2022 | NORTHWEST

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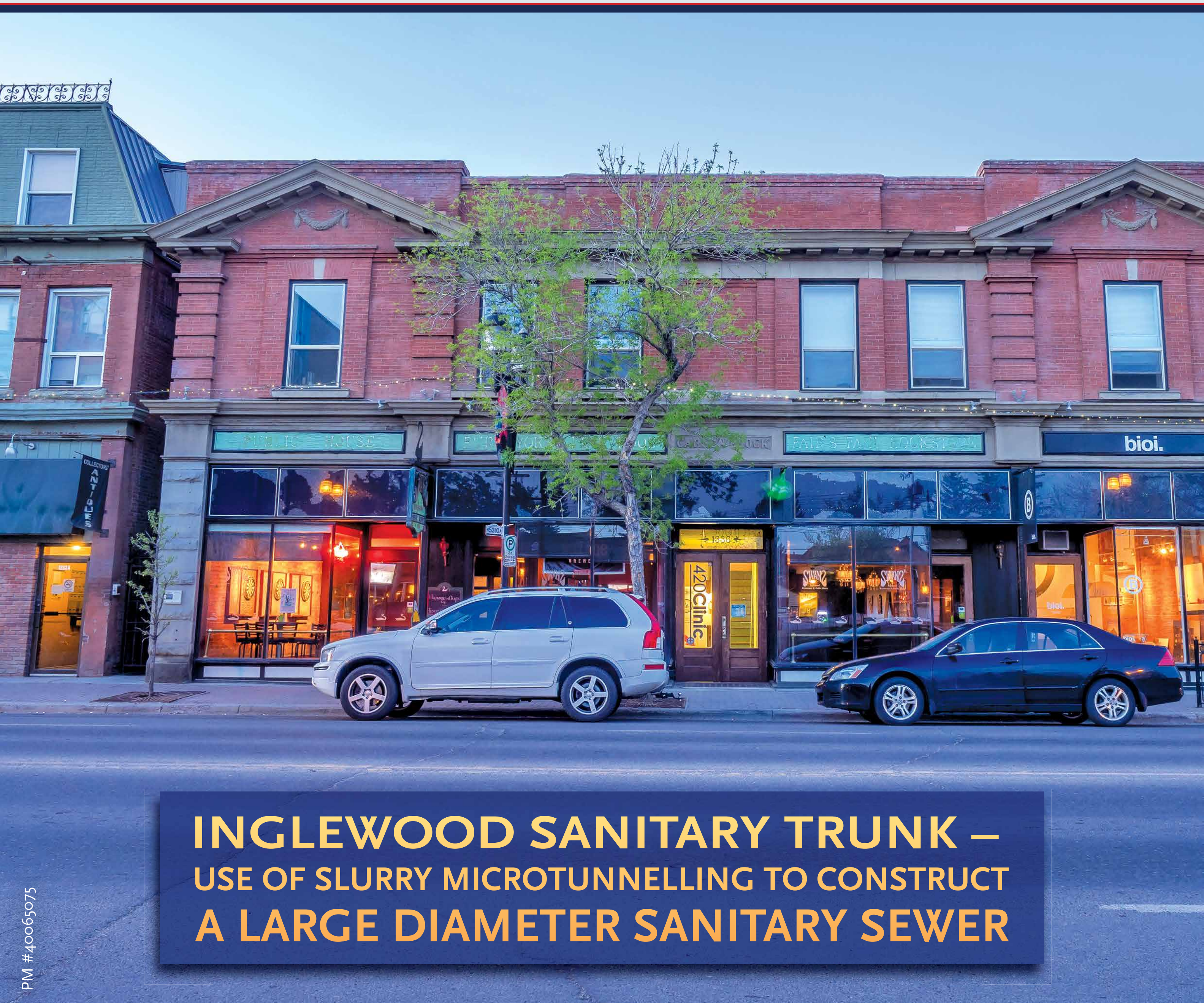
TRENCHLESS JOURNAL

THE OFFICIAL PUBLICATION OF THE NORTHWEST CHAPTER OF
THE NORTH AMERICAN SOCIETY FOR TRENCHLESS TECHNOLOGY



INGLEWOOD SANITARY TRUNK – USE OF SLURRY MICROTUNNELLING TO CONSTRUCT A LARGE DIAMETER SANITARY SEWER

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NO-DIG NORTH 2021 RECAP | 2022 NASTT-NW BUYERS' GUIDE


ANY SIZE. ANY LENGTH.
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2022 | NORTHWEST

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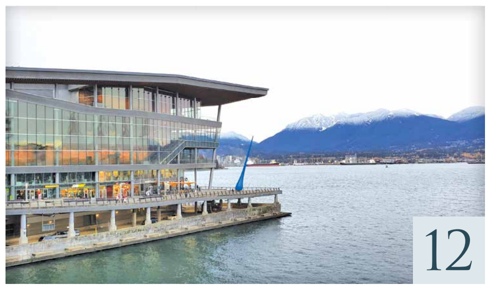
IN THIS ISSUE:



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SHARING OUR KNOWLEDGE

It is with great pleasure that I step into the role of Chair of NASTT-NW. I want to thank all of our current, new, and past board members for making this Chapter one of the best in the industry, and look forward to carrying that forward through my term as Chair. We have a well-rounded board of volunteers, consisting of members from consulting, contracting, suppliers, and municipal governments. Thank you Ben Campbell for being our Chair for the past term, and thank you to Greg Tippet, though on the national board of NASTT, for your continued involvement and support of our Chapter.

It promises to be an exciting year for both the Chapter and the trenchless industry. With the recent success of No-Dig North in Vancouver last November, the focus is now turned towards the third annual No-Dig North at the Beanfield Centre, October 17 to 19, in downtown Toronto. The outlook for this show is very strong, and it promises to be the biggest yet in Canada! I hope to see a lot of you there to take in knowledge from industry professionals, tour the tradeshow booths, network, and make long-lasting business and personal connections. This event is a collaborative effort between the three Canadian Chapters of NASTT, so please consider volunteering some time with the organizing committee or on site at the show. Check out the show website at *nodignorth.ca* for updates and information.

Further to No-Dig North, in-person events will be commencing again within the Chapter at the University of Alberta. These technical lunches bring together like-minded trenchless professionals for presentations on all things trenchless. The first luncheon is scheduled for May 26, 2022 with speaker details coming shortly. I encourage you to all attend if you get the chance to support both the Chapter and the industry. The trenchless community in the prairie provinces of Canada has always been strong and tight knit, and these events help solidify these unique relationships in our industry.

It is an exciting time to be a trenchless professional. Like other industries, we have adapted to current times, gathering limitations and restrictions, travel bans and everything else COVID had to throw at us. But our resolve to continue, to adapt, and to continue to advocate for our members in the trenchless industry is still strong, and perhaps even stronger. We continue to look for new opportunities to get together, showcase our talents, highlight and promote our knowledge, and share this education with our members and students just entering this exciting and ever-evolving field.

On behalf of the NASTT-NW board of directors, I wish everyone personal and professional health and success in 2022 and beyond!

Shane Cooper
Chair, NASTT-NW

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OUR CHAPTER MEMBERS & VOLUNTEERS ARE CRUCIAL TO OUR SOCIETY

The trenchless industry grows stronger every year. Even in the pandemic our membership and regional chapters moved forward to educate the public. It's amazing when you look back at what we were able to do during these challenging times. Now we are excited to start looking forward to the future! We've led the industry in safely meeting face to face. As an organization and an industry, we successfully met in Orlando last spring, in Vancouver, BC for No-Dig North this past fall, and just this past month in Minneapolis for the NASTT 2022 No-Dig Show.

We look forward to the coming months and the events we have planned to bring the underground infrastructure community together. This fall we hope you will join us in Toronto, ON for the 2022 No-Dig North conference, October 17–19. No-Dig North is hosted by the Canadian Chapters of NASTT and offers two full days of training, education, and networking. This is a must-attend event for trenchless training and networking in Canada. Visit *nodignorth.ca* for details!

NASTT's mission and vision are "to continuously improve infrastructure management through trenchless technology" and "to be the premier resource for knowledge, education, and training in trenchless technology." With education as our goal and striving to provide valuable, accessible learning tools to our community, one of the things of which we are most proud at NASTT is that even during uncertainty we have been able to grow. Recently, we welcomed our latest regional Chapter to the NASTT family and completed our representation of the entirety of North America. NASTT was so excited to announce that we now have our first chapter in Mexico!

APRIL 30-MAY 4 | PORTLAND, OR
NASTT
NO-DIG SHOW
2023

In keeping with our mission of education and training, we regularly review and update our training materials and offerings and are excited to roll out updated educational resources this year, along with more frequent opportunities for both in-person and virtual education. For the latest information on upcoming events, visit our website at *www.nastt.org/training/events*.

Be sure to mark your calendars and save the date for the NASTT 2023 No-Dig Show in Portland, OR, taking April 30 to May 4. The city of Portland is a perfect location for our industry to come together to celebrate and educate with the theme, Green Above, Green Below. It is important that our industry is a steward of our precious natural resources, and we welcome the opportunity to provide a forum to learn about the latest in innovative trenchless products and services. Learn more at *www.nastt.org/no-dig-show*.

GREEN ABOVE.
GREEN BELOW.

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

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

NO-DIG NORTH IS ANOTHER SUCCESSFUL EVENT

Welcome to the Spring/Summer issue of the **Northwest Trenchless Journal,** the official publication for members of the NASTT-NW Chapter.

In This Issue

In this issue of the magazine, we present some of the highlights from No-Dig North 2021 in BC, and we look ahead to the No-Dig North 2022 event in Toronto, ON in October.

Also in this issue, we put the spotlight on the Inglewood Sanitary Trunk microtunnelling project. This No-Dig 2021 paper begins on page 15. We also include the annual NW Chapter Buyers' Guide, beginning on page 24.

Find Us Online

Remember to join the Northwest Chapter on LinkedIn, at *www.linkedin.com/groups/4430433*.

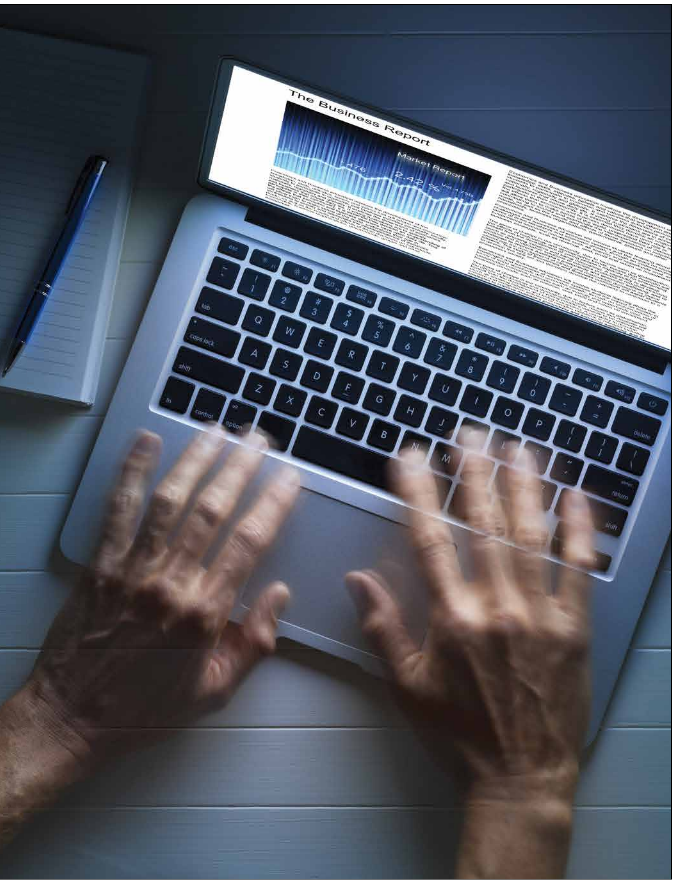
You can also find the most recent issue of the *Northwest Trenchless Journal* online at *https://nastt.org/resources/regional-chapter-magazines*.

Coming Up

The Chapter magazine is published twice a year. The next issue of the *Northwest Trenchless Journal* is scheduled for distribution in the fall of 2022.

We are looking for relevant, regional feature content to share with members. Please contact Shane Cooper at *shane.cooper@aecom.com* by August 22, 2022 for more information and to let us know if you have an article or paper you would like to contribute to the next issue of this publication.

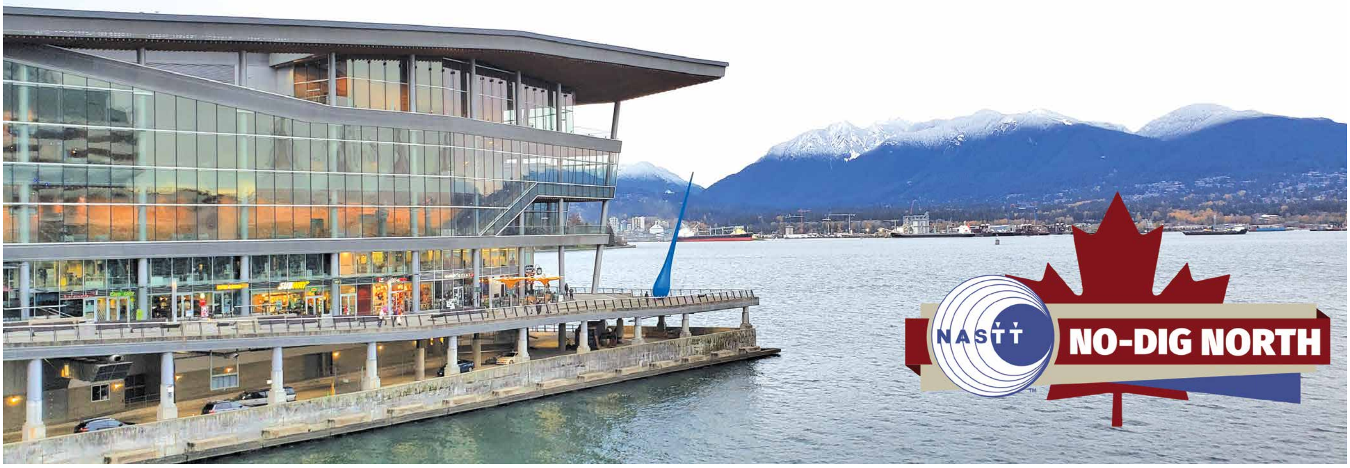
Call for Submissions



If you would like to submit your project paper or other content and photos for an upcoming issue of this Northwest Chapter magazine, please contact please contact Shane Cooper at *shane.cooper@aecom.com.*

Editorial submissions for the *Northwest Trenchless Journal* are welcome and due for our next publication by August 22, 2022.

NO-DIG NORTH 2021 RECAP



The 2021 No-Dig North show was held in Vancouver, BC with great success on November 8–10, with almost 500 attendees and 70 exhibitors. After an extended period of time apart, it was great to see folks from the industry again in person and have the opportunity to reconnect with everyone. While there were some obvious differences this year than at previous No-Dig events, the show had the same great energy that it always has. A big draw to the show is the networking, which just can't be accomplished to the same degree online, and it was wonderful to talk shop and share insights in person rather than through a screen.

Another big draw is, of course, the technical presentations and industry expert panels. This year there were more than 75 technical presentations on topics including condition assessment, pipeline and maintenance hole rehabilitation, various new construction trenchless methods including microtunnelling, horizontal directional drilling (HDD), and auger boring, as well as new and emerging trenchless technologies. There were also multiple expert panel discussions featuring leading industry experts from across North America.

The 2022 No-Dig North show will be held in Toronto October 17–19. We look forward to seeing everyone there!

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OCTOBER 17-19 | TORONTO, ON
NO-DIG NORTH 2022

OCTOBER 17-19

Beanfield Centre
Toronto, ON Canada

REGISTER TODAY

2022 Project of the Year Award Applications Open

The NASTT Canadian Chapters are accepting applications for the 2022 Project of the Year and will be presenting the following awards:

- **New Installation Trenchless Project of the Year >$5 million**
- **New Installation Trenchless Project of the Year <$5 million**
- **Rehabilitation Project of the Year >$2 million**
- **Rehabilitation Project of the Year <$2 million**

Projects submitted for consideration as project of the year must be located within Canada, utilize at least one form of trenchless technology (new installation/rehabilitation), and with the trenchless portion substantially completed between December 1, 2019 and June 30, 2022. **The application deadline is June 30, 2022.** Apply now at www.nodignorth.ca.

nodignorth.ca

For Sponsor & Exhibit info please contact Hannah Stakolich at Hstakolich@benjaminmedia.com.

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

NO-DIG SHOW

North American Society for Trenchless Technology (NASTT)
NASTT 2021 No-Dig Show
Orlando, Florida
March 28 – April 1, 2021

INGLEWOOD SANITARY TRUNK – USE OF SLURRY MICROTUNNELLING TO CONSTRUCT A LARGE DIAMETER SANITARY SEWER

Patrick Ilasewich, AECOM, Winnipeg, MB
Marvin McDonald, AECOM, Winnipeg, MB
Chris Macey, AECOM, Winnipeg, MB
Melanie Gray, City of Calgary, Calgary, AB

ABSTRACT

Located in Calgary, Alberta, The Inglewood Sanitary Trunk (IST) is a 2,286/2,500 mm (90/98") reinforced concrete sewer which spans approximately 4,000 m (13,000') from the Bow River to the Bonnybrook Wastewater Treatment Plant, the City's largest wastewater treatment plant. The IST upgrade will provide additional sanitary capacity for a total equivalent population of 1.1 million residents and support growth to the 2076 design horizon.

Construction of Phase One has been successfully completed, where closed faced slurry microtunnelling and sealed shafts were utilized to mitigate constraints and restrictions which would otherwise make the construction of a large diameter trunk sewer in this location impractical or near impossible.

Shaft construction to depths of 16m (52') consisted of seven sunk concrete caissons ranging in diameter from 8 to 11.5 m (26–38'), and one 11.5 x 8 m (38 x 26') secant pile shaft. Drive lengths through highly variable soils with high groundwater ranged from 250–860 m (820 – 2,822'). Most drives contained at least one 500 m (1,640') radius curve, some contained multiple curves, and one drive was on an entire curved alignment. The contractor mobilized three different Herrenknecht AVNs to the site. With the exception of one drive, all other drives came within project tolerances. The project contained four trenchless major railway crossings, and multiple utility crossings. In one instance a 900 mm (36") sewer was crossed with less than 150 mm (6") of clearance. In another instance an Art Gallery building was tunneled under with no damage to the structure or its contents.

PROJECT DESCRIPTION

The City of Calgary identified the need for additional sanitary sewer capacity for the existing 15th Street trunks to meet future demands from wet weather flows and residential growth. These large trunks convey sewage flows from the northern half of the city of Calgary as well as from the communities of Cochrane and Airdrie.

The original concept proposed the addition of a third trunk along 15th Street SE from the Bow River to the Bonnybrook Wastewater Treatment Plant (BBWWTP), sized to accommodate future loads through the planning horizon of 2,076. Estimated additional capacity of 7.3 cubic metres per second was required, conveyed via a 2,400 millimetre (8') diameter pipe.

It was identified early in preliminary design that the 15th Street SE corridor would be a challenging route for numerous reasons, including:

- It is already highly congested with regional utilities.
- The corridor crosses a densely developed residential area near the Bow River, which transitions to heavy industrial land use to the south.
- The route crosses Alyth Yard, likely Canadian Pacific Railways largest and busiest rail yard in Western Canada, known to have contaminated ground.
- Portions of the original 15th Street ROW have been closed with easements registered to or encroached by adjacent heavy industries.

An alternate "offload" concept was developed that intercepted two major inflows from the western parts of the City, including the Inner City Trunk (ICT) and the West Memorial (WM) trunk, which allowed the existing 15th street trunks to be used for additional flows from the northeast portions of the City. This concept allowed for development of alternate routes that would avoid this already congested and challenging right-of-way. This alternate route also allowed use of trenches construction which would limit community impacts. This alternate route shared a newly acquired right of way that was purchased from CN rail, for development of a new leg of the City's light rail transit (LRT) system called the Green Line South East LRT (GLSE). This new route would pose its own unique challenges.

TRENCHLESS DESIGN

During the design process, it became clear very on that in order to minimize community impacts, trenchless construction would be required. Depths of pipe cover ranged up to 17 m (56") the alignment crossed four major heavy railways, and crossed several major transportation routes.

The City of Calgary recently purchased lands for the GSLE LRT project, and was also eager for these lands to be utilized for the IST project as well. In order to use these lands and alignment, multiple curves were required to circumvent everything from an abandoned landfill to future LRT tracks and a tunnel.

The IST project was the largest microtunnelling project to be released in Calgary to date. A summary of shafts and drives is provided in Table 1 and Table 2.

Closed face slurry microtunnelling was selected for construction as it could

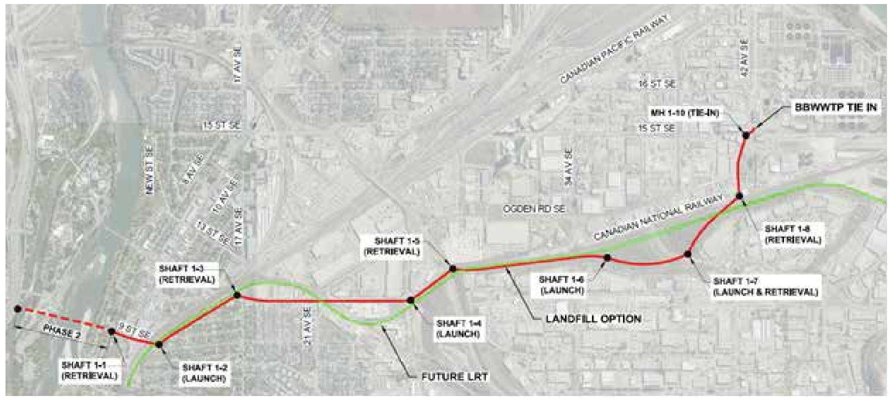

Figure 1. Selected Route Evaluated During the Design Phase.

SHAFT	DEPTH (m)	SOILS	GW m (BGS)
1	7.1	Sand/Gravel	5
2	12.0	Gravel	11
3	7.4	Gravel	5
4	9.7	Gravel/Rock	6
5	10.6	Sand/Gravel	9
6	9.9	Mixed/Rock	-
7	13.9	Sand/Rock/ (CS/SI)	8
8	5.8	Rock (CS/SI)	2
9	3.6	Gravel	-

Table 1: Shaft Summary

DRIVE	LENGTH (m)	SOILS	CURVES
1	245	Sand/Gravel	1
2	454	Gravel	1
3	856	Gravel	2
4	259	Rock/Gravel	0
5	764	Rock	2
6	406	Cohesive Till/Rock	1
7	386	Sand/Rock (CS/SI)	1
8	98	Gravels	-

Table 2: Drive Summary

mitigate these challenges. In order to reduce construction costs and ensure project success, the project was designed utilizing ASCE 36-15 – Standard Design and Construction Guidelines for Microtunnelling.[1]

GEOTECHNICAL CONDITIONS

Ground conditions along the route are highly variable and contain high ground water. Large portions of the drives are in gravels and sands. Extremely hard cobles and boulders were to be expected. The ground water table in these areas is influenced by the Bow River and pump tests indicated dewatering for shaft construction and tunnelling was not feasible in most areas. Ground water levels were frequently above the tunnel horizon. Sealed shaft construction with closed face slurry microtunnelling will allow installation of the sewer through these complex soils without dewatering. An example of the typical ground conditions is provided in Figure 2.

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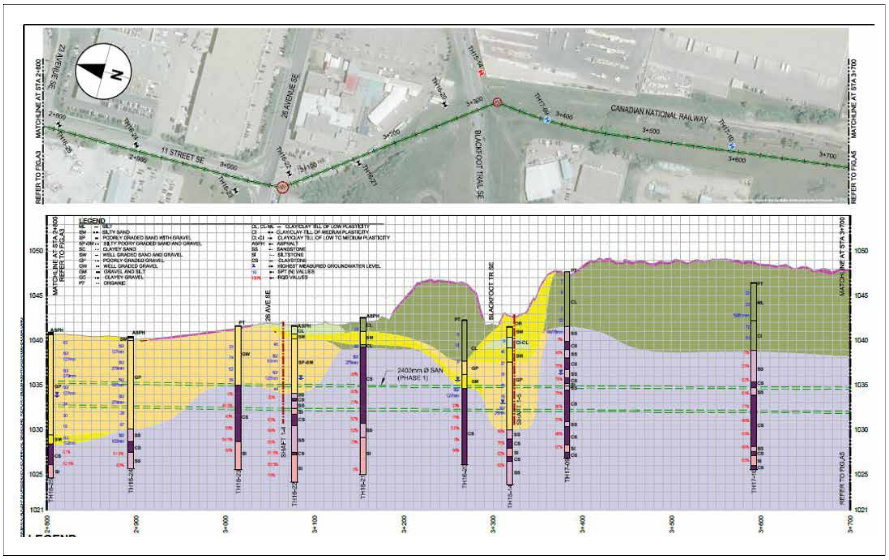

Figure 2. Typical Ground Conditions.

Figure 3. Typical Sunk Caisson Shaft Used in Construction.

PREQUALIFICATION AND TENDER STRATEGY

Due to the complexity of the project and the tight construction schedule a prequalification program was utilized. The prequalification was aimed at both the general and microtunnelling subcontractors. To work in the city of Calgary the general contractor was required to meet both City and Provincial safety requirements. Out of province contractors may have struggled with attaining the safety certification prior to construction. This left them the option to team up with a local contractor.

The prequalification program was released prior to the detailed design component of the project being completed. This provided advance notice to the microtunnelling industry of the upcoming project and ensured the contractors bidding on the project would have ample notice to have the required equipment available for construction.

The prequalification program also benefited the project by ensuring the contractors ultimately bidding on the project would have the appropriate experience for successful project delivery. As part of the prequalification evaluation, the microtunnelling contractors were required to demonstrate similar experience in the proposed pipe size, drive lengths, and curves. To qualify as a general contractor the contractor needed to demonstrate proper safety experience, bonding and management/financial of a project of similar size and scope.

A total of 12 submissions were received for the prequalification request, with five contractors qualifying as general contractor and five qualifying as microtunnelling subcontractor.

CONSTRUCTION

The Contract for Phase 1 was awarded in October 2018 to Whissell Contracting Ltd. (WCL) as general contractor who also completed the open cut construction portions of the project as well as the live sewer tie-ins. Ward & Burke Microtunneling LTD (WBMCL) were retained as the microtunnelling subcontractor. Construction of the shafts began in January 2019 and Substantial Completion was achieved in November 2020, with a total construction value of approximately CDN $70 million.

The contractor chose sunk cast-in-place concrete caissons for seven of the shafts (Figure 3), with diameters ranging from 8–11.5 m (26–38') and constructed one 11.5 x 8 m (38 x 26') secant pile shaft. Secant piles where selected in this location as the shaft was constructed around an existing 1,800 mm (71") pipe. Tremie plugs were successfully poured at shaft locations where the shaft floors were below groundwater.

All shafts were constructed during regular construction hours to meet noise bylaw requirements and to not adversely impact the public. All shafts were successfully constructed without any significant ground loss or impacts on adjacent structures, including an adjacent sound studio which was extra sensitive to noise and vibrations.

To meet the aggressive schedule, the contractor proposed a combination of 2,286/2,500 mm pipe to replace the proposed 2,400 mm pipe. This allowed the contractor to mobilize three different Herrenknecht AVN MTBMs to the site, and have enough pipe manufactured to meet the tight project schedule. A hydraulic analysis was completed to ensure project objectives were met, and the proposal was accepted. Tunnelling operations were allowed 24 hours/day seven days/week. The contractor used a mix of single and double shifts throughout the project.

The contractor used an advanced alignment control system (VMT) to successfully navigate the numerous curves. Seven of the eight MTBM drives were successfully completed within 20 mm (3/4 inch) of the specified alignment. On the one drives in question, the tunnel horizon increased to 200 mm above the intended invert, approximately 30 m outside of the retrieval shaft. Once noticed, the tunnel grade was corrected and brought into the shaft. Hydraulics were reviewed and no adverse hydraulic issues resulted.

On two separate drives the contractor chose to drive the MTBM into the shaft with either insitu material or backfilled material in place up to the level of the surrounding groundwater rather utilizing an exit seal (Figure 4). Once the TBM was pushed fully into the shaft, the annulus was grouted to form a seal at the shaft wall, The TBM was then excavated out and removed.

DESIGN CHALLENGES, INNOVATION AND LESSONS LEARNED

EPOXY COATED BELLS

It was identified in design that soils along the route were known to be potentially highly corrosive and abrasive. There was also a concern that stray current from the proposed electric GLSE LTR system could result in advanced corrosion of ferric metal elements of the pipe system. The mixed ground conditions containing boulders and cobbles with a Cerchar Abrasivity Index (CAI) of the boulders ranged from approximately 4.2 to 4.9, indicating that the boulders are extremely abrasive based on ASTM D7625-10 (AECOM 2017).[2]

The resistivity of soil and bedrock samples varied from 90 ohm-cm to 21,000 ohm-cm, indicating that the soil and bedrock units were essentially non-corrosive to extremely corrosive in certain areas. Soil and bedrock units were assumed to be extremely corrosive, and all metals in contact with the soils, bedrock and groundwater were to be designed for an extremely corrosive environment.

The typical microtunnelling pipe specified for the project utilizes a steel bell ring which forms an integral part of the joint, compressing the primary gasket. In buried applications, steel pipe systems primarily fail through pinhole corrosion, often associated with breaches in dielectric coating systems. Failure of the joint ring by corrosion could result in infiltration. To protect the bell rings from corrosion, the contract specified the joint bands be coated with a minimum 0.4 mm (16 mils) liquid or fusion bonded epoxy dielectric coating, further protected with a minimum 0.75 mm (30 mils) abrasion resistant overlay (ARO) to ensure long-term performance of the joint.

The contractor proposed to factory apply the epoxy coating of the joint rings prior to casting the pipe. Due to concerns with compatibility with the pipe forms, the contractor proposed coating the bell ring with 0.91 mm (36 mils) of high abrasion resistant epoxy. The proposal was accepted with a requirement that the first pipe of the drive would be pushed out after the drive to evaluate the effectiveness of the coating.

The pipe was pushed out after a drive of 406 m (1,332') which was entirely

Figure 4. Retrieval of the MTBM in Insitu Shaft Material.

Figure 5. Epoxy Coated Bell Ring After Drive.

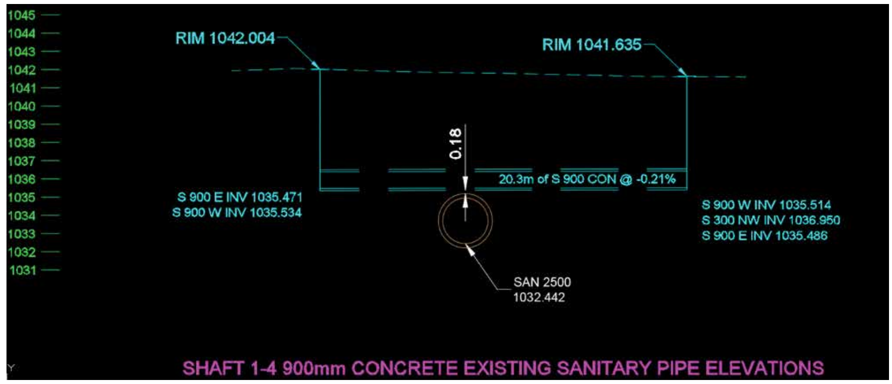

Figure 6. Minimal Clearance of Existing Pipe Crossing.

on a 500 m (1,640') radius curve. The ground conditions consisted of mixed conditions containing cohesive glacial till and bedrock. Visual inspection of the epoxy coating of the pushed recovered pipe indicated the coating performed well under the abrasive conditions experienced. However, some dis-bonding was identified, likely due to lack of adequate adhesion due to insufficient surface preparation (Figure 5).

EXISTING 900 MM SANITARY CROSSING

One of the project utility crossings involved an existing 900 mm wastewater pipe which had limited record information available. Surveys completed during preliminary design indicated there would be approximately 400 mm of clearance between the two pipes. Due to the upstream and downstream inverts of the IST being fixed, this distance could not be significantly increased. The clearance was conveyed to the contractor in the bid documents so the contractor could complete their own risk assessment and mitigation measures.

During the initial stages of construction, the contractor verified the invert from the preconstruction survey was correct; however, the pipe invert contained approximately 250 mm of solid debris. That meant the actual invert was lower, resulting in a reduction of clearance to approximately 125 mm from the tunnel overcut and the existing pipe wall based on a standard wall thickness (Figure 6). As the pipe was approximated to be constructed in the 1950s, there was additional concern that the pipe may have been cast in place with a thicker base resulting in a direct conflict with the tunnel. A subsequent CCTV inspection was arranged to confirm flow levels and indicated what appeared to be pipe joints.

A risk mitigation session was arranged with the project team to review mitigation options which included:

- Enhancing pipe support by ground improvements (jet grouting).
- Temporary pipe support by open cut excavation followed by concrete encasement around the existing pipe after the tunnel was complete.
- Installation of a CIPP liner or slipline in the existing pipe.
- Use of a temporary pumped bypass during construction to mitigate risk of a pipe breach during tunnelling.

Ultimately, the project team proceeded to install a CIPP liner into the 900 mm pipe as it was seen as the most cost-effective solution. The City had a CIPP contractor mobilized in the area already and was able

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Figure 7. Frac-out in an Adjacent Manhole.

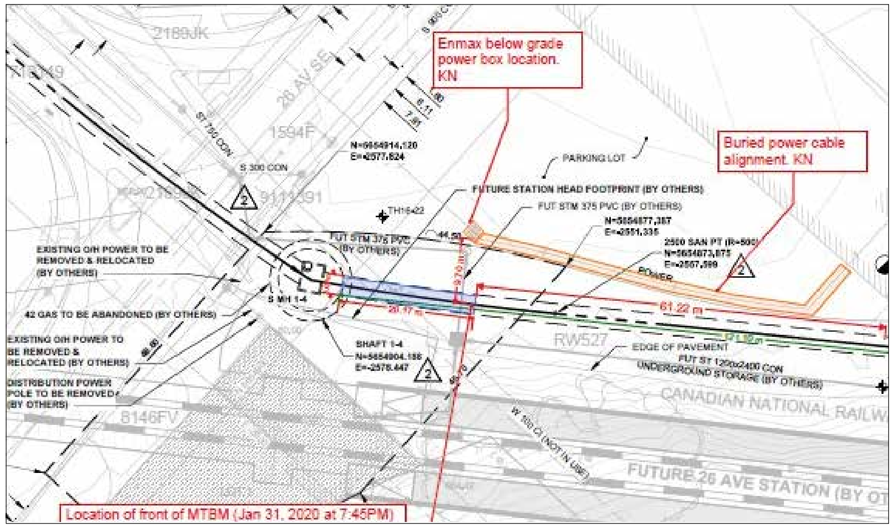

Figure 8. Location of MTBM and Unknown Flow Path.

to line this section of the existing pipe without any schedule creep.

It was recommended that the CIPP liner be installed but not bonded to the concrete pipe to allow for greater pipe movement and to prevent any joint movement in the existing pipe reflecting through the liner. As an additional safety measure the bypass used when installing the CIPP liner was left in place and utilized while the tunnel crossed the existing pipe. During construction, the pipe was monitored for movement, and follow-up CCTV inspections completed. No adverse effects on the existing pipe were noted.

Unknown to the project team was that the upstream manhole in the existing pipe, located approximately 5 m upstream of the crossing, was constructed with a cold joint between the base and wall slabs which resulted in a frac-out in the manhole (Figure 7). Tunnelling operations were suspended, the manhole was cleaned, and an additional concrete slab was poured to seal the joint. Tunnelling operations resumed with no further frac-outs at this location.

GBR FOR CONSTRUCTION CLAIMS

To share construction risk with the contractor, a GBR was produced prepared in accordance with ASCE Suggested Guidelines for Geotechnical Baseline Reports for Construction.[3] There were two instances in the project where the GBR was used to evaluate claims of unforeseen ground conditions.

The first occurrence took place shortly into the longest drive of 850 m (2,789'). It was suspected by the contractor that the MTBM struck an obstruction and began to experience rapid wear of the face tooling and hard facing. The contractor did not believe the machine would be able to safely complete the drive and selected an appropriate location 350 m (1,148') into the drive to sink a rescue shaft to inspect and repair the face of the MTBM. Face tooling was replaced as well as hard facing of the face and crusher cone.

Tunnelling continued but again began to experience rapid tooling wear after an additional 100 m (328'). To minimize risk associated with an upcoming large diameter watermain crossing, the contractor chose to sink a second rescue shaft in a convenient location approximately 662 m (2,172') into the drive. Again, face tooling was replaced as well as the hard facing of the face and crusher cone.

The contractor filed a claim for change in ground conditions. The drive was in mixed ground conditions and contained boulders and cobbles of extreme hardness and abrasiveness. Samples were collected at the site of the second intervention and analyzed for comparison to the conditions described in the GBR. It was determined that the ground conditions were consistent with those presented in the GBR. No evidence of an obstruction that resulted in the excessive wear could be found, but it was acknowledged an unknown obstruction may have been encountered. An amicable solution to claim was reached by all parties.

The second incident occurred shortly into a short drive where a frac-out occurred into a buried hydro vault housing electrical distribution cables for the area (Figure 8). The frac-out resulted in the power to an adjacent building being shut off, and a backup generator installed by the hydro utility for safety reasons. The vault was buried at surface with a granular base slab, and was located outside of the expected zone of influence of the MTBM.

The contractor filed a claim for change in ground conditions. At the time the MTBM face was in mixed ground conditions of cohesive and granular soils and face pressures were determined to be within expected limits.

Review of the claim concluded that a flow path developed likely due to unknown ground conditions and the claim was settled.

FOUNDATION TIE BACKS

During construction the project team became aware that a previously constructed building along the alignment was constructed with steel foundation tie backs to support the building shoring. Upon review of the available records, the extent of which tie backs were removed could not be confirmed (Figure 9) . This posed serious risk to the tunnelling operations as there was potential to strike tie backs in 15 locations. Adding to the risk was the drive started with crossing of Canadian Pacific Railway Mainline coming out of Alyth Yard. Any potential tie back strikes could result in the MTBM being stopped under the CPR mainline.

A risk mitigation meeting was held with the project team. The alignment was modified


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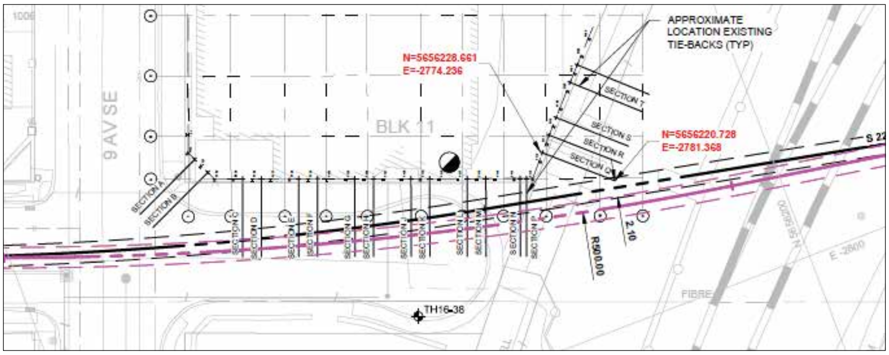

Figure 9. Potential Tie Back Locations.

Figure 10. Tie Back Recovered in Slurry Pump.

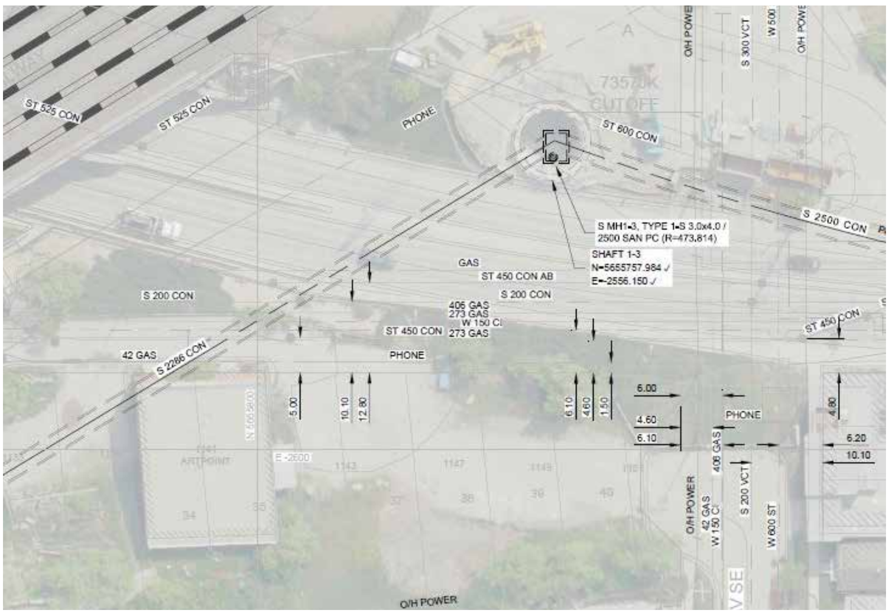

Figure 11. Alignment Under Art Point Building.

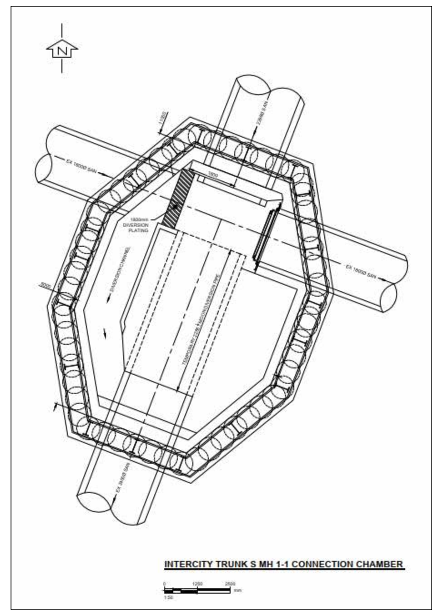

Figure 12. Upstream Shaft with Bypass.

slightly to provide more clearance to the tie backs where possible. It was decided that a narrow slot be excavated with a trench box along the alignment to dig and remove any potential tie backs located in the road right of way. No tie backs where found in the road right of way and the MTBM successfully navigated this section. The MTBM did, however, strike a tie back just outside of the area excavated with the slot but no damage to the machine resulted (Figure 10).

ART POINT BUILDING

The City of Calgary acquired lands for the future GSLE project, with the goal of maximizing land use for other City projects. The IST utilized these lands where possible and paralleled the proposed LRT alignment. Originally the Art Point building was being considered for demolition to make room for a future LRT station which would provide ample room for the IST alignment. However, during the design phase it was decided that the building was to remain. Due to conflicts with a future LRT station there was no room to move the IST alignment. After a site investigation, it was determined that the building was a slab on grade and the potential for a piled foundation was low. After a risk mitigation review it was decided to leave the alignment in its current alignment and tunnel under the north-east corner of the building (Figure 11). Vibration and settlement monitoring was specified in the contract placed at this location, and showed no adverse effects when the tunnelling was completed under the building.

UPSTREAM TIE-IN SHAFT

The upstream tie-in shaft for Phase 1 of the project connects to the existing 1,800 mm diameter ICT. The IST will also be extended in the future to the north from this tie-in location. It served as a retrieval shaft in Phase One and will be used as a retrieval shaft in the future Phase Two.

This shaft is located at the north end of the project in a dense residential neighborhood. Minimizing disruption of the community during current and future construction activities was a primary concern of the client.

Connection to the existing ICT was also a design concern. This trunk conveys approximately 1 cubic metre per second dry weather flow.

With a goal of minimizing future construction footprint, and safe connection to the existing trunk on minds, a unique shaft and chamber design was developed which included a suitable internal bypass flume to be used during connection of both Phase One and Two construction, and removable benching to facilitate removal of a TBM during future construction (Figure 12).

The shaft was designed as an 8 x 12 m oval. The contractor proposed construction of a 11.5 x 8 m (38 x 26') secant pile shaft in this extremely congested area as indicated in (Figure 13). The shaft was sized to house the permanent chamber structure, flow bypass, and retrieval operations for both phases.

During Phase One the MTBM was driven into the shaft and retrieved with the existing 1,800 mm (36") in service. This permitted both the chamber construction and retrieval operations to be completed in dry conditions. The bypass was activated along the west side of the chamber to allow the removal of the existing pipe and installation of the temporary benching and slide gate on the east (downstream) side of the 1,800 (36").

The bypass was left in operation to permit retrieval on the MTBM in dry conditions, after which it will be abandoned in place.

CONCLUSION

Completion of construction of Phase One of the IST demonstrates how the proper selection of trenchless construction technology results in a successful project. The project faced many complexities ranging from complex soils, high groundwater, and curved alignments, all of which closed face slurry microtunnelling construction was able to mitigate. The IST project pushed the acceptable limits of microtunnelling. From tunnelling under a building to long, multiple curved drives, many lessons were learned which will help guide the success of future microtunnelling projects.

"The IST project pushed the acceptable limits of microtunnelling. From tunnelling under a building to long, multiple curved drives, many lessons were learned which will help guide the success of future microtunnelling projects.

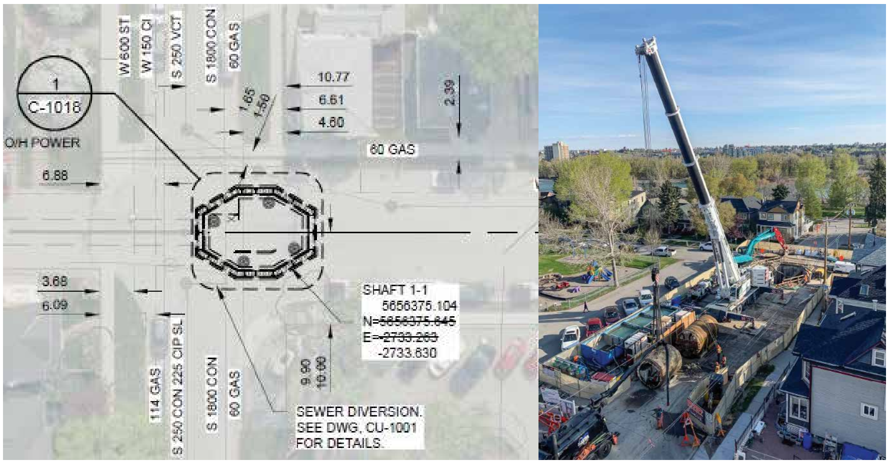

Figure 13. Upstream Shaft Layout l.

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1. American Society of Civil Engineers (ASCE) - Standard Construction Guidelines for Microtunnelling (36-15).
2. American Society for Testing and Materials (ASTM) D 7625-10 (2010) Standard Test Method for Laboratory Determination of Abrasive Rock Using the CERCHAR Method Policies and Priorities.
3. American Society of Civil Engineers ASCE (2007) Geotechnical Baseline Reports for Construction Suggested Guidelines.

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NASTT PARTNERS WITH UCA AND DOWN FOR THAT

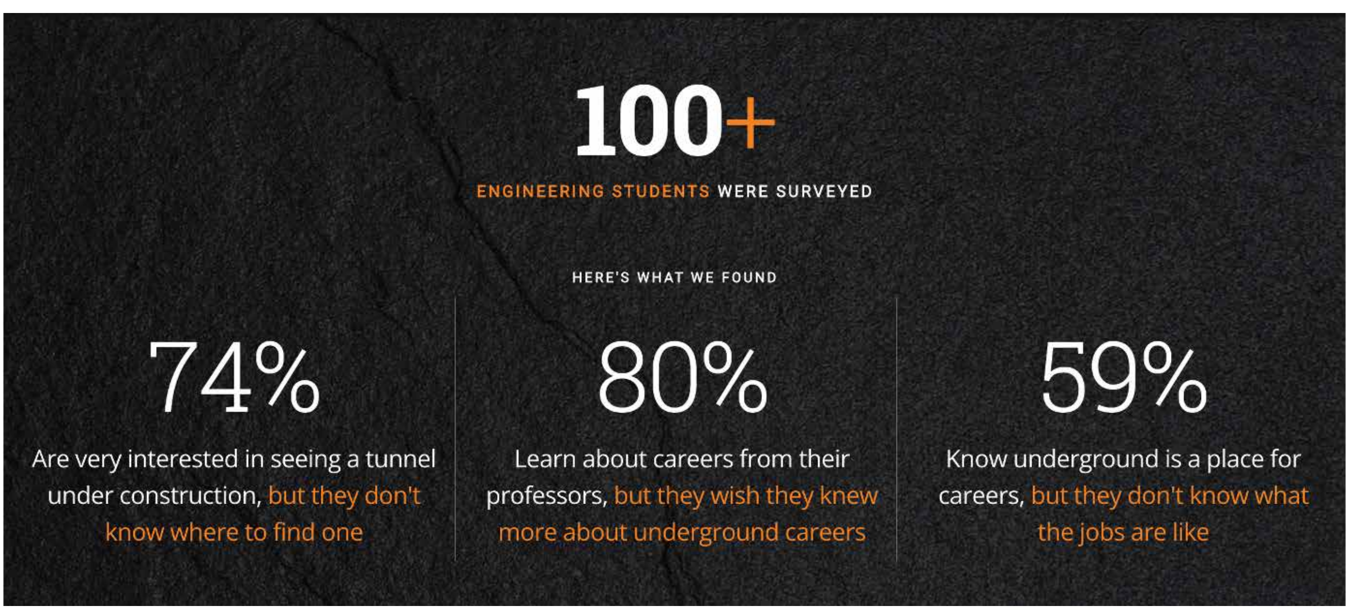
Source: *NASTT.org*

The North American Society for Trenchless Technology (NASTT) is pleased to announce it has partnered with the Underground Construction Association (UCA), a division of the Society of Mining Metallurgy and Exploration, Inc.

The objective of this initiative it to work collaboratively toward the betterment and technical innovation of the tunneling, underground and trenchless technology industries.

NASTT will be a key supporting organization of Down For That, which is the UCA outreach initiative specifically to universities, students, and university professors. Other key supporting organizations of Down For That are the ASCE Geo-Institute, Deep Foundations Institute, The Beavers, and the Moles.

NASTT will contribute to resources included on *www.undergroundcareers.org* to promote scholarships, tunnel tours, industry profiles, and all other items on the Down For That website for the benefit of members as a collective outreach initiative.



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When making purchasing decisions about products and services in the trenchless technology industry throughout Manitoba, Saskatchewan, Alberta, and beyond, please support the companies whose advertising makes the *NW Trenchless Journal* possible. You will find them quickly with our convenient, easy-to-use Buyers' Guide.

On the following pages, you will find information that will help you meet your purchasing requirements throughout the year ahead. The initial section of this Guide lists categories of products and services along with the various companies that can provide them to you. The following section provides an alphabetical listing of those companies, as well as the contact information you will need to reach them.

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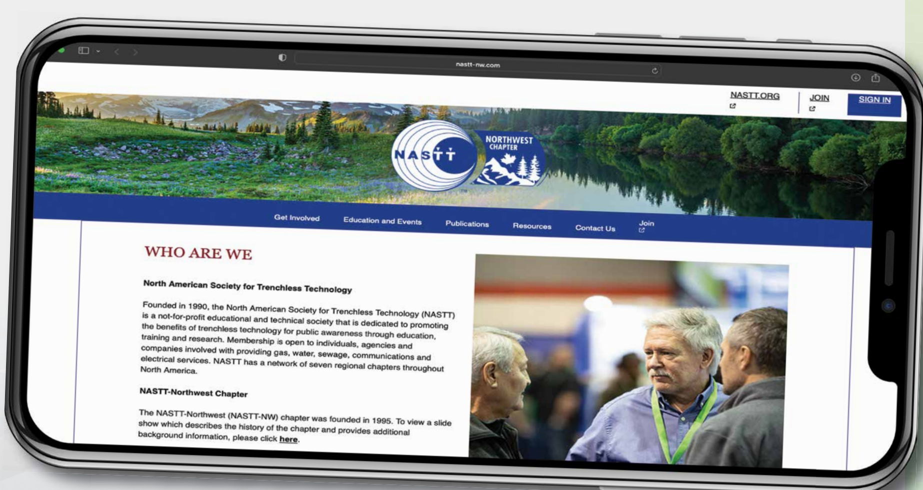

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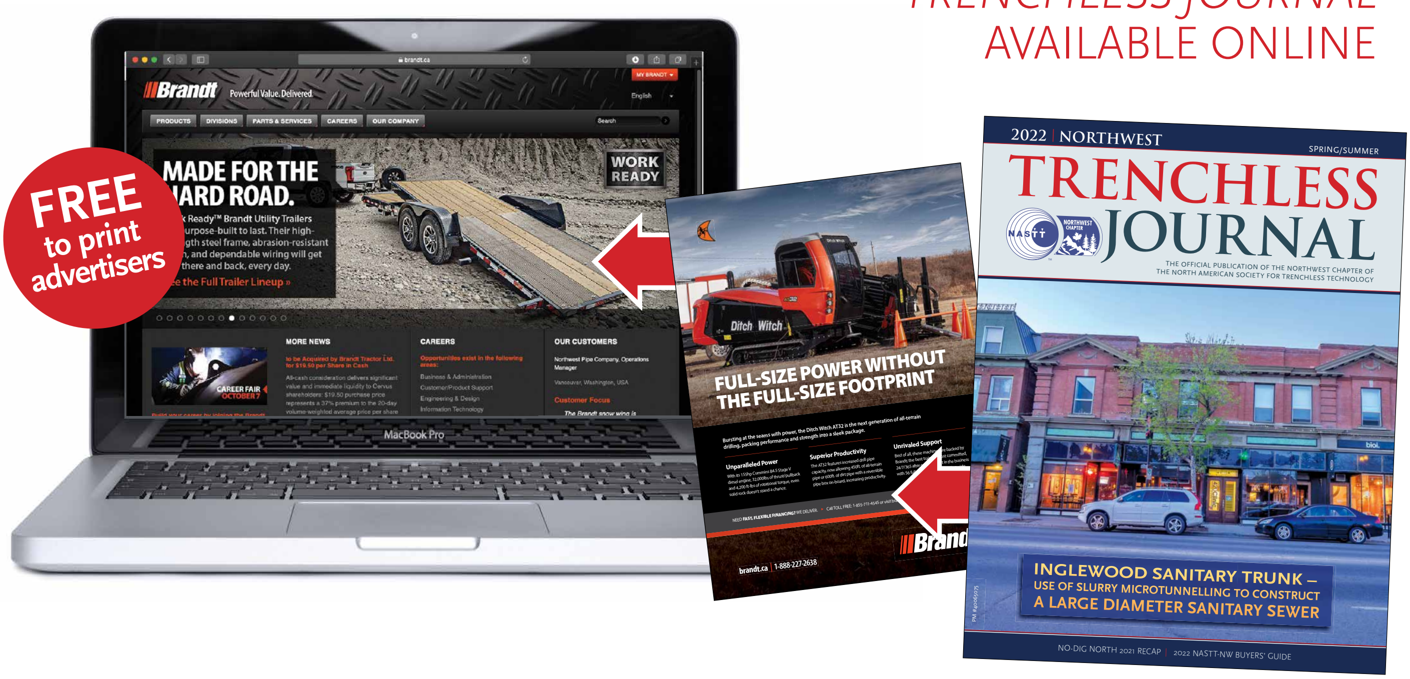

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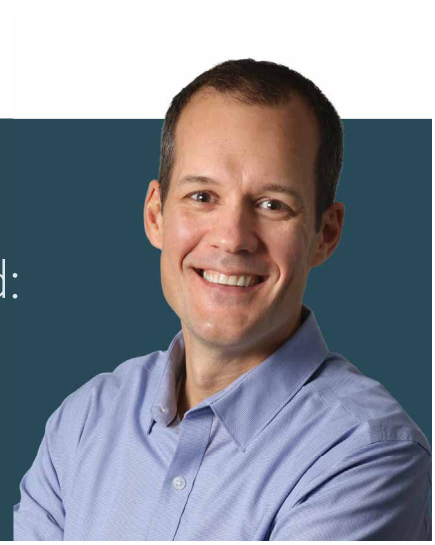


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