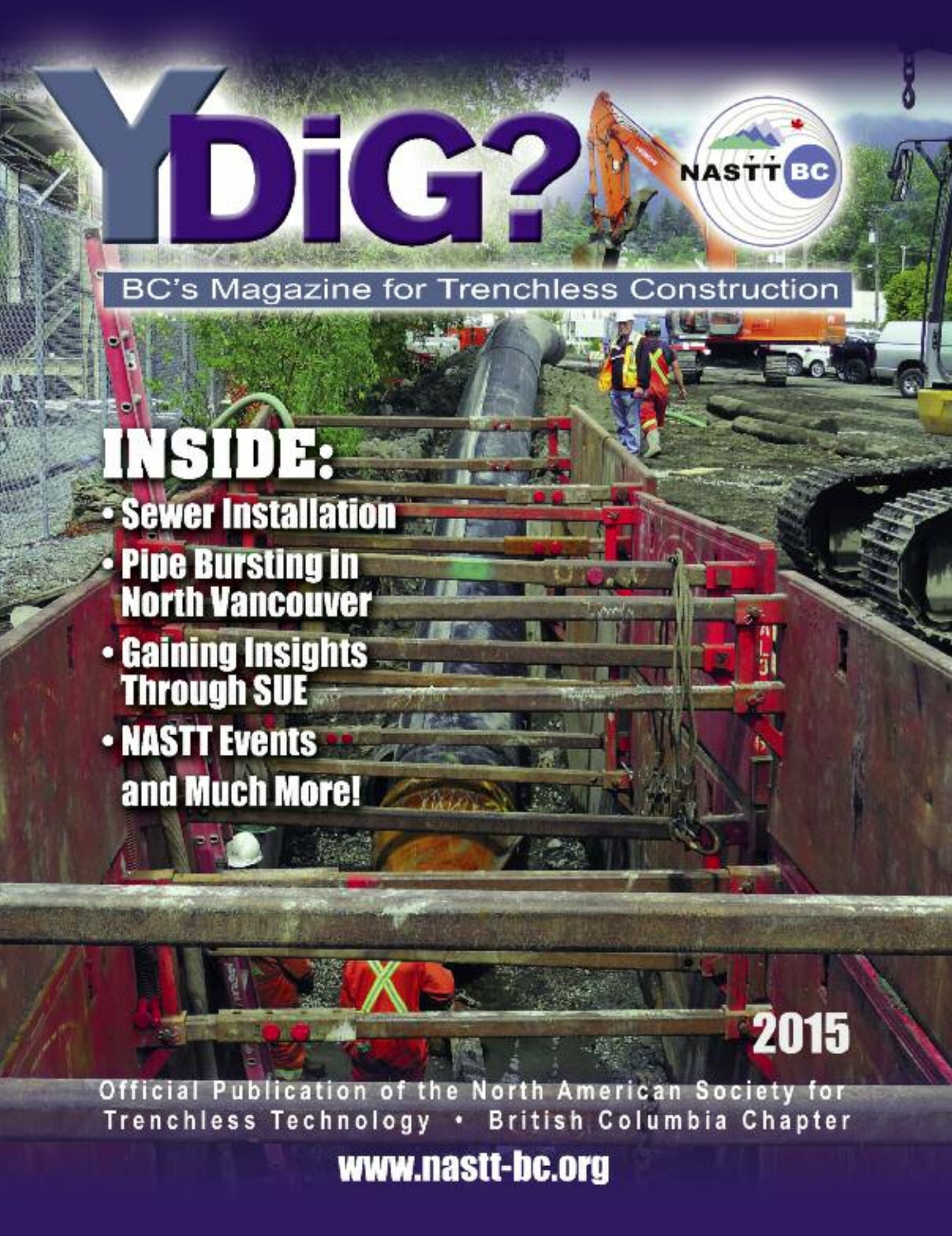
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NASTT BC
BC's Magazine for Trenchless Construction
INSIDE:
• Sewer Installation
• Pipe Bursting in North Vancouver
• Gaining Insights Through SUE
• NASTT Events
and Much More!
2015
Official Publication of the North American Society for Trenchless Technology • British Columbia Chapter
www.nastt-bc.org

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THE BRITISH COLUMBIA CHAPTER OF THE NORTH AMERICAN SOCIETY FOR TRENCHLESS TECHNOLOGY (NASTT)

NASTT BRITISH COLUMBIA CHAPTER: Leaders in Innovation

Formed in 1997 as part of the original NASTT Northwest Chapter, the BC Chapter was established separately in 2005. It exists to promote the use of trenchless technology in B.C. through education and standards. NASTT-BC has worked hard over the years to have trenchless standards adopted throughout the Province. In 2008, work began by the Chapter to develop a tool for accurately determining the reduced carbon footprint that various trenchless technologies offer - the Carbon Calculator! Use this program to estimate the tons of carbon emissions that were eliminated by the trenchless construction method that you have chosen for your project. Watch for the posting of the latest version of this useful tool to enhance sustainability in British Columbia.

- In the MMCD's new Platinum book, CIPP and Pipe Bursting are included, with remaining trenchless methods to follow.
- NASTT-BC held 4 seminars on 2 subjects last year in the interior, lower mainland and Vancouver Island. In 2015, NASTT-BC will host the 2015 Trenchless Technology Roadshow at the Executive Airport Plaza Hotel & Conference Centre in Richmond.
- NASTT-BC has worked to be a leader in promoting the use of trenchless as a low cost /low carbon method of construction.
- Since 2005, the chapter has published their annual magazine Y-DIG?
- The chapter and Y-DIG? Magazine is a great way for consultants to promote their successes, for cities to learn about the projects, methods, lessons and experiences of other cities, and for all 3 partners (owners, consultants and contractors) to share information.

WHAT IS NASTT?

Founded in 1990, NASTT is a not-for-profit educational and technical society. As the North American component of the ISTT (International Society for Trenchless Technology), NASTT is dedicated to promoting the benefits of trenchless technology through education, training and research. NASTT is the definitive resource for trenchless professionals like you, who are concerned with underground systems and the applications of trenchless technology.

Trenchless Technology

By using trenchless technology methods, you are reducing the impact of underground construction on your community. The benefits of trenchless technology are priceless:

- Minimizes surface disruption & trenching
- Reduces public inconvenience
- Cost-effective methods
- Less traffic congestion
- Widely utilized & accepted
- And this all adds up to - REDUCING CARBON FOOTPRINT BY UP TO 90%!

Membership

If you're interested or concerned in underground systems and the application of trenchless technology, then NASTT membership is right for you.

NASTT connects you to the people and businesses involved in the trenchless industry.

NASTT is your link to thousands of trenchless professionals and leaders working in regional, national and international levels. Membership is open to individuals, agencies and companies involved with providing gas, water, sewage, communications and electrical services.

Your Regional Chapter - NASTT-BC

A major contribution the NASTT-BC Chapter has made to the global trenchless effort is the promotion of trenchless technology as a low carbon option.

For more recent information on Trenchless Construction in British Columbia and BC Chapter activities, go to **www.nastt-bc.org**.

JOIN NASTT and NASTT-BC TODAY!

To become a member of NASTT-BC, contact Monica Perry at mwperry@telus.net

Y-DiG?

North American Society for Trenchless Technology - BC Chapter

FEATURED...

Bursting

To replace 300 m of an old storm sewer system in North Vancouver, a trenchless solution had to be applied

Installation

A combination of pilot tubing and pipe ramming was implemented in a challenging Chilliwack project

Evaluation

Subsurface utility engineering is becoming an integral part of the planning process for construction projects

ALSO...

COVER PHOTO: PW Trenchless Construction Ltd.

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President's Message

Kieran Field

Road Show Ahead

It has been another great year for trenchless technologies in British Columbia, with many high-profile projects proving once again that trenchless construction is a cost-effective, low-impact, greener alternative to traditional open-cut installation techniques.

The society has been continuing its efforts to advance the science and practice of trenchless technology for the public benefit. We do this by hosting seminars and other educational events. The seminars held in 2014 included a CIPP Good Practices Course held in February in Surrey (thank you to Chris Macey and Ian Doherty for taking time to travel across the country to share their extensive knowledge on the subject) and our Subsurface Utility Engineering (SUE) seminars held in Kamloops, Parksville and Surrey (thank you to representatives from BC One Call, T2 Utility Engineers, EECOL Electric, Canadian Subsurface Investigation Inc., Kinder Morgan, Badger Daylighting, and Kamloops Augering & Boring for sharing their knowledge) which were all very well attended.

In 2014 the society also took steps to register with the Environmental Operators Certification Program (EOCP) Society and arranged for Continuing Education Units (CEUs) to be available for attendees of our seminars.

"The Trenchless Technology Road Show will consist of one day of courses and one day of technical presentations"

Moving forward into 2015, the society's board retains its diversity with members of the contracting, supplier, consulting engineering, and municipal and regional government communities still at the helm (the latter accounting for over 30 percent of the board).

2015 will see a slight change in direction for the society's practices. This year we intend on hosting one seminar, the Laterals Best Practices seminar on February 12. The rest of our efforts will be focused on the much anticipated Trenchless Technology Road Show in November, which is a joint effort between the Centre for Advancement of Trenchless Technologies (CATT), Benjamin Media Inc. and NASTT-BC.

This two-day event will take place at the Executive Airport Plaza Hotel & Conference Center in Richmond and consist of one day of courses (attendees can choose from Trenchless Technologies 101, Asset Management Strategies, or Culvert Evaluation & Rehabilitation) and one day of technical presentations on subjects such as Trenchless Planning and Analysis, New Products and Materials, Environmental Benefits of Using Trenchless Construction Methods and Trenchless Design and Construction. The Road Show will also include an exhibition hall filled with the latest and greatest from the Trenchless Technology world, offering networking opportunities with industry peers. You can find more information at our website, www.trenchlessroadshow.ca

We are extremely thankful for the efforts CATT and Benjamin Media are putting into this event. Together they offer a wealth of experience and knowledge that we have no doubt will make this Road Show educational, beneficial and altogether successful.

If you have not considered getting involved in NASTT-BC, please consider doing so now. We are always looking for individuals to join the board of directors, but even a smaller commitment can make a big difference. Members who become active in the society learn and benefit from the exchange of ideas and business with others in their industry. More information can be found on page 4.

A Milestone Year for NASTT

Michael J. Willmets
Executive Director, NASTT

NASTT is thrilled to be celebrating our Silver Anniversary, 25 years of trenchless advocacy and education, in 2015. We could not have done it without our Regional Chapters, and NASTT-BC has been a big part of our success for the last decade. I would like to thank all the members and volunteers for their dedication to our Society and to furthering the trenchless industry.

Fortunately for me, I'll be returning to the great province of British Columbia for NASTT's Laterals Good Practices Course being held in Surrey on February 12. This course will be taught by fellow Canadian Dr. Jason Lueke, P.Eng., of Associated Engineering and also by trenchless expert Dr. John Mathews, P.E., of the Battelle Memorial Institute headquartered in Columbus, Ohio. This is sure to be a fantastic educational event. I'd like to thank your Chapter Chair, David O'Sullivan, for coordinating this important training event.

As you may know, NASTT is gearing up for the Annual No-Dig Show coming up March 15-19 in Denver, Colorado. We're featuring 160 top-notch technical papers covering numerous trenchless technology topics, along with pre- and post-show courses for more in-depth training. We will also have 150 quality organizations in the exhibit hall ready to meet with you to discuss the latest and greatest in trenchless products and innovations.

Of course, NASTT's No-Dig Show is also known for our networking events including the Opening Breakfast, Educational Fund Auction, Gala Awards Dinner and Closing Luncheon. Be sure to join us at these events for food, fun, entertainment and a chance to meet with trenchless industry colleagues from all over North America and the world.

New this year, NASTT's 2015 No-Dig Show is proud to announce our first ever Gas Industry Day. This event features a paper presentation track targeted specifically to covering trenchless technology and how it relates to the gas industry, access to the exhibit hall, networking luncheon and finally, a Gas Good Practices Course, taught by George Ragula, which is a four-hour course focusing on good practices for Horizontal Directional Drilling (HDD), Cured-In-Place-Pipe (CIPP) and Pipe Bursting.

2015 is shaping up to be a spectacular year for NASTT and our Regional Chapters. Cheers to 25 years and 25 more!

NASTT Events

March 15-19
NASTT's 2015 No-Dig Show
Colorado Convention Center
Denver, Colorado
Information: www.nodigshow.com

Sunday, March 15
NASTT's Trenchless Technology Short Course – New Installation
Colorado Convention Center
Denver, Colorado
Information: www.nodigshow.com

Sunday, March 15
NASTT's Trenchless Technology Short Course – Rehabilitation
Colorado Convention Center
Denver, Colorado
Information: www.nodigshow.com

Wednesday, March 18
NASTT's Gas Industry Day
Colorado Convention Center
Denver, Colorado
Information: www.nodigshow.com

Wednesday, March 18 & Thursday, March 19
NASTT's Pipe Bursting Good Practices Course
Colorado Convention Center
Denver, Colorado
Information: www.nodigshow.com

Wednesday, March 18 & Thursday, March 19
NASTT's New Installation Methods Good Practices Course
Colorado Convention Center
Denver, Colorado
Information: www.nodigshow.com

Wednesday, March 18 & Thursday, March 19
NASTT's HDD Good Practices Guidelines Course
Colorado Convention Center
Denver, Colorado
Information: www.nodigshow.com

Wednesday, March 18 & Thursday, March 19
NASTT's Cured-In-Place Pipe Good Practices Course
Colorado Convention Center
Denver, Colorado
Information: www.nodigshow.com

Wednesday, March 18 & Thursday, March 19
NASTT's Laterals Good Practices Course
Colorado Convention Center
Denver, Colorado
Information: www.nodigshow.com

May 27-30
BCWWA Annual Conference & Trade Show
Delta Grand Okanagan and Prospera Place
Kelowna, B.C.
Information: www.bcwwa.org

November 17-19
Trenchless Technology Road Show 2015
Executive Airport Plaza Hotel & Conference Centre
Richmond, B.C.
Information: www.trenchlessroadshow.ca

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NORTH AMERICAN SOCIETY *FOR* TRENCHLESS TECHNOLOGY

NASTT REGIONAL CHAPTERS

REGIONAL ISSUES, INTERNATIONAL SUPPORT

Contact your regional chapter today.

The grassroots of NASTT is a network of ten regional chapters throughout the United States and Canada. Regional chapters network at the local level, share infrastructure challenges and develop new ideas. Regional chapters hold various events throughout the year, and like NASTT, are dedicated to the advancement of trenchless technologies for the benefit of the public and the environment.

With your NASTT membership you are automatically enrolled not only in the national and international organization, but also in your regional chapter. So join today and get to know the "local heroes" that are making their communities better places through the innovative engineering solutions of trenchless technologies.

REGIONAL CHAPTERS

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www.nastt-bc.org
British Columbia

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www.glsla.ca
Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador

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North American Society for Trenchless Technology
14500 Lorain Avenue #110063 • Cleveland, Ohio 44111
Phone: 216-570-6711

North Vancouver Pipe Bursting for Storm Sewer Replacement

Greg Deacon
Project Manager
PW Trenchless
Construction Ltd.

Approximately five years ago, the District of North Vancouver became aware of a failed CSP (corrugated steel pipe) storm sewer. The pipe was the last 300 metres of a storm sewer system before it entered the ocean on the north side of the Burrard Inlet. As the invert was below high tide and ran at virtually 0% grade, it would have received salt water with each tide change, resulting in its complete failure. Also, with the pipe being submerged twice a day, it was not self-cleaning and thus full of debris from the upper reaches of this system.

With the knowledge that the pipe was not functioning properly, the district had installed a low-volume bypass to another catchment area that allowed some storm discharge. In 2012, they installed a 350-mm pipe parallel to the CSP but at a higher grade due to the poor ground conditions. The 350-mm pipe increased the flow to some extent, but it still did not reach what was required. Ultimately, the CSP pipe had to be replaced.

There were a number of challenges with construction in this area:

1. The ground had plumes of pollution that could not be disturbed.
2. There was no road right of way, only a sewer easement which passed within

For the first of three bursts, pipe was staged at the southern end of the project.

four metres of five large silos that were founded on floating slabs.

3. The new shipbuilding contract from the federal government dictated that this area was going to be very busy for the next five to seven years.

Due to these challenging conditions, a trenchless solution had to be used. The existing pipe was 900-mm-diameter CSP, but with the size of the catchment area being served a 1,050-mm pipe was required. This meant that the existing pipe would have to be pipe burst.

The CSP was 90% full of debris, which added an extra element of difficulty to the job. The city had attempted to clean the pipe on numerous occasions but did not succeed due to the deteriorated condition of the pipe. Each time material from the inside was removed, more material would enter. Therefore, any attempts to clean the inside were abandoned to avoid sinkholes. This also meant that there was no CCTV footage of the pipe before work commenced, as there was no clear path for the camera equipment.

In 2014, the city put out an RFP for solutions to the replacement and three contractors submitted proposals using pipe bursting or pipe ramming. PW Trenchless (PWT) was awarded the contract in the spring of 2014. A decision was made to use a static pipebursting system from TT Technologies. A 2500G machine was to be used; this machine, the largest that TT

Technologies supplies, has an ability to pull 250 tonnes.

The first step of the job was to dig test holes to confirm depths, location, and condition of the existing pipe and to also take water samples. The contamination of the surrounding ground meant that all of the water that was in the excavations would have to be treated before it was allowed into the district's sewer system. PWT then set up a 200-mm bypass system for the storm water and a 150-mm header pipe to the treatment plant for the contaminated water.

Locations of the exit/entry pits were dictated by the locations of the silos. The job was split into three runs, each approximately 100 m long. Taking all factors into account, there were concerns that pushing the rods through the debris would cause the rods to push out of the pipe and into the ground. It was decided to directional drill through the debris and then pull the bursting rods back using the pulling force of the drilling rig. This would keep the rods inside the CSP.

A CSP of this size had not been burst before, so some precautions were taken to minimize the risk of getting stuck mid-burst. Instead of using a 1,050-mm expanding cone which would have an outside diameter of 1,300 mm, a 900-mm DIPS size expanding cone was used which had an OD of 1,125 mm. Reducers from 1,050 mm to 900 mm were then manufactured for this transition. This reduced any possibility of heaving, and reduced the likelihood of the CSP bunching on the expanding cone, which could cause a stall.

Small relief pits were dug to the top of the CSP every 20 m; this allowed for a visual inspection of the burst as it happened and also provided an opportunity to vacuum out the debris inside the CSP as it was pushed by the expander that was bursting the CSP and pulling in the 1,050-mm HDPE. Calculations would

HDPE pipe enters the entry pit while vac trucks extract material from the host pipe.

Locations of exit/entry pits were dictated by the locations of silos.

later prove that the majority of the debris inside the pipe was displaced back into the ground, avoiding costly disposal.

The first run was successfully completed in one day, with no bunching of the CSP on the expander. The second and third runs followed the same process with connections being tied in using over-build manholes. The job took a total of eight weeks to complete from mob on site to the final tidy-up, including all of the water treatment setup and teardown. The District of North Vancouver now has a pipe it can rely on and new manholes for easy inspection and cleaning.

The silos' foundation elevations were taken before work commenced and again while bursting took place. It was found that there was no movement in any of the five silos. This job clearly shows what pipe bursting can offer clients.

Chilliwack Pipeline Crossings
Pipe Ramming and Pilot Tube Installation

Harry Dickinson, AScT.
Kamloops Augering and
Boring Ltd.

A utility owner required the replacement of 600 metres of an existing 762-mm (30-inch) OD mainline to meet class location changes under CSA Z662-11 pipeline code. The existing right of way (ROW) and temporary work space will be used for construction. The replacement pipe section crosses through commercial land and the adjacent 914-mm (36-inch) OD mainline loop will be in service during construction. The unique location and proximity of the existing line created a challenging work environment.

Horizontal directional drilling and microtunneling were considered; however, the geological conditions and construction space requirements made these two options unrealistic. The pipeline replacement sections are located in Chilliwack through the parking lots of commercial shopping areas and major arterial roads.

Kamloops Augering & Boring (KAB) proposed to use a pilot tube system to install 914-mm (36-inch) steel casings for the replacement pipeline. The trenchless portion was broken up into three sections: 83 m (272 feet) Luckakuck Way East, 138 m (453 feet) Vedder Road, 147 m (482 feet) Luckakuck Way West. KAB was working with a pipeline contractor responsible for the open-cut sections and installation of the 30-inch pipeline.

An Akkerman guided boring machine was used in the Chilliwack project.

Because of the two existing high-pressure, large-diameter gas pipelines and other underground utilities within the ROW, the geotechnical investigation could only be carried out with Hydro Vac excavation from surface to six metres deep. Using a Hydro Vac for geotechnical analysis leaves room for interpretation due to the added water during the process, and no method of determining the density of the material. All we had to go by was that it is silty sand and gravel with cobbles, loose to medium dense.

The crossings' lengths were longer than typically designed and accepted for the pilot tube method of trenchless construction; in fact, the two longer crossings were the longest ever installed to date in Canada. The subsurface conditions, as per the geotechnical data report provided, was loose to medium dense sand to sand-and-gravel soils with varying depths of groundwater. Because of KAB's newly acquired Akkerman 4815 Guided Boring Machine, we were comfortable tackling the long crossing requirements with this pilot tube system. These conditions seemed to be favorable for a pilot tube followed by an auger bore installation.

KAB made use of slide rail trench shoring systems for our jacking and receiving pits. The slide rail system is ideal for long open spans with no cross members to accommodate installing 40-foot sections of casing. The depths of the crossings were around 4.5 m. The dewatering for the slide rail systems was very successful in controlling the groundwater, so much so that the ground became very hard.

After a successful pilot tube installation, we were approximately five metres in on the first crossing with the auger bore machine when it was noted that jacking pressures had spiked and pilot tubes had stopped moving on the exit side. The transition weld-on adapter from 18-inch to 36-inch had failed. The 36-inch pipe began to engulf our lead transition piece of 18-inch pipe.

Dewatering and shoring proved successful in controlling groundwater.

The casing was cleaned out and confined space procedures were implemented to investigate and repair the apparent problem. We had to remove the 36-inch pipe to replace our transition adapter to a different style of 36-inch weld-on ream head. To do so, we had to ram a larger-diameter pipe over the existing pipe to remove the damaged transition piece and all of the 36-inch previously installed. A new lead pipe was prepared and pushed into place and reconnected to the pilot tubes.

The continued installation procedure with the new weld-on head did not provide the anticipated relief in jacking pressures that was desired. Work continued until it became apparent that the auger boring methodology would not advance the casing. Because of KAB's large inventory of trenchless equipment, we were able to switch to pipe ramming without delay and this would now become the preferred method of installation.

The guided auger boring execution plan had to be revised to incorporate the pipe ramming method to install the casing pipe due to the ground conditions encountered. We proposed to use TT Technologies' Pneumatic Pipe Ramming System as it can accommodate a wide variety of soil types (cobble, soft rock, shale, compacted gravels, etc.). The pipe ramming process with the weld-on reaming head would allow for the larger rocks to enter the casing as it moves forward. The revised plan had to be approved by the National Energy Board. With approvals in place, the first crossing was then completed using our Taurus Hammer.

An intermediate jacking pit slide rail system that was four metres wide x 17 m long x

4.5 m deep would be implemented as a common pit where we were able to install the casings in both directions along the proposed alignment. This is where we would complete the two longest shots. However, during the installation of this larger slide rail system we encountered wood during the excavation procedures. The wood debris was approximately 450 mm (18 inches) in diameter and one metre (three feet) in length. Some wood remained at the end of the pit as we were unable to remove it. This wood served as a reminder of what could be encountered during our pilot tube installation, as any wood obstruction could potentially stop the pilot tube installation. Old existing helical pipeline anchors were also excavated and noted as potential obstructions.

Fortunately, the pilot tubing was very successful and our operator successfully set a new in-house KAB record for length of a guided bore. It should be noted that at about the 120 m mark the optics for a pilot tube crossing typically becomes the limiting factor. With the line and grade issues resolved, it was time to continue with the casing installation.

With approximately 48 m of casing installed on the second crossing the rate of advancement started to recede and the Taurus Hammer was deemed inadequate. Again, because of our large inventory of equipment we were able to bring in our Apollo pipe rammer without delay. This is the largest available pipe rammer manufactured by TT Technologies. It provided temporary relief but at approximately the 88-m mark the casing was beginning to slow down again, even with the large hammer.

We proceeded to auger out the casing to investigate the face of the bore and found we were dragging several of the old pipeline anchors. We believed that we were dragging anchors and most likely had some wood debris attached to the weld-on head. We were instructed to continue to ram. We continued to ram and were able to successfully install the casing until completion. When the casing pipe exited the ground in the receiving pit, it was apparent that there were anchors and woody debris wrapped around the head, which is what caused the slow penetration.

Pipe ramming was used in addition to pilot tubing.

The third and final crossing was very difficult to pilot tube. The guided bore machine was at maximum torque and thrust and almost impossible to complete. This indicated to us that the ground had an SPT ≥ 50. The difficulty of the previous crossing coupled with the increased length was cause for concern. The Apollo hammer was able to advance the casing to approximately 85 m without incident. However, the continued rate of advancement was hindered to the point that we had to investigate the weld-on head.

Pipeline sections had to be installed under busy parts of Chilliwack.

The casing was cleaned out and confined space procedures/permits were executed to see what was impeding the casing installation. Four pipeline anchors were wrapped around the casing pipe. We removed them and the casing was advanced to approximately the 100m mark. There were significant concerns that we could damage the Apollo hammer with the minimal advancement of the casing. The pipeline contractor was able to Hydro Vac a slot trench to provide relief. Once the trench was excavated, the pipe was rammed into place. This slow process was continued until the crossing was completed. This was not the preferred method, but was the only remaining option to complete the crossing.

The use of the combined technologies of pilot tubing and pipe ramming could change design considerations for pipeline installations in highly congested areas.

SUE: Delivering Subsurface Insights for Informed Decisions

Steven Mooney, M.Sci.
Subsurface Survey Technician
GeoScan Subsurface Surveys

Until recently, accurately recording the presence and location of subsurface utility infrastructure was not formally required, nor carried out in a consistent manner. Many of the map records that currently exist are inaccurate, obsolete or in formats incompatible between utilities, and if relied upon can lead to costly project delays, utility damage and liabilities.

As such, the practice of subsurface utility engineering (SUE) is becoming an integral part of the planning process for construction projects across the country. SUE is applied during the design phase to locate, identify, and characterize all existing utility infrastructure (and other relevant non-utility features) found within a given project. This information is critical for the success of a project as the use of existing records is simply inadmissible. Past studies revealed that existing records and visible feature surveys are typically 15 to 30 percent off the mark and in some cases considerably worse (Stevens & Anspach, 1993). Historically, the lack of regulation around collecting, recording and managing subsurface data placed the burden on the constructor to deal with utility relocation in the midst of a project, creating unnecessary delays, driving up costs and exposing them to a world of potential liability.

GeoScan Subsurface Surveys' SUE provides accurate and reliable underground utility information. This data is secured through documented processes to ensure a comprehensive understanding of underground structures. Field verification is completed with the latest available technologies and all information is captured and rendered using the CSA and BCCGA best practices guidelines. GeoScan technicians tailor SUE surveys to individual projects and provide design teams with detailed, professional drawings. Our authentic SUE program adheres to the four quality levels outlined by the American Society of Civil Engineers Standard (ASCE, 2002). We encourage the leverage of these standards as a records management framework because, ultimately, better information means better design and more productive construction.

Using the Right Technology

Today, electromagnetic (EM) induction and ground-penetrating radar (GPR) are the primary methods of finding buried utility assets, and the effectiveness of these tools is directly related to the training and experience of the field technician. Locating is a highly interpretive skill, so when selecting a SUE provider it is important to choose an organization with the required experience and expertise, utilizing a wide range of geophysical tools on site rather than just basic induction equipment.

Visual assessment on site provides a starting point for the survey. This is followed by the verification process. The RD7000+ Underground Utility Locator is the latest in radiodetection technology and can accurately locate live power lines without the need for fixing to the source. It can also detect un-energized utilities by introducing a signal into the utility line

Located utilities are marked in paint.

using a transmitter, the location and depth of which can then be detected by the receiver. This is not an effective option for locating non-conductive utilities; however, guiding a fish tape through the pipe can enable transmission of a signal and overcome this problem. This method is functional yet has several limitations. The signal transmission is often altered by unwanted signal coupling or "bleeding." Essentially, because current will want to follow a single path (the path of least resistance), the signal can jump from the target utility to a more conductive line, thus affecting the accuracy of the trace. Ground distortion effects, caused by differing soil types and proximity to other conductors, make the job more difficult and time-consuming but when used in conjunction with GPR, even sites with varying utility composition and depths can be surveyed for a comprehensive understanding of the underground structures.

GPR transmits high-frequency (typically 250-800MHz) radio waves into the ground or structure and analyzes the reflected velocity and energy to create a profile of the subsurface features; the GPR provides immediate on-screen results, relying on the technicians' skill and ability to interpret the data, to pinpoint the target's location and depth. This technology is highly effective for locating non-conductive utilities and its completeness and speed of covering the survey area make it one of the most cost-effective applications of advanced subsurface geophysics. Location by GPR is often necessary for position accuracy because maps (even those provided by BC One-Call) lack the pinpoint precision needed to ensure proper clearance. The GPR often finds numerous unknown utilities, something that is crucial to SUE, and these utilities can conflict significantly with the planned construction of a project. In addition, non-invasive 3D imaging data enables mapping in complex utility corridors without the need for costly and disruptive pit tests.

GPR is not without its limitations, however, and can be affected

Ground-penetrating radar is used in subsurface utility engineering.

by poor soil conditions such as brackish groundwater and high clay contents which affect conductivity. The selection of appropriate geophysical methods is crucial. If any of the utilities are missed due to the wrong equipment or lack of expertise, the main objective of the SUE program, which is to mitigate risk, will not be fulfilled.

Implementing the Program

As Metro Vancouver's TransLink moves forward with complex expansion upgrades to their Metrotown Skytrain Station, GeoScan's expert SUE services were acquired to aid with the important pre-design process. SUE allows responsible parties to better manage their assets. The results are staggering; the successful implementation of SUE provides the platform for successful design, reduces the risk of expensive extras during construction, and ensures a safer working environment as the unknown is eliminated. A cost-benefit analysis, based on 71 actual construction projects where SUE was employed, revealed that more than 10 times the funds invested in the SUE service were returned to project owners (Jeong, H., Abraham, D., & Lew, J., 2004).

The TransLink project's SUE survey was completed using both EM and GPR methods to accurately locate targets within the subsurface. GeoScan's high level of technical knowledge coupled with a systematic data collection procedure led to the creation of a digital utility composite of the entire project work area. The information from the SUE survey enables TransLink to plan the construction for the proposed project in advance so they can quickly rebuild the busy station avoiding unforeseen conditions, and keep it operational at the same time.

The Importance of SUE

A clear understanding of SUE on behalf of project owners is necessary to accurately define the scope of work required, estimate costs, and set expectations around deliverables. What is important to remember is that SUE is not just a form of locating buried utilities; it is an

Successful implementation of SUE ensures a safer working environment.

engineering process that combines civil engineering, subsurface geophysical surveying and mapping, and utility asset management programs.

Despite previous trends of "unintentional underground utility damage" (CGA National Utility Damage Assessment, 2008), there is hope on the horizon. The 2013 annual Damage Information Reporting Tool (DIRT) report provides a summary and analysis of the submitted events occurring during the year 2013. The report indicates that 224,616 "utility damage" events were submitted, approximately 8,000 fewer than were submitted for 2012. It is positive to note that this 3.5% reduction in events is not the result of lower industry participation. Instead, the opposite is true: 2013 saw an overall 10% increase in the number of locate requests being made.

Combined, these figures demonstrate the importance of SUE. The decrease for 2013 may suggest actual improvements and that efforts to promote safer practices are indeed leading to fewer damages. The integration of these standards as a records management framework could quickly become a facet of municipal construction contracts and eventually legislated in Canada, essentially reducing what would otherwise be an unnecessary risk for project stakeholders.

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Conquering Coquitlam's Burke Mountain: Horizontal Directional Drilling in Rock

Eric Dykman
General Manager, Trenchless Drilling Services Inc.

Installing gravity sanitary sewers presents challenges on its own in favourable formations, never mind formations consisting of dense glacial tills and boulders. Such challenging conditions were present in a sanitary sewer installation project at Coquitlam's Burke Mountain.

In November, Trenchless Drilling Services started a horizontal directional drilling project on Burke Mountain for the prime contractor, Pedre Contractors Ltd. of Langley. The scope of work is to drill 94 metres of 300-mm HDPE DR17 and 110 m of 300-mm HDPE DR17 sanitary sewer at 6% and 9% grades.

The project was originally designed with 250-mm HDPE DR26, but Trenchless recommended at the time of bid that there be either an upsizing to 300-mm or increased SDR value. We recommended this due to tensile loads that would be placed onto the HDPE product pipe during pullback, along with the potential for creating out-of-round pipe during pullback. With increasing the SDR value on the 250-mm thus decreasing inside dimension, the engineer upsized the final product size to 300-mm HDPE DR17.

A Vermeer horizontal directional drill was deployed in the Burke Mountain project.

To complete the project, Trenchless deployed a Vermeer D36x50DR, which is a highly advanced horizontal directional drill, using a six-inch TCI Tricone drill head and an F5 locating system. Conventional means of directional drilling through this formation would present a very low success rate and inefficiencies, whether it be unacceptable grade or refusal on the boulders. We decided to deploy the Vermeer 36x50DR for its capability and proven track record for being able to handle such formations. Used on previous projects, whether it be glacial till with boulders or solid sandstone, the equipment and crews have proven to be highly productive in such formations without the associated support and mess with a typical mud motor. The Vermeer 36x50DR and the six-inch TCI Tricone drill head are designed to cut through the rocks and dense formation without the sort of deviation that would occur with conventional directional drilling. This allowed us to achieve grades within 0.1 percent of planned grade and alignment tolerances within millimetres.

Throughout the pilot drill we were able to keep flow with 5 gal/min. We were able to keep mud requirements to a minimum, and disposal costs to a minimum as well. Once the pilot drill was completed, we up-sized to 250-mm and 400-mm using TCI roller cone reamers to cut the dense glacial till and boulders. We opted for these rock reamers as they achieve the same accuracy as the pilot drill. With conventional reamers the likelihood of deviation or inability to cut the

The project's success demonstrates HDD capabilities within extremely tough formations.

The first HDD section was within a tight right-of-way with a house on one side and a storm sewer on the other.

rocks was too great and they would be highly inefficient. By use of such tooling, Trenchless prevented costly and high-risk excavations to remove rocks that would require removal during conventional reaming.

The first horizontal directional drill install was within a tight right-of-way that has an existing 300-mm concrete storm sewer on one side and a house foundation on the other. To handle the resident's concerns over vibrations from drilling alongside the house, the home was seismically monitored to ensure the drilling does not cause any adverse structural effects. The pilot drill, 250-mm and 400-mm rock reaming passes proved to not have created seismic readings that indicate any negative structural effects. The pilot drill and rock reaming passes took place with the equipment working at the top of the section, drilling to the bottom and pullback taking place from the bottom to the top. This was the most optimal outcome as it allowed for traffic to maintain one lane alternating with a fully fused 94-m length of pipe. The first horizontal directional drill segment was successfully installed on December 29, 2014.

Once completed, Trenchless mobilized to the second horizontal directional drill section. The section consists of mature cedar trees and a working zone under high-tension BC Hydro power lines. At the time of writing the pilot drill had been completed and the 250-mm rock reaming was to begin. The upper-section horizontal directional drill will consist of pilot, rock reaming and product pullback to take place with the equipment located at the top drilling down. Due to the quiet nature of the neighbourhood on this section, the pipe pullback can be fully fused and pulled back from the bottom exit pit.

This project highlights HDD capabilities within extremely tough formations. Pojects previously deemed unfeasible are now being considered for HDD applications due to such successful installations.

HDD Conduit at Roberts Bank

Preston Creelman, P.Eng.
Specification Engineer, Royal Building Products

Last July, six runs of Rigid PVC Conduit were installed by HDD below railway tracks at Westshore Terminals in Delta. This is the first use of this new product made by Royal Building Products in British Columbia. There were two locations that required three conductors for power upgrades to be run below the railroad bed, minimum five feet of bury.

IRONMAN Directional Drilling only required just over one hour to pull in each of the triple-duct runs. Three bells were removed from the duct and attached onto the swivel and reamer. Next, three lengths (at 20 feet) were pushed into the special bells. A small "pullback" was done to set the grip rings, and then the drill commenced the pullback. When the first 20 feet of triple conduit was almost pulled into the bore hole, three more lengths were joined to each of the conduits. Assembly of each joint took approximately 30 seconds. This was about the same amount of time it took for the drill rig to detach, remove a drill rod and then re-attach. Joining/assembly did not slow down the pullback rate.

Royal HDD Rigid PVC Conduit was chosen for this application because it utilizes a cartridge-style assembly method to join the pipe sections. Layout/set-up space was minimal behind berth. Not only would it have been very difficult to "string" fused product, the actual procedure of fusing would have been difficult given the close proximity of coal dust. The ring/gasket bell afforded a simple connection method that had more than enough strength to withstand pullback forces.

Royal's HDD Rigid PVC Conduit is CSA-approved for use as Rigid Conduit. The HDD style has a ring assembly in front of a gasket in each bell. The ring assembly consists of a casing ring that is formed into the bell along with the gasket. Then, at the manufacturing plant, a gripper ring shaped like a C is placed into the casing ring. On the inside surface of the gripper ring are three (or four) serrations angled so that a spigot will slide through into the gasket, but when tensioned the serrations "grip" onto the spigot. The harder the pull, the greater the grip. The gasket is to provide a water-tight seal to prevent moisture from affecting wiring.

Presently, Royal HDD Conduit is available in four- and six-inch sizes, with plans to add three- and five-inch later this year. Should jobs require DB2 duct, Royal can supply adaptors to transition to the duct on either end of the Rigid PVC Conduit.

HDD Rigid PVC Conduit below rail tracks at Westshore Terminals

IRONMAN Directional Drilling rig

Triple-conduit run connected to swivel and reamer, as pullback began

Assembly area adjacent to Berth 1

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Rehabilitation of Brick Storm Drains in Victoria

George Bontus, P.Eng.
Director of Engineering, Aegion Corporation

The City of Victoria's Public Works department is responsible for the management of nearly $2 billion of assets and infrastructure. This includes an extensive stormwater system that serves almost 80,000 residents. Portions of the City are serviced by some unique storm drain systems. More than 10 kilometres of these pipes are constructed of hand-placed bricks, installed in some areas by tunneling, and in others by open-cut methods.

Over 95 per cent of the brick storm drains are non-circular pipes – including egg-shaped pipes which are typically a 3:2 ratio of height to width, and up to 1,800 mm by 1,200 mm in size, and arch sections ranging in profile from 2:3 to 3:4, height to width, and up to 2100 mm to 1855 mm in size. Some of these pipes were constructed as early as the mid-1860s and are now utilized as combined sewers, carrying both sanitary and stormwater flows. These pipes were converted to storm sewers a number of years ago.

Based on the size of the sewers, their irregular shapes, and complications of repairing failed brick, the City realized that any structural failure would have significant consequences. Therefore, consultants were commissioned beginning in 2007 (M.J. Pawlowski and Associates; and AECOM in 2009-2011 and 2013) to assess over 10,000 m of the storm drains.

Many of Victoria's brick storm drains are well over a century old.

All pipes inspected were assigned a Structural Performance Grade (SPG) of 1 ("like new") to 5 (in need of immediate repair). As of August 2014 approximately 30 per cent of the brick storm drains were ranked SPG 4 and 5. An asset preservation program developed in conjunction with the studies, and updated on an ongoing basis, considers the structural and functional ratings to prioritize the individual pipe segments for rehabilitation.

Several options for rehabilitation or replacement were considered. Because some of these sewers are in areas developed over 150 years ago, it was not unexpected to find some pipes now located under houses and other structures. One particular outfall was even routed under an occupied cemetery. Other segments were found running under boulevards, often directly under majestic old trees, and occasionally exiting under roadways. In addition, it was not uncommon to find other utilities in close proximity, both horizontally and vertically.

Cured-in-place pipe (CIPP) lining was one of the technologies assessed for rehabili-

tation of these brick storm drains. It was judged to be feasible for the egg-shaped inventory and some of the arch shapes. As a result, rehabilitation projects were tendered in 2011, 2012 and 2014 to line some of the most critical segments of the brick storm drains. In addition to less digging and disruption, trenchless technologies such as CIPP provide cost-effective options to mitigate impacts on the local and commuting residents, as well as significantly reduce the carbon footprint of the construction work. In addition to the large-scale rehabilitation work, local defects such as missing bricks and holes in the pipes were identified for stabilization, where a local repair might reduce the potential for failure and delay the need for full rehabilitation.

Insituform Technologies Limited won the three CIPP rehabilitation contracts and has successfully completed 1,665 m of brick storm drain rehabilitation with egg-shaped pipes ranging from 914 mm x610 mm to 1,275 mm x 850 mm, and liner thicknesses over 30 mm. Two arch-shaped sewers have been lined, with the largest a 900 mm x 1,350 mm, with a liner over 45 mm thick. While these are not the largest pipes Insituform has lined, they have provided some unique challenges. The project teams on these three projects, including the City, an engineering consultant and Insituform, worked together to identify and address these issues, and the lessons learned have been applied to subsequent projects.

Unique CIPP Challenges

Typically, CIPP liners are installed from one manhole to the next, sometimes passing through intermediate manholes. For larger installations, where the diameter of the liner tube is greater than the inside diameter of the manhole or the manhole cover opening, either the frame and cover or the down shaft must be removed and subsequently replaced. In some instances, new manholes are required to meet pipe or alignment geometry, or simple length of install issues. Both of these conditions exist for the brick storm drain rehabilitation.

In smaller-diameter CIPP installations, service connections can be located after lining by a characteristic "dimple." Thicker liners, in larger pipes make it more difficult to see these dimples, so horizontal man entry to place lag bolts at services is required. It is typical to obtain diameter measurements at manholes to confirm pipe size. For non-circular sewers, many specifications call for internal measurements of the height and maximum width of the existing pipe at specified spacing prior to lining to ensure the proper sized liner is selected.

For the brick sewer drain rehabilitation, the projects were planned and designed using CCTV inspection data and the City's historical records while adhering to local bylaws and environmental requirements. At the outset of the projects, the project team meets to confirm the planning and schedule, as well as carry out a detailed site review to confirm design intentions and identify any potential unforeseen conflicts. This can result in changing the locations of new access points, with resulting impacts on shot lengths, to accommodate local conditions such as public safety, traffic concerns or potential damage to trees or other features.

In these projects, cleaning and preparation of the sewers for lining was addressed either in a separate contract or as a component of the lining work. This included the internal measurements and installing lag bolts at

Projects were planned and designed using CCTV inspection data and Victoria's historical records.

services as described previously, as well as testing or proving services, and CCTV inspection. Although this is a storm drainage system, many buildings have stormwater runoff connections. In some cases these may have been abandoned during upgrading of the buildings, so the status of service needs to be confirmed by either dye testing or "lamping." All of this work is executed while observing strict safety standards and requirements.

Once the inspections and measurements have been completed, the liner is ordered specifically for each shot. Length is a simple component of the liner design. For circular pipes, ASTM F1216 is the standard used to determine required liner thickness. In the case of non-circular pipes, the designs must also consider the beam effect seen in some segments of the perimeter of the liner. As in circular pipes, external forces such as soil loads, groundwater and traffic loads impact the thickness of liner required. For the same size of egg-shaped pipe, the depth of cover and groundwater can result in significant differences in liner thickness.

The tube material for these projects is manufactured at Insituform's facility in Batesville, Mississippi, and shipped to the Edmonton wet-out facility, where the tube is impregnated with resin. The wet-out tubes are cooled and shipped to Victoria in refrigerated trucks. Installation of the liners in these projects has been accomplished using air inversion/steam cure in the inversion process. This keeps the liner inflated and tight against the host pipe wall through inversion and the cure phase.

A post-lining CCTV inspection confirms that the liner is properly installed and that services have been reinstated. Plate type samples of the liner material are cured on site, and tested in third-party labs to confirm that the liner strength properties in the field meet the initially designed values. The contracts include a requirement for a maintenance video approximately a year after installation.

The City of Victoria's Brick Storm Drain project has provided a cost-effective, low-impact solution to the need to renew the existing 150-year-old pipes. CIPP lining has been used since 1971, and continues to meet the needs of many municipalities around the world. In this ongoing program, it has permitted rehabilitation of an important segment of the City's infrastructure under a cemetery, houses and trees, and in busy commercial areas.

Many thanks to Mr. Mike Brady and Mr. Chris Macey (AECOM), and Mr. Marek Pawlowski (M.J. Pawlowski and Associates) for information on the study and planning phases of the project, and for photographs.

Manhole Rehabilitation in Esquimalt

Bob Taylor
Mar-Tech Underground Services Ltd.

In early 2014 the Capital Regional District sent out a tender to rehabilitate a dozen manholes in Esquimalt, a suburb of Victoria. The manholes were in very poor condition due to hydrogen sulfide and would require a customized approach for repair due to the high flow passing through the 900-millimetre line they were connected to.

When we first viewed the site and the manhole condition, we could see that the 11 manholes situated just outside the Esquimalt Naval Base had become structurally unsound – making the job unsuitable for chemical grouting. In some cases you could literally take a manhole lid hook and put it through the wall.

Our solution was to re-concrete each manhole using Permacast. Permacast is a cast-in-place technique designed for manholes. The process uses a Spincasting head which is lowered and raised repeatedly by a winch on a crane arm. The process is somewhat like shot-creating. You can put on an inch, an inch-and-a-half, two- inch, whatever your designs require for structural manhole through a multitude of passes. It's an excellent application for manholes that need replacement, especially due to hydrogen sulfide attack.

The job in Esquimalt, however, involved another challenge besides getting the manhole walls back into operating condition. Mar-Tech's client, the CRD, was concerned that hydro-blasting the manholes would cause debris to end up in their pump station.

Knowing that setting up a roadside bypass for the 36-inch trunk line would be a costly endeavour – maybe three to four times the cost to repair each manhole – Mar-Tech had another plan. We came up with an internal bypass system, so that we could bypass the flow through the pipe itself while still isolating the manhole. That way we could clean the manhole, use one of our vac trucks to remove the material, and once the manhole was all cleared we spin-cast the new concrete.

Among its key services, Mar-Tech identifies cleaning, hydro-excavation, inspection, rehabilitation and traffic control.

The technique for rehabilitating the manholes in Esquimalt worked well, and if Mar-Tech has its way, the company will get a crack at six more manholes, five of them located on Department of National Defence property. Those manholes are in even worse shape than these first ones we have repaired.

This manhole was in very poor condition.

Manhole was cleaned prior to re-concreting.

Manhole was rehabilitated with Permacast.

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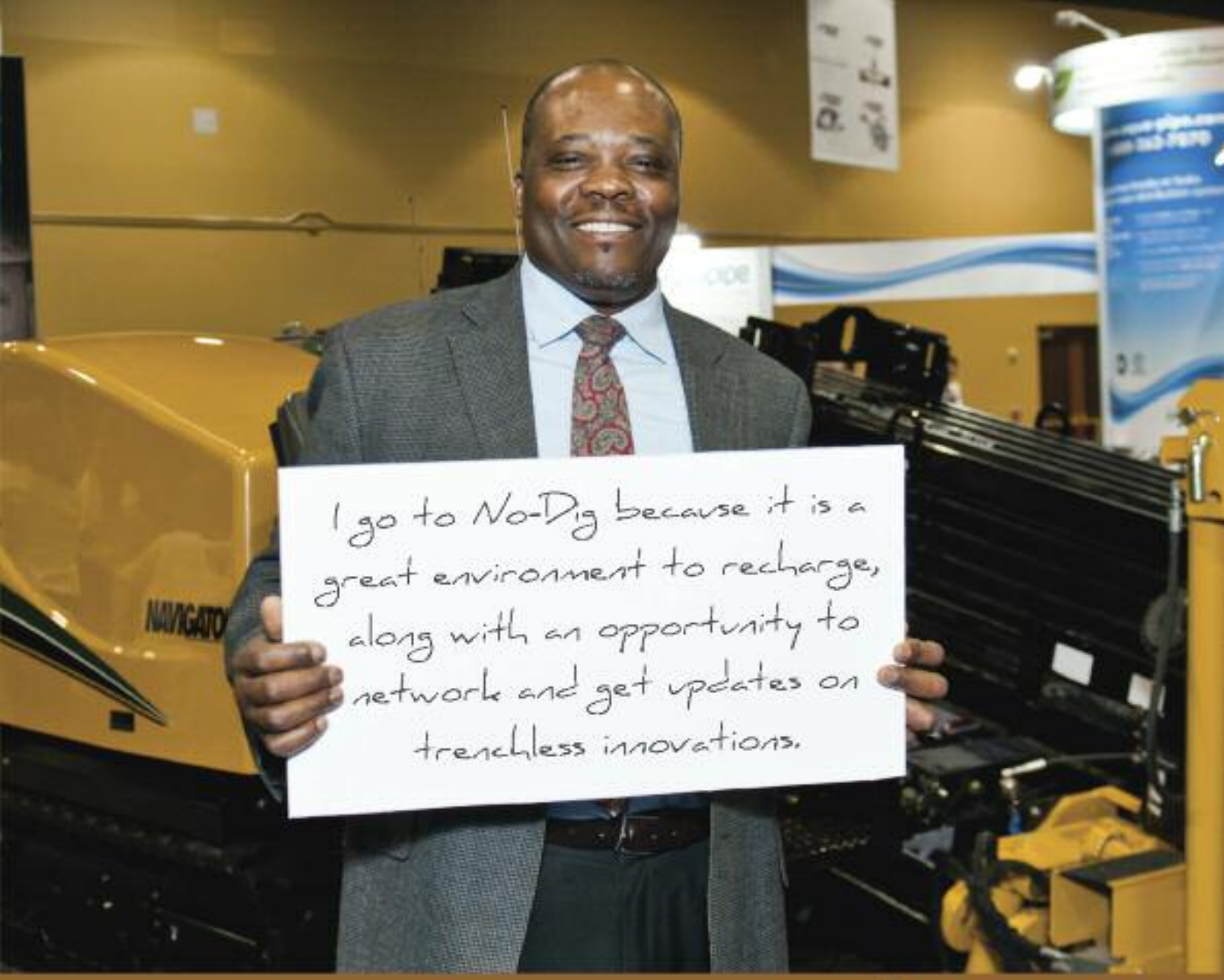

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Pictured above: Babs Marquis, Construction Manager, Jacobs Associates, Burlington, MA

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