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At Brandt, we’re committed to providing our customers with innovative, powerful tools that get the job done with minimum down time and maximum productivity.

We’re proud to announce that Brandt Tractor now distributes the full line of Hammerhead Trenchless Equipment – Hammerhead Moles, Pipe Bursting, Pipe Ramming and HDD Assist. These products are used by contractors around the globe to install or replace fiber, communication, water, sewer and gas lines with minimal disruption to above ground landscapes, structures and traffic flow.

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THANKS TO OUR DEDICATED VOLUNTEERS

On behalf of the Northwest Chapter of the North American Society for Trenchless Technology, I thank you for taking the time to read through the fifth annual edition of our Chapter Journal. As we believe it provides a valuable resource to the trenchless industry, I encourage you to circulate the publication to your friends and colleagues. The Chapter is more active than ever, with events planned across our region of Alberta, Saskatchewan and Manitoba. We encourage all readers to get involved – drop me a line at dstrayer@nastt-nw.com and we can discuss possibilities. The mandate of the Chapter is to promote the trenchless industry at the grassroots level; to fulfill that we are always looking for new members in the government, consulting, construction or supplier sectors. An excellent way to get involved and learn more about the industry is through attendance at a Good Practises Short Course. These one day courses are taught by experts in the trenchless industry and offer continuing education credits. Our next short courses are planned for November in Calgary and January, 2012 in Winnipeg. Watch our web site – www.nastt-nw.com for updates and volunteer opportunities.

Speaking of volunteers, I want to thank the volunteers who serve on the Chapter Board and its sub committees. It is only through the dedication of this hard working group of individuals and their respective employer’s that we are able to exist. A list of Board and sub-committee members is included in this publication – I encourage you to take a minute to review and see if there is someone you already know. The work we do as a group is as rewarding as the resulting networking opportunities. Volunteers from the Northwest Chapter and the Tunnelling Association of Canada (www.tunnelcanada.ca) were responsible for organizing the 2010 Northwest Trenchless Conference held over two days last November in Edmonton. The conference was a resounding success with over 200 registrants for the Short Course and Symposium. Presentation of the 2010 Northwest Project of the Year for the ‘Athabasca River Crossing’ project was made to the R.M. of Wood Buffalo, Stantec Consulting, and Direct Horizontal.

The 15th Annual Conference, in partnership with the Tunnelling Association of Canada, will be held November 16-17, 2011 at the Coast Plaza Hotel in Calgary.

The first day will include eleven peer reviewed technical presentations, a trade show and presentation of the 2011 Project of the Year. The NASTT Cured-In-Place Pipe Good Practices Short Course will be held on the second day of the conference.

As Canada’s infrastructure ages, upgrading and replacement through trenchless methods is becoming more commonplace. Participation in the NASTT provides you access to a significant knowledge base of the current state of the art in trenchless technology – I encourage you to visit www.nastt.org to see first hand the benefits of membership. Enjoy the Journal!

Duane Strayer
Chair - Northwest Chapter, NASTT
An employee-owned Canadian company, Associated Engineering has provided consulting engineering services to public and private sector clients for over 60 years. With more than 800 staff, we offer a full-service, multi-disciplinary team. Associated Engineering provides consulting engineering, project management, and asset management services in the infrastructure, water, environmental, transportation, energy, and building sectors. We offer expertise in trenchless technologies, including horizontal directional drilling, large diameter tunneling, micro-tunneling, auger boring, pipe bursting, pipe jacking, and CIPP/fold & form lining.

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MESSAGE FROM THE NASTT CHAIR

Less than a month from the 15th annual Northwest Trenchless Conference in Calgary, I cannot help feeling extremely excited for our volunteer members of our Northwest Chapter. By the time you get a chance to read this, the conference will be well underway. From the presentations to the exhibits, attendees can expect another extraordinary event.

For nearly two decades, the Northwest Chapter has been and continues to be the focal point for advancing the use of trenchless methods and applications in Alberta, Saskatchewan and Manitoba. Indeed, the Northwest Chapter has always been one of our Society's strongest.

The Chapter is fortunate to have great leadership at the helm from NASTT members, including Duane Strayer, Dave Krywiak, Dan Willems, Bill Boyes, Mark Brand, Albert Kwan, Scott Gilles and Siri Fernando to name a few. Many other chapter members are active in NASTT, serving in various capacities.

Commitment and involvement are essential ingredients for success. The Northwest Chapter demonstrates an abundance of these attributes as illustrated by the breadth of its Chapter activities, which include conducting a first-class conference in every respect. As a further service to the region, the Chapter will host the NASTT Cured-In-Place Pipe Good Practices Course together with the Conference.

I believe strongly in the role NASTT regional chapters can and must play in driving the growth of trenchless technology at the grassroots level.

George Ragula
Chair - NASTT

NW CHAPTER DEMONSTRATES COMMITMENT AND INVOLVEMENT

“I BELIEVE STRONGLY IN THE ROLE NASTT REGIONAL CHAPTERS CAN AND MUST PLAY IN DRIVING THE GROWTH OF TRENCHLESS TECHNOLOGY AT THE GRASSROOTS LEVEL.”

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NASTT-NW CONFERENCE
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and to detect breaks in these wires in near real time. Failures in PCCP were becoming a huge liability for utilities and while on average not more than 4 – 5% of PCCP is compromised, failures have significant consequences. Pure Technologies developed acoustic monitoring systems for PCCP using tethered hydrophone arrays in operating pipelines and were able to monitor relatively short sections of pipe, a mile or two at a time in real time to determine if wire breaks were occurring and at what rate. It was thought then that knowing the rate of deterioration would lead to better management of PCCP and avoid catastrophic failures that are always costly and whose socio-economic impacts are even more severe. The need that developed from these hydrophone arrays in pipes became clear and a solution to monitor long sections of pipe in real time became the new target.

The next development was today’s acoustic fibre optic monitoring system whereby 20 plus miles of pipeline can be monitored in near real time from one data acquisition unit by means of a fibre optic cable that is strung the length of the pipeline that can detect and locate wire breaks and much more in near real time. Data collected is sent via the internet and then forwarded to the client so that any pipes entering a state of incipient failure can be managed before a catastrophic event. The technology is by no means simple but it is very effective.

The Crossi

The City of Edmonton is one of the few municipalities in North America that has its own expertise, labour and equipment for both trenched and trenchless construction. Its Design and Construction section (D&CC) started tunnel construction as early as the 1900s. Since then, D&CC has accumulated knowledge and experiences in hand tunnels and machine excavated tunnels with diameters ranging from 0.9 meters (3 ft) to 6.0 meters (20 ft). Since 1970s, the City started using other trenchless technologies for in-house construction as well as construction using private contractors. In 2008, pipe ramming and pilot tube micro-tunneling equipment were acquired and both joined the City’s trenchless construction toolbox.

In May 2010, D&CC completed construction of the storm servicing works for a roadway expansion project in City of Edmonton. The scope of the work included a 1060 meters (3480 ft) long 2340 mm (92 in) diameter tunnel, a series of manholes with diameters between 1200mm (48 in) and 2400mm (96 in), and tie-ins lines ranging from 300mm (12 in) to 1050mm (42 in) diameter. Since the traffic flow had to be maintained during the construction, D&CC utilized a variety of tools in its trenchless construction toolbox, including TBM tunneling, hand tunneling, pipe ramming, unguided auger boring and pilot tube micro-tunneling to meet the tight schedule.

9:25AM - 9:50AM
CITY OF EDMONTON – DESIGN AND CONSTRUCT TUNNEL PROJECT IN EDMONTON
Siri Fernando

The City of Edmonton is one of the few municipalities in North America that has its own expertise, labour and equipment for both trenched and trenchless construction. Its Design and Construction section (D&CC) started tunnel construction as early as the 1900s. Since then, D&CC has accumulated knowledge and experiences in hand tunnels and machine excavated tunnels with diameters ranging from 0.9 meters (3 ft) to 6.0 meters (20 ft). Since 1970s, the City started using other trenchless technologies for in-house construction as well as construction using private contractors. In 2008, pipe ramming and pilot tube micro-tunneling equipment were acquired and both joined the City’s trenchless construction toolbox.

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9:50AM - 10:15AM
THE CROSSING COMPANY – ANNULAR PRESSURE MANAGEMENT
Manley Oushak

Horizontal Directional Drilling involves the construction of a borehole in the earth by advancing a mechanical cutting structure through the ground and removing the soil or rock cuttings from the borehole by means of hydraulic transmission. The fluid used to transport the cuttings out of the hole produces a pressure within the borehole that can, and often does, provide sufficient force to push the drilling fluid to the surface of the ground. Commonly referred to as a ‘frac-out’ or a ‘hydro-fracture’, the inadvertent flow of drilling fluid to the surface can have a significant environmental

In simple terms, the failure of large diameter pipelines, water or waste water flow of drilling fluid to the surface can have a significant environmental

Commonly referred to as a ‘frac-out’ or a ‘hydro-fracture’, the inadvertent flow of drilling fluid to the surface can have a significant environmental

b
and operational impact. Despite the well known impact of hydro-fracture, annular pressure management is not widely practiced within the HDD industry. The practice is gaining ground however, and has been practiced, at least intermittently, by a few engineers and contractors within the global market. One of the barriers to the broader practice of annular pressure management is the shortage of information concerning its practical application and the predictive capabilities of the available models. This paper describes the predictive capabilities of one such model, and the practical application of annular pressure management, as it has been applied on nearly 200 HDD projects over the past five years. The paper describes the variables that determine the resultant annular pressure and a method to calculate or model it. Several project examples are used to show how the predicted values compare to actual measurements and how analysis of the annular pressure can provide important down-hole diagnostics. Finally, the paper considers some areas of modeling and annular pressure management that require further development.

10:15AM - 10:45AM
COFFEE BREAK

10:45AM - 11:10AM
IPEX INC. – RECORD BREAKING FUSIBLE PVC PIPE PROJECT
Louis-Philippe Dube
PVC is the most commonly used pipe material for new municipal infrastructure installations in North America. With the rise in popularity and efficiency of trenchless technologies for the installation and replacement of underground piping systems, designers and installers can no longer use the traditional unrestrained bell and spigot PVC pipe system in these installations; they often have to use dissimilar materials between the open trench and trenchless portions of their installation. Fusible PVCTM pipes now offer a solution where the entire system can be completed with the same material, PVC, regardless of the installation method.

Fusible PVCTM pipes are now used on trenchless projects across North America, including the record setting, 2010 Trenchless Technology Project of the Year Award, HDD project in Perth Amboy NJ where a 1645m pull of 600mm DR18 was completed under the Raritan River. This presentation will review how cooperation between owner, designer, installer and pipe manufacturer helped mitigate the risks involved in such an installation and bring it to a successful completion.

Since its 2008 launch in Canada, Fusible PVC has been successfully used and is being considered in increasingly challenging HDD installations across the country.

11:10AM - 11:35AM
AECOM – TUNNEL PROJECT IN CITY OF TORONTO
Dan Ifrim
AECOM was retained by City of Toronto to provide professional engineering services for the design services and construction administration services for the construction of a watermain from the intersection of Wellington and Spadina west on Wellington, north on Bathurst to Dupont and east on Dupont to connect to the existing watermain at Huron. The proposed 4.9 km 1650 mm Bathurst Watermain will reinforce water supply to north Toronto and York Region. The proposed watermain tunnel will be installed entirely in the bedrock of the Georgian Bay Formation. The bedrock consists of fine grained, thinly bedded, grey weak to very weak shale with interbedded weak to medium strong shaly limestone. The Bathurst Watermain tunnel is proposed as 3m in diameter and will be constructed by TBM in rock. The watermain will be centered inside the tunnel and grouted with cementitious material. The tunnel ranges from 15m below the surface at the intersection of Spadina Avenue and Wellington Street to 42m below the surface at the intersection of Dupont Street and Huron Street. The tunnel will be constructed exclusively in City of Toronto right of way. The tunnel alignment includes two challenging curves of 50m radius.

11:35AM - 11:40AM
2011 NORTHWEST TRENCHLESS PROJECT OF THE YEAR AWARD PRESENTATION

11:40AM - 12:05AM
PROJECT OF THE YEAR TECHNICAL PRESENTATION
TUNNELING IS A TRENCHLESS CONSTRUCTION METHOD THAT HAS NOT BEEN WIDELY USED IN CANADA PRIOR TO OUR LOW POPULATION DENSITY AND LARGE LAND MASS. AS OUR CITIES GROW AND AS REGULATIONS AND RESTRICTIONS BECOME TIGHTER, WE ARE SEING AN INCREASE IN DEMAND FOR TUNNELING SERVICES. TUNNELING NEEDS TO BE CONSIDERED AS A TRENCHLESS CONSTRUCTION OPTION BECAUSE OF THE ADVANTAGES IT OFFERS. MOST OFTEN WHEN WE THINK OF TUNNELING WE THINK OF LARGE TRAFFIC OR TRAIN TUNNELS, HOWEVER MOST OF THE TUNNELS CONSTRUCTED IN THE WORLD ARE LESS THAN 800M IN LENGTH AND LESS THAN 3 METRES IN DIAMETER AND ARE USED FOR PEDESTRIAN WALKWAYS, UTILITY INSTALLATIONS, AND OIL AND GAS PIPELINE INSTALLATIONS.

Steffen Bramm, of Stuttgart, Germany and partner in The Tunneling Company based in Calgary, is a second generation tunneler, German certified mechanic, and a certified explosive and construction engineer. He has been the Chief Estimator and Project Manager at H. Bramm GmbH Construction (a leader in European tunneling for over 35 years) from 1997 to 2011. His technical education combined with his long tunneling bloodlines make him an expert in his field. This presentation will provide a brief overview of some of the most common tunneling methods of tunnels with a diameter less than 3 meters in diameter, discuss why tunneling has been overlooked in Canada, explore the advantages of tunneling and review the criteria for a successful tunneling project.

Road settlement issues have been a concern for transportation industry for years. Similar issues have been observed on both asphalt and concrete roads. The increased costs on the frequent repetitive pavement and traffic safety concerns have drawn the attention of transportation-related industry. Different methods have been attempted to solve these types of problems in the past, and the advance in technology has resulted in new methods in tackling road settlement issues.

This paper reviews the common reasons for road settlement issues and outlines the two innovative solutions for the settlement issues on both asphalt and concrete roads, respectively. Properties on new permeation, compacting grouts and trenchless construction methodology have been introduced for soil stabilization and road lifting applications. Recently, Alberta Transportation has taken the initiatives in applying the new technology in some existing challenges. Certain sections of the Edmonton Anthony Henday ring road have settled at the concrete road joints after years’ operation.

In this paper, the trenchless construction by using an innovative compacting grout has been explained. The construction time to achieve the precise grade level at each joint was within 2 hours. Another soil stabilization project for Alberta Transpiration on Hwy 56 (at the north of Camrose) is also discussed by presenting the innovations, benefits and cost saving in the construction practices.

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A competitively bid technology that has carried out approximately 75% of the annual rehabilitation program from 1998 to date. Hand-in-hand with a technology that brings the manufacturing process out to the field has been the evolution of an extensive quality assurance program to measure the installed physical properties of the pipe within a pipe. This paper presents an overview of the overall quality assurance program itself which has matured considerably since 1998 and some of the more recent results of quality assurance testing in terms of ASTM D790 flexural modulus of elasticity and flexural strength testing.

### 2:10PM - 2:35PM
**THE ROBBINS COMPANY – MIXED GROUND SMALL(36”-78”) BORING UNITS**

**Chris Sivesind**

Mixed ground conditions are ever-present in the trenchless industry, and can be a common source of project delays if the proper equipment is not used. This presentation discusses recently employed methods for installing steel casing in mixed ground conditions ranging from 36 to 78 inches in diameter. These methods use common auger boring and pipe jacking equipment in conjunction with hybrid or customized cutting heads to match a variety of mixed ground conditions. In general, this type of equipment can range from small 36 inch diameter auger boring heads to small diameter, manned-entry tunnel shields ranging in diameter from 48 to 78 inches. These machines, known as Small Boring Units (SBUs) excavate hard, relatively dry glacial till or alluvium containing hard rock, cobbles and boulders greater than 1/3 the bore diameter and with unconfined compression strengths greater than 10,000 psi. A brief overview of the development of these small mixed ground tools is presented. The presentation examines the advantages and disadvantages of the technology and their use in conjunction with common mechanical excavation methods.

Project #1: Approximately 430 ft of 48 inch steel casing installed for a waterline through sand, cobbles and boulders at a project in Fort Mc Murray, Alberta. The project utilized a 48 inch motorized SBU with mixed ground cutterhead.

Project #2: Approximately 420 ft of 48 inch steel casing installed through dirt and cobbles for a storm drain at Bagram Air Force Base in Afghanistan. The operations utilized a 48 inch motorized SBU with a new combination cutting head.

Project #3: A recent 36 to 42 inch crossing utilizing a specialized Small Boring Unit through mixed ground will be detailed.

### 2:35PM - 3:05PM
**COFFEE BREAK**

### 3:05PM - 3:30PM
**AECOM – TESTING OF CIPP PIPE FOR CITY OF WINNIPEG**

**Chris Macy**

This paper presents an overview of the quality assurance program and testing for the CIPP Program in Winnipeg, MB. Winnipeg has undertaken sewer rehabilitation by CIPP methods for 34 years, as the first installations were carried out in the late 1970s. The quality assurance testing results compiled in the Winnipeg market represent the longest history of ASTM D790 testing results for CIPP installations in North America.

The City of Winnipeg, Manitoba, Canada has a sewer system that services approximately 700,000 people. As the City was over 250,000 before 1920, much of its sewer inventory is at an advanced state of deterioration. It commenced sewer rehabilitation with cured in place pipe (CIPP) in its first trial installations in 1978, some of the earliest installations of CIPP in North America. A trial rehabilitation method initially, the program increased in frequency from a project every couple of years in the 1980’s to annual trials in the 1990’s. By 1998, the annual Sewer Condition Upgrading Program was transformed and CIPP evolved from a trial rehabilitation technology to a competitively bid technology that has carried out approximately 75% of the annual rehabilitation program from 1998 to date. Hand-in-hand with a technology that brings the manufacturing process out to the field has been the evolution of an extensive quality assurance program to measure the installed physical properties of the pipe within a pipe. This paper presents an overview of the overall quality assurance program itself which has matured considerably since 1998 and some of the more recent results of quality assurance testing in terms of ASTM D790 flexural modulus of elasticity and flexural strength testing.

### 3:30PM - 3:55PM
**HERRENKNECHT – EXPANDING THE APPLICATION OF MICRO-TUNNELLING**

**Gerhard Lang**

Microtunneling has been proven successfully all around the world as one of the most versatile trenchless installation methods. It covers the widest range of geological and hydrological conditions whilst minimizing the effects on the environment.

With the development of the PipeThruster Technology the microtunneling method could be introduced into the pipeline industry as new installation method for river crossings which previously have been dominated by the HDD method. The so called Direct Pipe technology complements the HDD technology for geologies where HDD is too risky to apply or poses an imminent threat to the environment.

Especially RTBM (Retractable Tunnel Boring Machine) has shown its advantages as safe and economical installation method for e.g. conductor pipe installations and provides an alternative to the less accurate pneumatic hammer and pipe telescoping method.

One of the latest developments is the Pipe Express method. The main objective during the development has been to reduce the impact on the surface affected by the construction work whilst maintaining highest performance. The presentation gives an overview over the different installation methods and outlines the benefits of the different applications combined with several case histories.

### 3:55PM - 4:20PM
**DILLON CONSULTING – INFRASTRUCTURE IN CONGESTED URBAN AREAS**

**Adam Sullo**

The Wellington Street Trunk Sewer is a combined sewer that is 500 m long and carries flow from south Chatham to the Chatham Sewage Treatment Plant. The sewer is comprised of a brick sewer in the shape of an inverted egg with a vertical dimension of 900 mm and a horizontal dimension of 600 mm. The sewer is approximately 100 years in age and is in moderate structural condition.

The Wellington Street Trunk sewer is located in the heart of Chatham’s downtown core. The Downtown Businessmen’s Association was concerned about the impacts on business from any infrastructure upgrading work. To minimize the impacts from a sewer rehabilitation project, a trenchless solution, Cured in Place Pipe (CIPP) Lining was selected.

Recent CIPP projects had been completed within Chatham-Kent and a concern regarding the use of styrene based resins was identified by the Municipality. The problem stemmed from the disruption of the anaerobic digesters located at the local wastewater treatment plants and their inability to handle...
higher concentrations of the styrene in CIPP curing water discharge. This problem was reviewed with treatment plant staff and trenchless contractors and led to modifications of the municipal specifications to mitigate these concerns.

This concern was reviewed and became an operational constraint in the creation of an alternative delivery method Request for Proposal (RFP) that required the submitters to provide a common sense approach to balance cost with their offering. The RFP detailed the CIPP lining to be done and also specifically requested the use of alternative measures to reduce the styrene concentration in the discharged curing water to predetermined levels to reduce impacts at the treatment plants. As a result of this RFP, two contractors and an independent supplier developed an innovative approach to solving the problem at hand. Allowing the contractor to tailor the approach reduced the time needed to perform the work and removed the concerns of disrupting the local wastewater treatment plant.

The recommended approach still utilized resins that contained styrene but followed the requirement to capture and treat all curing waters with a proprietary chemical in order to reduce styrene levels to an acceptable concentration.

Due to our brief investigation we concluded that the concentration of styrene levels relative to low wastewater flow rates associated in relatively small communities may present an operational concern with the wastewater treatment facility when performing any type of CIPP liner installation. Also, while the issue of styrene use is not currently a concern in larger Municipalities, it may be in the future if water quality guidelines are changed. The innovative approaches as developed by the Contractor performed under this project may prove to be considered standard practice in the future.

4:20PM - 4:30PM
CLOSING REMARKS - CONFERENCE CHAIR

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NASTT NEW INSTALLATION METHODS
GOOD PRACTICES COURSE
JANUARY 25, 2012 WINNIPEG, MANITOBA

You’re Invited to Attend!
The Northwest Chapter of NASTT is pleased to offer a one-day course on New Installation Methods: Application of Grade and Alignment Control and Guidance, on Wednesday, January 25, 2012 in Winnipeg.

This course will address a number of trenchless methods commonly used to install new pipe and conduit. These methods include: auger boring, pipe ramming, pipe jacking and the pilot tube method.

What You Will Learn
• The trenchless methods used for grade and alignment control and guidance
• The limitations and advantages of each method discussed
• The steps you need to follow “to know the underground”
• How to establish the invert for a proper launch
• The history, sizes, equipment options and process of excavating through different ground types, pipe materials
• Ways to track where the pipe is located underground
• Installation and jacking forces and ways to reduce these forces
• The best method to use through actual case studies which are used to illustrate what can go wrong if the project is not designed for success

Course Topics
• Introduction of Trenchless Methods for New Installations
• Understanding Subsurface Conditions
• Site Set-up, Shafts, Pits and Portals
• Pilot Tube Method
• Auger Boring
• Pipe Ramming
• Pipe Jacking
• Casing vs. Product Pipe and Grouting
• Examples and Case Studies

Who Should Attend
• Engineering consultants
• Utility engineers and managers
• Government engineers and public works managers
• Contractors
• Others with responsibilities for implementing or managing construction projects using trenchless construction techniques

Expert Course Instructors
Glenn Boyce, Ph.D., P.E. is a Senior Associate with Jacobs Associates in San Francisco. Glenn earned his BS and MS in Civil Engineering from Drexel University in Philadelphia before moving out west to receive his Ph.D. in Geological Engineering from the University of California at Berkeley. He is a past chair of NASTT and the course developer/instructor of NASTT’s New Installation Methods Good Practices Course.

Craig Camp is a Senior Engineer with Jacobs Associates in San Diego, California. He has more than 25 years of experience in underground construction. He has been involved in over 100 microtunneling and other trenchless construction projects installing approximately 250,000 feet of pipelines throughout the country. This extensive experience covers virtually every aspect of trenchless construction.

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You will receive comprehensive course handouts and other useful references.

Registration
For registration information, visit the Northwest Chapter web site at: www.nastt-nw.com.

NASTT Member $200 (early)/$250
Non Member $300 (early)/$350

Future Events

The Northwest Chapter of the North American Society for Trenchless Technology – www.nastt-nw.com
What is No-Dig?

Trenchless Takes Center Stage in Nashville

Dear Trenchless Professionals,

Nashville, home of country music’s hottest stars, will host the industry’s premier trenchless technology event in North America – NASTT’s No-Dig Show – the hottest ticket in town. We invite you to join us, March 11-15, at the beautiful and well-appointed Gaylord Opryland Hotel.

Our 21st annual conference marks the third return of No-Dig to Nashville rousing a sense of nostalgia for many. When we first met here a decade ago, some would say that it was a turning point, a sort of renaissance for the organization and the industry itself. The 2001 event sparked a renewed interest in trenchless technology as a viable method to repair/replace underground systems while minimizing surface disruption.

Since 2001, No-Dig has nearly doubled in size, keeping pace with the rapid growth of our industry. Cutting-edge technologies are continually being developed and introduced to the marketplace. Each year brings new products, new services and new players. Projects are continuously pushing the boundaries of what can be achieved with trenchless technologies. Our conference creates a unique opportunity for you to see, hear and interact with leaders in the industry who drive the trenchless marketplace today.

We have 155 technical papers in the conference program packed with timely topics and useful information that you can put to use right away. The papers and presenters are of the highest quality, making for an excellent technical program. We are pleased to announce the addition of a sixth track to the paper schedule, offering you even more educational opportunities! (Refer to the detailed schedule in this brochure.)

That’s not all! The trenchless education provided at the No Dig show is unmatched. You can choose to attend one of our pre- and post-conference courses on HDD, pipe bursting, laterals, new installation methods and CIPP lining. New this year, we are offering an expanded one-day ‘Introduction to Trenchless Technology’ Course on Sunday, March 11 with the latest advances in trenchless techniques.

Benefit from the in-depth sessions and courses offered at No-Dig in more ways than one. For every ten hours you attend, you receive one continuing education unit to advance your professional career.

The overall No-Dig program is focused on one objective: helping you maximize your investment in trenchless technologies, services and applications. Owners, Utilities and Municipalities can immediately benefit. You will learn how to replace/repair and install pipelines with minimal excavation while reducing the impact to your surroundings. You will find that trenchless technology is not only the least disruptive option, but oftentimes is the most cost-effective. The technical sessions and exhibitions are designed to provide you with information you need to make the best possible decisions.

Starting with Monday’s Opening Kick-off Breakfast, you will have plenty of opportunities to network with your industry peers throughout the week. We also invite you to support our Annual Education Fund Auction by donating or bidding on amazing items to help raise funds for NASTT’s educational initiatives. This year’s auction promises to be truly exciting with a country western theme and costume dress-up. Also new this year, NASTT will unveil its Trenchless Technology Hall of Fame awards at the Tuesday evening Gala Awards Dinner. Stay tuned for more details.

Please mark your calendars for March 11-15 in Nashville, where we hope you will join us as ‘Trenchless Takes Center Stage.’ We look forward to seeing you in attendance.

George Ragula
Program Chair
Kim Staheli
Program Vice Chair

Start Time Function

Sunday – March 11, 2012

8:00 AM – 5:00 PM Attendee & Exhibitor Registration
8:00 AM – 11:45 AM Trenchless Technology Short Course – New Construction & Rehabilitation
12:00 PM – 3:00 PM Student Orientation Meeting
1:00 PM – 5:30 PM NASTT Regional Chapter Meetings
1:00 PM – 2:30 PM MSTT Annual Membership and BOD Meeting
2:30 PM – 4:00 PM SESSTT Annual Membership and BOD Meeting
4:00 PM – 5:30 PM MASTT Annual Membership and BOD Meeting
4:30 PM – 5:00 PM GLSLA Chapter Meeting
4:30 PM – 5:00 PM WESTT Chapter Meeting
4:30 PM – 5:00 PM Northwest Chapter Meeting
4:30 PM – 5:00 PM Pacific Northwest Chapter Meeting
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<th>Monday – March 12, 2012</th>
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<td>7:00 AM – 5:00 PM</td>
<td>Attendee &amp; Exhibitor Registration</td>
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<td>7:30 AM – 9:15 AM</td>
<td>No-Dig Kick-off Breakfast &amp; Entertainment</td>
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<td>9:30 AM – 11:35 AM</td>
<td>5-Track Tech Paper Sessions</td>
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<td>11:45 AM – 3:45 PM</td>
<td>Exhibit Hall Open</td>
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<td>2:00 PM – 2:30 PM</td>
<td>Student Poster Competition in Exhibit Hall</td>
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<td>3:45 PM – 5:25 PM</td>
<td>5-Track Tech Paper Session</td>
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<td>5:30 PM – 6:15 PM</td>
<td>Pre-Auction Reception</td>
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<td>6:15 PM – 7:30 PM</td>
<td>NASTT 11th Annual Educational Fund Auction</td>
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<td>6:00 PM – 7:00 PM</td>
<td>Pre-Gala Awards Dinner Reception</td>
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<td>NASTT No-Dig Gala Awards Dinner</td>
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<td>10:00 AM – 12:30 PM</td>
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<td>12:30 PM – 2:00 PM</td>
<td>No-Dig Closing Luncheon &amp; Entertainment</td>
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<td>2:30 PM – 5:30 PM</td>
<td>NASTT Pipe Bursting Good Practices Course (Day 1)</td>
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<td>2:30 PM – 5:30 PM</td>
<td>NASTT Sewer Laterals Rehabilitation &amp; Replacement Good Practices (Day 1)</td>
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<td>NASTT New Installation Methods Good Practices Course – Application of Grade, Alignment Control and Guidance (Day 1)</td>
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<td>HDD Consortium/NASTT Horizontal Directional Drilling (HDD) Good Practices Guidelines Course (Day 1)</td>
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<td>8:30 AM – 12:00 PM</td>
<td>NASTT Pipe Bursting Good Practices Course (Day 2)</td>
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<td>8:30 AM – 12:00 PM</td>
<td>The Rehabilitation of Pressure Pipelines Using Trenchless Renovation Technologies – Key Design &amp; Selection Issues (Day 2)</td>
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<td>NASSCO Pipeline Assessment Certification Program (PACP) (Day 1)</td>
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<td>NASSCO Pipeline Assessment Certification Program (PACP) (Day 2)</td>
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<td>8:30 AM – 5:00 PM</td>
<td>NASSCO Lateral (LACP) &amp; Manhole (MACP) Assessment Certification Program</td>
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The Direct Pipe® method

Tried and tested many times

Almost four years have passed since the successful world premiere of Direct Pipe® in Worms. What has happened during this period and what development has the story taken which began so promisingly as a research project?

By Dipl.-Ing. Diana Pfeff, Herrenknecht AG, Product Manager Direct Pipe®

Brief explanation of the principle of operation

When using the Direct Pipe® method, the Herrenknecht Pipe Thruster operates as a thrust unit – comparable with the jacking frame used for pipe jacking. Developed as an auxiliary tool for the pullback of the pipe in the HDD-method, it was presented for the first time at the Hannover Fair in spring 2006. The Pipe Thruster embraces the prefabricated and laid out pipeline and pushes it into the ground at thrusts of five meters each. The requisite bore hole is excavated by a slurry microtunnelling machine (AVN) which is arranged at the front of the pipeline. The soil excavated by the cutterhead at the tunnel face is mixed with the slurry in the excavation chamber and then pumped through the entire pipeline to the separation plant using a slurry pump integrated inside the machine. Apart from transporting off the excavated material, the slurry also provides support at the tunnel face. After treatment in the separation plant, it is conveyed back into the circuit via a feed line.

In terms of its general function, the machine is very similar to a conventional microtunnelling machine, one difference however being its length, for example. In order to ensure the requisite curve motion of the machine and subsequent pipeline in culverts, it features two to three back-up pipes. Considering that all of the individual back-up pipe connections feature articulated tensile couplings, optimum control of the machine is ensured. Another advantage is that in an emergency, the machine and pipeline can be extracted along with the Pipe Thruster. Just like the microtunnelling method, prior to launching the machine is positioned at the requisite access angle on a launch rail in front of the launch seal which is protecting against ingress of groundwater and soil. This is followed by welding the pipeline (mounted on rollers behind the launch pit) with the conical section of the machine at the rear. The clamping unit of the Pipe Thruster embraces the pipeline and thrusts it into the ground along with the machine. The current maximum pipeline diameter which can be clamped is [insert maximum diameter].

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Graphic presentation of the Direct Pipe® method
is 60” (OD = 1524 mm). The forces to be anchored depend on the pipeline access angle and the maximum thrust or retraction force to be applied. Horizontal forces applied can be absorbed by lateral support profiles mounted in the shaft while deep sheet pile or bore pile walls can be used for the vertical forces. In the course of the Direct Pipe® development process outlined below, the individual process components have been permanently improved and adapted to changing demands. For example, an innovative launch rail is to be used as of 2011 in setting up the machine in the launch pit. In the Direct Pipe® method, this is part of the Pipe Thruster. It should be possible to save two to three days during setup using this hydraulic height- and angle-adjustable support.

**Brief introductory outline of the pilot project in Worms**

With the aid of a Pipe Thruster (HK500PT) and an AVN1000 Direct Pipe® machine, it was possible to successfully install a 464-meter steel pipeline under the Rhine in 2007. The steel pipe was intended to serve as a protective pipe for a water line and various protective cable pipes at a later stage. As the lack of space prevented the 48” pipe (OD = 1219 mm) from being installed in one piece, it was laid in sections of approx. 90 meters. The fact that the pipeline was pushed with only 80 tons into the small target pit in Worms port within only 13 days shows that the friction arising during the Direct Pipe® method is very low although no lubrication was applied along the entire length of the pipeline. This advantage has meanwhile also been displayed in the form of relatively low thrust forces required within the framework of various other projects.

As the Worms project involved a bare, uncoated steel pipe, it remained to be seen whether coated product pipes such as gas or oil pipelines could also be clamped and thrust by the Pipe Thruster without any damage being incurred. In a lab-quality test in the Herrenknecht AG workshop in Schwanau, initial evidence was provided in collaboration with a German gas supplier. Tests with a PE coating (polyethylene) and a GfK coating (GfK on PE) indicated that no damage is incurred to the coating when full clamping force is applied by the clamping unit and maximum thrust by the two large hydraulic cylinders.

**The second Direct Pipe® project in summer 2009 – the Ems-outfall application in Rysum**

The next step in the development of the Direct Pipe® history was to install a 280-meter brine outlet pipeline for the construction of the Jemgum natural gas storage facility at the Rysumer Nacken near Emden. A PE-coated 48” steel pipe (OD = 1219 mm) in which a DN900 GfK pipe was subsequently inserted was installed here for a North-German energy supplier by means of the Direct Pipe® method. During project planning, the direct trenchless advance of GfK product pipes in the partially soft tidal flats of the Ems estuary was not regarded
as possible. As the steel pipe required as a casing pipe could not be laid out in the water on account of the currents prevailing, advance was necessary from land. However, owing to the tight spatial conditions, the pipe could only be installed in sections of 36 meters which would have posed a risk of the bore hole collapsing if the HDD-method had been applied along with the welding associated with this process. At advance speeds of up to 25 cm/min., it was possible to install a 36-meter pipe within only 4 hours. A coupling process generally involves one to two shifts. While tunnelling through sand, silt and in some cases clay, unanticipated old banking reinforcements made of wood and water stones were also driven through. Obstacles crushed by the mixed-soil cutterhead and cone crusher were pumped to the surface through the slurry line. As the invert line ended in an insertion structure in the Ems, the machine was to be recovered in there. The requisite accuracy of only a few centimeters was easily achieved by the surveying system deployed. The conclusion drawn by the client after successful realization of this project was that the Direct Pipe® method was the only practical method for this project and that it represents a good alternative for product pipe intersections with large-volume steel pipes.

First-time installation of gas pipelines

The next phase of development undergone by the Direct Pipe® method, i.e. the direct installation of product pipes, was preceded by another lab-quality load test conducted on the pipeline coating. Confirmation was given to a Dutch gas supplier planning realization of one of his projects using the Direct Pipe® method that the Pipe Thruster would not cause any damage to the polypropylene (PP) coating.

Following successful testing, a total of five projects were realized in the Netherlands in 2010. Crossings of between 360 and 540 meters in length bypassing obstacles such as archaeological sites, smaller rivers and a railway line formed part of the approx. 500-km long North-South Route in 48” (OD = 1219 mm) intended for transporting gas throughout the Netherlands in the future. This first-time installation of gas pipelines in the Netherlands represented yet another milestone in the history of the Direct Pipe® method. The most unusual of these five projects was the 540-meter crossing of the very deep and busy Hartelkanaal in Rotterdam’s Europoort in summer 2010. What made this project so different was the requisite course depth of 30 meters under the ground surface and the ensuing very steep access and exit angles of 10° and 12°, respectively (approx. 3°-5° had been the standard to date). The altitude to be overcome necessitated the application of a slurry pump within the pipeline (in addition to the one at the end of the machine). In geology comprising sand and silt, September 2010 saw the entire...
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pipeline being installed successively in 10 sections of 54 meters each over a period of two weeks. The NSTT (Netherlands Society for Trenchless Technology) awarded the client and construction company the 2010 No-Dig Award for successful realization of the project using this alternative installation method. This No-Dig Award was the second of its kind with the first award presented in Moscow in 2008 by the ISTT (International Society for Trenchless Technology). The innovative process was also nominated for the Hermes Award at the Hannover Fair in 2008. And the Direct Pipe® method received the IPLOCA New Technologies Award in San Francisco in 2009. Another milestone was achieved during the last two of the five Dutch projects (both over 500 meters long) involving first-time crossing of a railway embankment using the Direct Pipe® method. The overburden under the railway tracks on the Zwolle-Almelo line totaled 15 meters. The 48” gas pipeline was thrust in one single piece and inserted into the target pit together with the machine with only 150 tons of thrust force. Advance rates of up to 124 meters were achieved in a shift lasting approx. ten hours.

Debut of Direct Pipe® in the USA

The Direct Pipe® method celebrated its successful premiere in the USA in August 2010. Unlike the 48” pipelines (OD = 1219 mm) already installed in Germany and the Netherlands, the three gas pipeline crossings realized in Florida only involved diameters of 30” and 36” (OD = 762 and 914 mm). The drive lengths of 119 to 226 meters were therefore correspondingly shorter. Considering the lack of space, the AVN machines used for these very small diameters could not be fitted with a hydraulic power pack which meant that the drive length is currently limited to approx. 250 meters for pipeline diameters which are smaller than 40” (OD = 1016 mm).

One particular feature of the first American Direct Pipe® project is its alignment. Unlike previous alignments, the pipeline under Highway 70 not only had to be installed with a vertical curve (R = 914 m) but with a horizontal one (R = 1828 m), too. The navigation system featuring a gyroscope and electronic water leveling system kept the machine on the specified space curve. After only 3 days of tunnelling (in 3 day shifts of 12 hours each), the site team had installed the 215-meter gas pipeline in one go. The HK500PT Pipe Thruster used required average thrust forces of 15 tons (maximum 28 tons).
In early 2011, the Direct Pipe® machine including a 36” pipeline was extracted for the first time using the Pipe Thruster in the third project performed in the USA. After tunnelling through 102 meters, the machine was recovered to the surface with the aid of the Pipe Thruster together with the pipeline, the cutterhead replaced and reinserted into the bore hole – all within a single day. During the pullback process, the bore hole was filled with bentonite to prevent it from collapsing. The cutterhead required changing after encountering an unexpected rock formation which could not be passed through without disc cutters. The remaining 124 meters were then installed over a period of three days.

Summary of experience gleaned and outlook for the years to come

As indicated by all projects realized since Worms, the Direct Pipe® method allows fast installation speeds. This has made the process a technically practical alternative to HDD and microtunnelling. The improved installation reliability in difficult soil – compared to HDD – as well as the economic advantage over conventional pipe jacking translate into considerable competitiveness on the part of this method.

The fact that in the past it has always been possible to overcome invariably new challenges is already an indication that the limits of the process will shift increasingly from one year to the next making areas of application even more obvious – something which was difficult to assess in the early days. It will therefore remain exciting for observers and especially for those wishing to use the Direct Pipe® method.
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Warner Robins, Georgia, is a military town named in honor of Brigadier General Augustine Warner Robins. The city is built around Robins Air Force Base, Georgia’s largest employer.

The military background has had consequences for Warner Robins’ infrastructure. Rapid wartime expansion meant that sewers and other assets went in quickly, with relatively little planning or inspection. As a result, “We have a lot of older corrugated metal pipe (CMP) storm sewer, even under roads,” according to Storm water Management Technician Krag Woodyard. As a result (and also due to EPA mandates) the city is now struggling with major rehabilitation challenges.

“We’ve divided our stormwater system into five sectors, and we need to address one each year in order to keep up with EPA requirements,” Woodyard explains. That means he has to be organized and diligent. Inspection teams pull up to 60 manholes daily, and inspect inlets and outlets as well. Flow direction is determined, condition assessed, and the amount of debris and blockage is estimated. Using a handheld tablet, the results are noted and later uploaded to an office GIS. The result is a good record of a failing system—Warner Robins has a lot of aging CMP and there is much work to be done. And since there is too much work for one big project, priorities need to be set.

Two main factors are considered when setting priorities: pipe condition, and public safety. “If we’re comparing two sewers that pass under roads, and both are showing 50-percent corrosion and need repair,” explains Woodyard, “the one that gets more traffic is going to be a higher priority. We really can’t have pipe collapsing under roads, there’s too much at stake.”

Numerous CMP sewers in need of rehabilitation, many of them under high-traffic roadways… Warner Robins needed a solution that was trenchless, cost-effective and, ideally, structural. Utility Asset Management Incorporated (UAM), a longtime city contractor, was working with a new technology that seemed to fit the bill perfectly.

**STEPPING INTO CLEANER WATER**

UAM is a certified female business enterprise whose three principles each have about 20 years experience in manhole and sewer rehabilitation. The firm has been in existence for six years, and has a reputation for technical excellence, good client relations, and completing projects on time within budget. And they’re ambitious. “We’ve done a lot of manhole work, and a lot of sanitary sewer work,” says UAM President Anita Clyne, “A year ago we were setting goals for our company and realized that storm sewer rehabilitation was an untouched area for us, mainly because we’d been waiting for good options.” That realization set off a search for new trenchless solutions that eventually led...
to Centri-pipe, a spin casting system designed by AP/M Permaform.

“We’d been thinking about spray applications, and when we looked at the science and the engineering of this system, we realized it was a good fit with our expertise,” Clyne says, “so we got licensed.”

Centri-pipe is based on a computer-controlled spincaster that is pulled back through pipes at calculated speeds, spraying on thin, precisely measured layers of high-strength cementitious grouts. It doesn’t require backhoes or large staging areas, and according to studies conducted by the Minnesota Department of Transportation, it costs less per foot than CIPP. The result is a smooth layer of grout that adheres tightly to the inner surface of the rehabilitated pipe, effectively replacing the pipe from within with a new, structurally sound concrete pipe. Flow reduction is minimal.

“We had worked with spray systems on manholes, so this was an easy transition for us,” says Clyne. She also likes the project engineering that comes with the Centri-pipe system. “We give the project specifications to AP/M Permaform,” she explains, “and they give us engineered thickness and layer calculations the same day. It gives us a level of comfort, especially on a project like Warner Robins’ where there’s a lot of elliptical CMP.”

Woodyard agrees, saying “The engineer’s stamp, with the soundness rating, really raises our confidence in this system.” Because it’s a spray system, Centri-pipe projects don’t have to completely rehabilitate a pipe from end-to-end. Woodyard likes that aspect. “If corrosion is a lot worse at the downstream end of a crossing,” he explains, “it’s feasible to do just the corroded half of a pipe—that gives us more options. And we don’t have to worry about bridging diameter changes. Several times already we’ve rehabilitated from an opening just to a junction box, without going past the box.”

---

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Under every great community lies solid infrastructure that works quietly, safely and efficiently for its homes, businesses, families and facilities.

The City of Edmonton Design and Construction team specializes in the use of trenchless technology to build and maintain underground infrastructure in developed areas. Our design/build capacity is leading-edge and has gained us a reputation around the world.

We create the smartest, safest and most sustainable solutions for underground infrastructure projects that are delivered by engaged and energetic people working to create great communities now and for the future.

Let us create for you

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And Clyne cheerfully offers yet another advantage of storm sewer rehabilitation with Centri-pipe, “After all the sanitary sewer we’ve worked in,” she says, “it’s nice to step in cleaner water for a change!”

**SO FAR SO GOOD**

Video inspection allows UAM to assess the amount of damage and get the data needed for the engineered specifications for a particular length of pipe. Bottoms are often a concern. The Centri-pipe applicator needs a fairly smooth bottom so that it can be moved along the pipe evenly, without jerking or stops. Sometimes a new bottom is poured to provide a smooth pulling surface. Pipes also have to be dewatered and cleaned. “A little moisture is fine,” Clyne says, “But if there’s standing water, as there often is in CMP bottoms, we go in with air hoses and blow it out.” Clyne says that her crew can rehabilitate up to 200 feet of sewer pipe daily.

To monitor thickness and quality, manual gauges are used to confirm the thickness of each pass, and logs are kept to monitor the amount of material being applied. After a length of pipe is completed, it’s videotaped again and the city is shown before and after comparisons. “We do need man entry to do a good job,” says Clyne, “But for any pipe that’s 30-inches or bigger, we feel that Centri-pipe is definitely the way to go.”

“We’ve been doing this for a few months,” says Woodyard, “and so far so good! We don’t have to stop traffic, we have a structural repair, and there’s no hindrance at all for the public. The before and after videos are just incredible—it’s like we’re replacing all the CMP under roads with new concrete pipe!”

Clyne and UAM are also happy with their new infrastructure solution. Warner Robins is the firm’s first Centri-pipe project, but they’ll be starting another soon in Macon, Georgia, and have quoted about a million dollars worth of work to other municipalities.

“Warner Robins is the firm’s first Centri-pipe project, but they’ll be starting another soon in Macon, Georgia, and have quoted about a million dollars worth of work to other municipalities.”

“We know these cities well from all our work in sanitary sewers and manholes,” says Clyne, “They have been telling us for a while that storm sewers needed attention, and now we have a good way to help them out.”
Since the beginning of the Horizontal Directional Drilling (HDD) industry, accurate navigation has been one of the biggest challenges and guiding bores across rivers, roads, and other obstacles, was precarious at the least and often was a combination of experience and luck. As a result, the need for ever more accurate steering systems has brought about numerous technological advances in the industry throughout the years. These advances offer the Contractor several options to consider when planning and executing a project.

Walkover systems aside, the most popular wireline guidance systems are the Magnetic Steering Tools (MST) which incorporate the use of external wire grid(s) which are laid on the surface to provide a secondary locating method. While many thousands of bores have been successfully completed using MSTs, the use of surface grids is often cumbersome and/or prohibited and, because the MSTs are negatively influenced by magnetic interference, they are simply not effective as a ‘stand alone’ survey method on most projects.

As a surveyor for over twenty years, I have witnessed the effect that the advances in locating systems has changed the industry and allowed for the completion ever more challenging crossings to be completed in a safe, timely, and accurate manner. Still, there are many projects for which the HDD method has been considered impossible due to depth or because access to the surface is prohibited or unworkable. As a result, a navigation system that eliminated these issues was the next logical progression.

GPS mapping systems has provided Optical Gyroscope technology which could be utilized in the industry and has led to the development of the Drillguide Gyro Steering Tool (GST) which was developed and used by Brownline BV throughout Europe.

Although I was quite familiar with Gyro Based tools in the oilfield, I was not aware of the Drillguide Gyro that was specifically designed and manufactured for use in the HDD Industry and, a few years ago, SlimDril International was given the opportunity to see the GST in action on several projects in Europe. Brownline and SlimDril came to an agreement to introduce the Drillguide GSTs to contractors in the US and the Americas.

The Drillguide GST operates on the True Magnetic North of the Earth and is not influenced by any other magnetic interference. This allows the drilling operations to be completed without using secondary locating system (i.e.; wire grids on surface).

Other advantages include:
- Higher Accuracy – (Azi .04°/1000’, Pitch .01°/1000’)
- Continuous Monitoring while drilling & rotating.
- Minimal Set-Up and Calibration Time.
- Pressure Monitoring.
- High Degree of Accuracy in drilling Horizontal Curves.
- No Surface Assess Requirement or Depth Limitations and Minimal Environmental Impact.

The set-up time from arrival to the site to the commencement of drilling operations is minimal in comparison to MST Systems. Prior to drilling the Surveyor is provided with the Entry, Exit, as well as any other PIP/PC Points in WGS84 (World Geodetic System). These points, along with the other relevant drilling parameters (radii, entry & exit angles, depth, etc.), are entered into the software and used to develop the bore trajectory and Azimuth(s). The Surveyor then performs a ~20-minute Full Calibration of the Gyro and the Bottom Hole Assembly (BHA). The BHA is then installed on to the rig and a ~12-minute ‘North Seek’ operation is performed just prior to drilling and is repeated approximately every two hours to check for drift and to insure the accuracy of the bore. Throughout drilling operations, all drilling parameters and the progress of the bore is monitored and displayed on the computer & Drillers Monitor.

Since the introduction of the Drillguide GST, well over 2000 bores have been successfully completed worldwide and the system continues to improve. Pressure and Vibration Monitoring are now available and numerous software and hardware upgrades have been implemented to make the GST more robust. Brownline is committed to the continued development of the GST to evolve with the ever-changing requirements of the HDD industry and several other advances will be announced in the near future.
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INDUSTRIAL STRENGTH.
A primer for jacking with reinforced concrete pipe

By Trevor Moran, Technical Resource Engineer, Alberta Chapter, Canadian Concrete Pipe Association, tmoran@ccpa.com

CONTENTS
Precast reinforced concrete pipe (RCP) is the most commonly used pipe material for jacking operations where deep installations are necessary, or where the conventional open-cut excavation and backfill method may not be feasible. Jacking pipe is becoming an increasingly common method of pipe installation due to the benefits of minimal traffic disruptions, and potential disturbance of utilities buried under the surface of streets and roadways.

Jacking concrete pipe first appeared in North America in 1896 when Northern Pacific Railroad utilized this procedure for installing drainage systems under rail lines. Jacking techniques and equipment have advanced to where installation of long, large diameter runs is possible with minimal surface interruption. Concrete pipe as large as 3350mm diameter has been successfully installed by the jacking method.

The general procedure for jacking is to construct a reaction access shaft at the beginning of the tunnel and a reception shaft at the end of the tunnel, carefully excavate the soil at the front of the pipeline and push the pipeline into the excavated opening with powerful jacks. For some projects, manual excavation is still the most common construction method, but microtunneling machines and tunnel boring machines (TBM) are frequently used for mechanical excavation.

On long tunnels, intermediate shafts may be used to install the pipeline in shorter more manageable tunnel segments that can reduce the total required axial force required to push the pipeline. Axial thrust is necessary to push the pipeline through the soil, and in the case of mechanical excavators, provide enough axial force on the cutter heads to break down the soil or rock at the head of the tunnel. Axial loads are transmitted through the pipeline based on factors such as pipe diameter, length of the pipeline, soil friction, the type of lubrication used, and method of excavation.

The pipeline is led with a circular steel cutting shield that defines the dimensions of the tunnel, and protects the worker as the soil in front of the pipe is excavated. Microtunneling machines are often used for installing small diameter pipe that do not permit entry by the worker (usually less than 900mm). Operators direct the cutter head from a remote location near the access shaft. Tunnel boring machines are used with pipe greater than 900mm and may be full-face style with a rotating cutting head or an open-faced style equipped with an articulated mechanical excavator arm. The TBM can be operated from within the machine itself, or from an operating station in the pipeline.

LOADS ON JACKED PIPE
Two types of loads are imposed on jacked pipe. The axial load, due to the jacking pressures applied during jacking process, and the bearing load due to the earth cover. Live loading may also be a consideration depending on the project site and the depth of the pipe installation.

Axial Loads: It is necessary to provide uniform distribution of the load around the periphery of the pipe to prevent localized stress concentrations. This is accomplished by assuring that the pipe ends are parallel and within the tolerances prescribed by CAN/CSA-A257.2-M92. Furthermore, utilization of a cushion material such as solid core plywood or hardboard in conjunction with an experienced contractor will ensure that the jacking force is properly distributed through the jacking frame and parallel to the axis of the pipe. The cross-sectional area of the concrete pipe is more than adequate to resist pressures encountered in any normal jacking operation. It is always a good idea to meet with the jacking contractor to ascertain the jacking forces expected to be applied on the pipe. For projects where extreme jacking pressures are anticipated, due to long jacking distances or excessive unit frictional forces, concrete compressive strength higher than standard may be required, along with greater care in avoiding bearing stress concentrations. A factor of safety on axial load capacity shall be 3.20 based on the ultimate strength of the concrete. The effect of eccentric or concentrated loads on the pipe joints should also be evaluated.

The magnitude of the anticipated axial loads is a function of many factors includ-
A primer for jacking

1. of stress distribution for axial thrust:
   ASCE Standard Practice details three stages of compressive strength of the pipe. The Design method for determining the axial transverse loads and the Ultimate Strength is specified, designing and installing precast concrete pipe... with high axial forces, an external steel band can be added to the bell. The steel band confines the concrete to allow full development of the concrete compressive strength and prevent concrete spalling or localized crushing.

**PIPE CHARACTERISTICS**

- **Materials:** Requirements for cement, aggregates, reinforcing steel and other additives shall be as specified in the appropriate CSA material standards.
- **Manufacture:** Reinforced concrete pipe shall be manufactured according to CAN/CSA-A257.2-M92, Reinforced Circular Concrete Culvert, Storm Drain, Sewer Pipe, and Fittings, with attention being given to: nominal dimensions, pipe lengths, and the compressive strength of the concrete. At no time shall the compressive strength of the concrete be less than 40 MPa.
- **Lubrication (bentonite) ports are generally installed at the time of manufacture, and may or may not involve the use of a one way valve.** It is best to check with the jacking contractor to locate these ports where they will work best. To reduce frictional forces of the surrounding soil, contractors will inject bentonite through grout ports to act as a lubricant and fill the overcut cavity. Joints in the pipe should be as symmetrical as possible; that is, the thickness of the tongue should be as close as possible to the thickness of the groove end. Gasket options for jacking pipe include ‘O’ Ring or single offset since these gasket types are not affected by small movements in the joint area, as jacking pressure is applied and relaxed. Subaqueous lubricant should also be supplied with the pipe.

**PERMISSIBLE VARIATION**

CAN/CSA-A257.2-M92, Reinforced Circular Concrete Culvert, Storm Drain, Sewer Pipe, and Fittings provides the user with minimum requirements for pipe variations.

---

**CONCRETE PIPE... IT STAYS IN SHAPE!**

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http://www.youtube.com/user/CanadianConcretePipe
Users should contact the concrete pipe supplier to determine how the manufacturer ensures the dimensional limitations are met.

Internal Diameter: The internal diameter of 1200mm to 3000mm reinforced concrete pipe shall not vary more from the design diameter than +/- 1% or +/- 10mm, whichever is less.

Outside Diameter: The external diameter of 1200mm to 3000mm reinforced concrete pipe shall not vary more from the design diameter than +/- 1% or +/- 10mm, whichever is less.

JACKING PIPE

Wall Thickness: At any location along the length of the pipe, or at any point around its circumference, the wall thickness shall not vary by more than +/- 5% or 5mm, whichever is greater.

Roundness: The outside diameter of the pipe shall not vary from a true circle by more than 1%. The out of round dimensions shall be one half the difference between the maximum and minimum diameter of the pipe at any one location along the barrel.

Taper: The outside barrel of the pipe shall not vary in taper from the spigot end to the bell end by more than 3mm.

Pipe Length: Finished pipe length shall not deviate from the design length by more than +/- 5mm/m, with a maximum variance of +/- 10mm in any length of pipe.

Length of Two Opposite Sides: Variations in the laying length of two opposite sides of the pipe shall not be more than 3mm for any size of pipe.

End Squareness: End squareness across outside diameters shall govern over lengths of two opposite sides.

1200 – 1500mm 4.4mm variation
1650 - 2250mm 5.5mm variation
2400 – 3000mm 7.0mm variation

OTHER DESIGN CONSIDERATIONS

During certain installations, the pipes will rotate slightly as the pipe is advanced in the tunnel. The reason for this phenomenon is not widely understood, but many specifications allow only full circular reinforcing cages and 360 degree stirrup placement. This requirement is for economics rather than structural integrity and generally does not affect the reinforcing design of pipes 1200mm or less in diameter.

Seldom is sufficient soil data information provided to assume a consistent benefit from cohesion along the length of the pipeline. Because of this the American Society of Civil Engineers discourages the assumption of a reduced soil load on the pipe as a result of cohesion unless adequate testing is performed.

REFERENCES:
- CAN/CSA-A257 SERIES-09 - Standards for concrete pipe and manhole sections (Consists of A257.0, A257.1, A257.2, A257.3 and A257.4). This Standard applies to circular precast concrete pipe, manhole (maintenance hole) sections, and accessories intended for (a) use as sewer pipe for the conveyance of sewage, industrial wastes, and storm water, and (b) the construction of culverts. Pipe that is intended to be used for jacking longitudinally in tunnel operations is provided for in CSA A257.2. http://shop.csa.ca/en/canada/concrete/cansa-a257-series-09/invt/27020022009/
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Building on 40 years of experience, Insituform brings global expertise and project management capabilities to your installation site. We manufacture our own cured-in-place-pipe (CIPP) tube using proprietary technology and ISO-certified manufacturing processes. Our research and development center is dedicated to innovating products and processes for consistent high performance in the field. Installations are completed using our own safety-certified crews. We are proud to have invented one of the most widely used forms of trenchless rehabilitation and are committed to continuing to lead the industry today.
The Sabine River Authority (SRA) was created in 1949 to equitably distribute the waters of the Sabine River and its tributaries. As part of this distribution, “We provide surface water to eleven industrial customers, such as Conoco and Louisiana Pigment, for cooling and processing,” says SRA Facility Manager Mike Carr. This water is conveyed mostly via a 35-mile long open canal, but where that canal must cross under roadways and railroad tracks the water passes through inverted siphons.

The siphons are made from reinforced concrete pipe that is typically used in storm sewers and other low-pressure applications. But the siphons are usually full and with wear and movement over time, leaks and structural cracks have occurred; “Most of this concrete pipe went in back in the ’70s,” explains Carr, “and now we’re seeing broken lips at the joints, a lot of leakage, and sediment is getting into the water and compromising quality. Also, the possibility of collapse at the crossings is a danger to the public and the railways. So when we see problems, we have to fix them.”

The Authority is systematically rehabilitating all 40 siphon crossings in its network. The preferred method is cured in place pipe (CIPP) and SRA has a long history with this method. But CIPP hasn’t worked well in large diameter pipe, and there have even been problems when cured linings have had to be cut out and removed.

Two crossings in particular were problematic. One was a roadway crossing with three 84-inch diameter siphons running in parallel for 180 feet. The other was a railroad crossing with two 78-inch siphons running in parallel for 185 feet. Both were bid for CIPP. “We’ve used linings before with a lot of success, but that was mainly on pipes up to 42-inches,” explains Carr, “we tried to use cured linings on pipe this size and we ran into problems.” In fact, the first attempt at cured-in-place lining one of the 78-inch siphons was a disaster; the lining collapsed and had to be laboriously cut out and removed. A second attempt was successful, but not totally satisfactory. There was visible sagging at siphon ends, and the Authority was uneasy about structural integrity. Carr asked the project engineer, Meyer & Associates, to look into alternatives. The contractor, Boh Brothers Construction Company, LLC, also wanted an alternative for the larger diameter siphons, and suggested CentriPipe, a centrifugally cast lining...
solution used by one of their associated firms. CentriPipe turned out to be a successful alternative for these troublesome large-diameter crossings.

**A PERFECT STORM**

It is important to keep in mind that several factors—size, heat, equipment availability, and staging area requirements—combined to make CIPP impractical on this project. “Lining this big can be installed,” explains Meyer & Associates Project Manager Wayne Harris, P.E., “but the necessary equipment is hard to find and lease—there just aren’t that many setups available.”

And Harris says that heat was a major factor. “It was the middle of July when it’s very hot, and it was extremely difficult to keep the lining cool until it was in place and ready to be cured.” Staging, too, was a consideration. For linings this size, several cranes are needed for handling, along with other bulky equipment, which means that very large pads are needed at both ends of the siphons. Sometimes, the necessary space simply isn’t available.

For all these reasons, CIPP is also proportionally more expensive at larger diameters. Harris realized that there were very good reasons to look into CentriPipe. If it could overcome the challenges that made cured lining impractical, it could solve a very real problem for the Sabine River Authority.

**CENTRIFUGALLY CAST CONCRETE PIPE**

CentriPipe, from AP/M Permaform, is a process also known as centrifugally cast concrete pipe (CCCP). This system was initially developed for manhole rehabilitation and other vertical uses, but improvements in materials and casting control have made CCCP effective for large horizontal pipes. For example, the Florida Department of Transportation has used CentriPipe to line a 13-foot diameter culvert near Jacksonville.

Basically, the CentriPipe system uses an automated retrieval system and spincaster to apply thin, precisely-calculated layers of high strength cementitious grout to pipe interiors—the spincaster is inserted into the pipe and pulled back slowly as the structural liner is applied.

The cementitious grout applied was PL-8000 from AP/M Permaform. PL-8000 is a fiber reinforced high-strength cementitious grout that can be mixed onsite and used with the CentriPipe spincaster. It can be applied to most substrates (brick, concrete, metal, etc.) and it is waterproof, corrosion-
resistant, and structurally sound even in relatively thin layers. It also adheres extremely well, even when the substrate is damp… which was the case on the SRA siphons. Since flows were active in the parallel siphons while the by-passed siphons were being repaired, serious infiltration from the saturated soils was occurring.

The finished thickness was calculated according to projected loads, and the minimum thickness was determined to be two-inches. SRA opted for 2.75-inch thickness under the railway crossing as a hedge against heavier loads and vibration. These thicknesses were applied in five full-length, continuous passes.

Despite the multiple passes, CCCP was still efficient, compared to CIPP. “On the 78-inch crossing—which was two, basically identical, siphons—we did one with CIPP and one with CentriPipe,” Harris explains, “But if we’d done that, we wouldn’t have ended up with a fully lined pipe.”

Cost comparisons are also favorable. For larger diameter pipe, CentriPipe clearly cost less per foot than CIPP. “We also considered spot repairing as an option, and that would have cost less than either CIPP or CentriPipe,” Harris says, “But if we’d done that, we wouldn’t have ended up with a fully lined pipe.”

A SATISFACTORY SOLUTION
By being open to a relatively new infrastructure solution, Sabine River Authority ended up with fully rehabilitated pipes that are smooth, structurally sound, and completely sealed with minimal flow disruption during the procedure. Carr is still waiting to see how CentriPipe performs in the long run, but is very satisfied with initial results; “I like the look of it. Its smooth bore doesn’t restrict flow and there are no known leaks… we’re happy.”

“We’ll consider it in the future,” Harris adds, “especially for larger pipe, and places where space is an issue. It appears to be a good product. We’ll be dewatering and inspecting repairs eventually; and, if CentriPipe performs like it should, I can see us using it for all of the larger siphons in the system.”

“SABINE RIVER AUTHORITY ENDED UP WITH FULLY REHABILITATED PIPES THAT ARE SMOOTH, STRUCTURALLY SOUND, AND COMPLETELY SEALED WITH MINIMAL FLOW DISRUPTION DURING THE PROCEDURE.”

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Contact Info:
Monica Perry
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Email: mwperry@telus.net

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