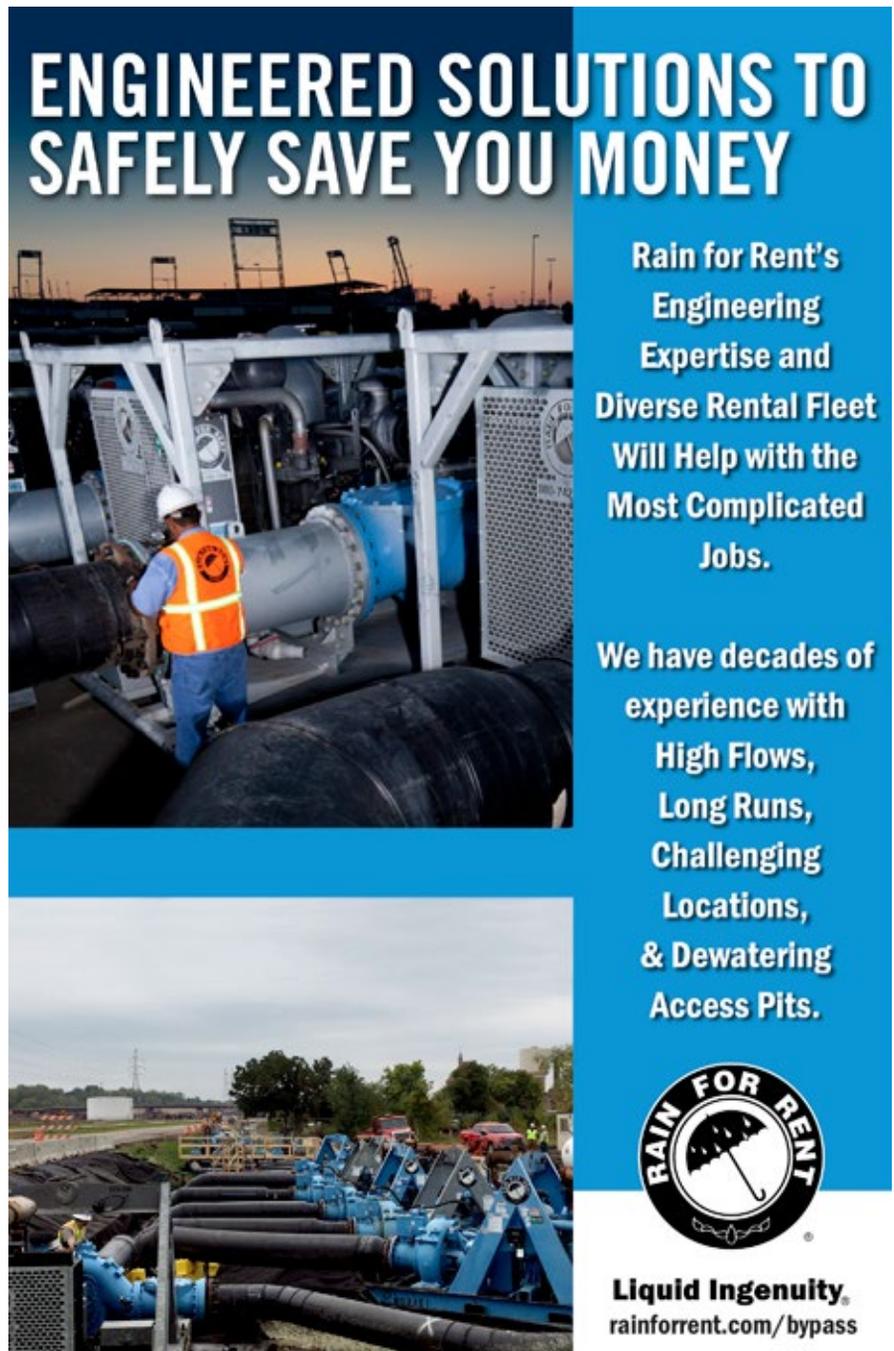
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www.mstt.org

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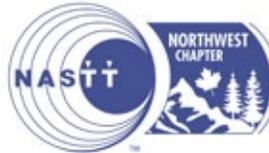


Mexico
Website coming soon!

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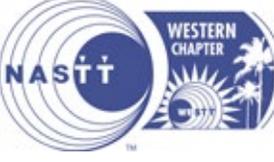


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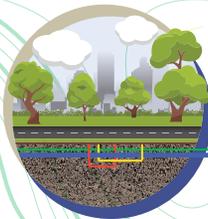
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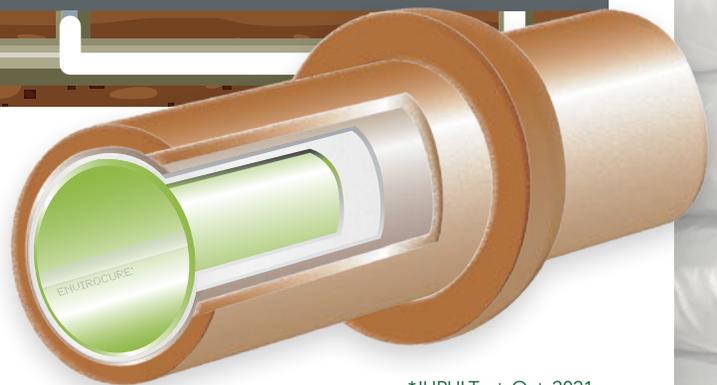
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*IUPUI Test, Oct. 2021



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