2019 | NORTHWEST

FALL/WINTER

TRENCHLESS JOURNAL

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

PM #40065075

IMPLEMENTATION OF AN UPGRADING APPROACH FOR THE NORTHEAST INTERCEPTOR IN WINNIPEG


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2019 | NORTHWEST

TRENCHLESS JOURNAL

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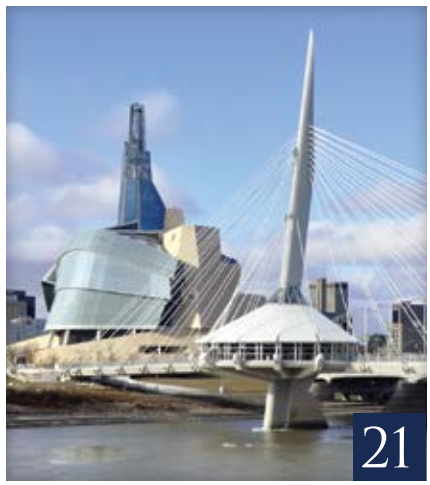
IN THIS ISSUE:



DEPARTMENTS:

ON THE COVER: Downtown view of the city of Calgary Alberta, Canada. © Brandon Smith | Dreamstime.com

NO-DIG NORTH IS JUST A FEW SLEEPS AWAY!

Trenchless professionals from all three Canadian Chapters – NASTT-BC, NASTT-NW, and NASTT-GLSLA – have been working long and hard on planning No-Dig North. No-Dig North 2019 is being held at the TELUS Conference Center in Calgary, Alberta between October 28 and 30.

As we are only a few weeks away, we can't keep our excitement contained. If you haven't heard (where have you been!), the No-Dig North show is a brand-new National Canadian Trenchless Conference that will provide a great opportunity for Owners, Consultants, Industry Experts, Suppliers, and Contractors to reach a larger Canadian audience to showcase the great things that are happening in the trenchless industry.

The response to this conference has exceeded our expectations; it will be the largest-ever Canadian trenchless tradeshow:

- Two keynotes, Mr. Frank Firsching and Dr. Kimberlie Staheli
- 72 exhibitors
- 61 papers presented over two days
- Three regional and one national Project of the Year awards
- Four pre-conference Short Courses

For more information and to register, please visit the Conference's webpage – *www.nodignorth.ca.*

> "The response to this conference has exceeded our expectations; it will be the largest-ever Canadian trenchless tradeshow."

Also new this year, we held very successful NASTT-NW mixers in both Edmonton and Calgary. The Calgary mixer was held during the Stampede and the Edmonton one was held in conjunction with the commencement of the fall semester at the University of Alberta. These mixers were a great opportunity for our members, students, and non-members to catch up with colleagues to discover what is happening in the trenchless industry. These won't be the last; look for further information via email over the coming months for future mixers.

Later this month, our Chapter will also be kicking of the Technical Lunch Programs in both Edmonton and Calgary. At these lunches, we not only highlight our great local projects but also new products, new techniques, and national projects. Watch your emails and our website, *www.nastt-nw.com,* for additional information on upcoming technical lunches. I would also like to extend an invitation to our members and remind you all that we are always looking for great topics and new presenters to become active and participate in our Chapter!

I encourage all of our members to take part and bring a friend or coworker to all of our events as they are great networking events!

We are always looking for volunteers, fresh ideas, and new perspectives! If you wish to participate as a volunteer or just provide suggestions on how to improve our Chapter, please do not hesitate to contact me directly at *gtippett@nastt-nw.com.*

Greg Tippett
Chair, NASTT – Northwest Chapter

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Erez Allouche, Tunnelling and Trenchless Technology Leader

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COMING SOON: NO-DIG NORTH

The trenchless industry continues to grow and expand in the US and Canada, and this is particularly obvious this year as a long held dream has now become reality! I am beyond excited to be able to join you at the first annual No-Dig North conference in Calgary this October. In recognition of the need for quality trenchless education in Canada, all three Canadian NASTT Chapters have joined forces for the first time to host a combined trenchless technology conference. None of this would be possible without the dedication of the volunteer members of the Northwest Chapter, the Great Lakes, St. Laurence and Atlantic Chapter, and the BC Chapter. I would like to extend a very special thank you to the 2019 No-Dig North Conference Chair, Greg Tippett. Greg has poured his heart and soul into this effort and the results are promising to knock your socks off!

> "The exhibit hall has already sold out – twice! You do not want to miss an opportunity to experience the latest and greatest in our growing industry and to network with your peers."

The inaugural No-Dig North conference will offer a variety of learning and networking opportunities for trenchless professionals as well as those new to the industry. The conference includes four NASTT Good Practices Guidelines Courses offered as pre-event options. These full-day courses include: HDD Good Practices, New Installation Methods Good Practices, Introduction to Trenchless Technology – Rehabilitation Good Practices, and CIPL Gas Good Practices. All our NASTT Good Practices Guidelines Courses are both non-commercial and peer reviewed and taught by leading industry experts. The courses include continuing education units as well as course materials to take back to the office for use on your next trenchless project.

The conference offers two full days of technical presentations and an exhibit hall bringing you industry innovations for trenchless products and services. The exhibit hall has already sold out – twice! You do not want to miss an opportunity to experience the latest and greatest in our growing industry and to network with your peers.

The No-Dig North conference has been in the works for many years and I cannot thank the regional Chapter volunteers and members enough for your dedication and passion. The Canadian Chapters certainly embrace the mission and vision of NASTT and we value you all as true Trenchless Champions.

I look forward to seeing you at the Telus Convention Centre in Calgary this October.

Michael J. Willmets
NASTT Executive Director

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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 Carlie Pittman, Magazine Committee Chair, at *pittmanc@ae.ca*.

Editorial submissions for the *Northwest Trenchless Journal* are welcome and due for our next publication by early April 2020.

FIRST ANNUAL

NO-DIG NORTH

OCTOBER 28-30, 2019

Calgary, AB, Canada

HIGHLIGHTS

The NASTT-NW Chapter is proud to be jointly presenting the No-Dig North Conference in partnership with the Canadian Chapters of NASTT. The Conference will take place in Calgary, Alberta on October 28 to 30, 2019 at the TELUS Conference Centre. Pre-event Good Practices Courses will be available on Monday, October 28, 2019. The show will consist of two days with three tracks of technical paper presentations and industry exhibits in the trenchless technology field on October 29 and October 30.

For more information on registration, the program, and our exhibitors, please visit the Conference's webpage: *www.nodignorth.ca.*

PLANNING COMMITTEE

- Greg Tippett, Stantec Consulting, Conference Planning Committee Chair
- Remco Kleinlugtenbelt, Thurber Engineering, Technical Committee Chair
- Brett Knievel, Insituform, NASTT-NW
- Dave Krywiak, Stantec Consulting, NASTT-NW
- Carlie Pittman, Associated Engineering, NASTT-NW
- Kevin Bainbridge, Robinson Consultants, NASTT-GLSLA
- Gerald Bauer, Stantec Consulting, NASTT-GLSLA
- David Crowder, RVA, NASTT-GLSLA
- Julia Noble, PipeFlo Contracting Corp., NASTT-GLSLA
- Ophir Wainer, T2, NASTT-BC
- Steaphan MacAulay, Global Raymac, NASTT-BC
- Brittany Cline, BMI
- Heather Centorbi, BMI

Thank you to the planning committee for all their hard work and time in putting this event together!

CONFERENCE VENUE

Telus Convention Centre, 120 Ninth Avenue SE, Calgary, AB T2G 0P3

HOTEL

A courtesy block has been reserved at the Hyatt Regency Calgary for $235.00 CAD.
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PRE-EVENT GOOD PRACTICES COURSES

Monday, October 28th 8:00 AM – 4:30 PM

NASTT'S HDD GOOD PRACTICES COURSE

NASTT's HDD Good Practices Course provides an in-depth overview of Horizontal Directional Drilling (HDD) and covers six topics: operation and application; equipment and materials; planning, including surface and geological investigations, utility surveys, bore planning, and regulations and permitting; jobsite safety; risk reduction, trouble shooting and mitigation; and design.

Dr. Samuel T. Ariaratnam, Professor and Construction Engineering Program Chair, Ira A. Fulton Schools of Engineering at Arizona State University
Dr. Jason Lueke, National Practice Leader for Trenchless Technologies, Associated Engineering

NASTT'S NEW INSTALLATION METHODS GOOD PRACTICES COURSE

NASTT's New Installation Methods Good Practices Course cover the following topics: 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 and 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. This course will review auger boring, pipe ramming, pipe jacking, and the pilot tube method.

Don Del Nero, Tunnel Practice Leader, Stantec
Dr. Kimberlie Staheli, President and Founder, Staheli Trenchless Consultants

NASTT'S INTRODUCTION TO TRENCHLESS TECHNOLOGY – REHABILITATION GOOD PRACTICES COURSE

This introductory short course is ideally suited for both newcomers to the industry and for anyone who is interested in seeking a refresher course on trenchless technology methods. The rehabilitation section provides an overview of the methods and techniques available to public works and utilities to inspect repair and rehabilitate water and wastewater systems, including watermains, sewers, laterals, and maintenance holes (MH) with minimal excavation.

Kevin Bainbridge, Rehabilitation Technical Lead, Robinson Consultants Inc.
Jennifer Glynn, P.E., Senior Project Manager, Woodard & Curran

NASTT'S CIPL GOOD PRACTICES COURSE

NASTT's CIPL Good Practices Course provides an in-depth overview of this valuable trenchless application. The following topics will be discussed: design & construction; design considerations for natural gas pipelines; CIPL application range; key notes for a successful project; CIPL testing; and inspection.

George Ragula, Distribution Technology Manager, PSEG

NO-DIG NORTH

OCTOBER 28-30, 2019

Calgary, AB, Canada

OPENING RECEPTION

ALL ATTENDEES

MONDAY, OCT 28.
5:30 P.M. – 7:30 P.M.

PRE-EVENT GOOD PRACTICES COURSES

OCT 28 | 8:00 A.M. – 4:30 P.M.

NASTT's HDD Good Practices Course
Dr. Samuel T. Ariaratnam, Professor and Construction Engineering Program Chair, Ira A. Fulton Schools of Engineering at Arizona State University

Dr. Jason Lueke, National Practice Leader for Trenchless Technologies, Associated Engineering

NASTT's New Installation Methods Good Practices Course
Don Del Nero, Tunnel Practice Leader, Stantec

Dr. Kimberlie Staheli, President and Founder, Staheli Trenchless Consultants

NASTT's Introduction to Trenchless Technology – Rehabilitation Good Practices Course
Kevin Bainbridge, Rehabilitation Technical Lead, Robinson Consultants Inc.

Jennifer Glynn, P.E., Senior Project Manager, Woodard & Curran

NASTT's CIPL Good Practices Course
George Ragula, Distribution Technology Manager, PSEG

TUESDAY
OCT 29

FROM	TO	TRACK 1 AM Pipe Ramming/Auger/Case Boring and More	TRACK 2 AM Lining/Sliplining/Coating	TRACK 3 AM Microtunneling/Pipe Jacking
7:30 AM	9:15 AM	**Kick-off Breakfast** Welcome Address, Keynote, and Awarding all Projects of the Year		
9:25 AM	9:50 AM	Horizontal Drain Installation Under a Building Michelle Macauley, Macauley Trenchless	Rehabilitation of Large Non-Circular Combined Sewers Using Reinforced CIPP Adam Braun, AECOM	Dixie Road & Queen Elizabeth Highway Crossing Sanitary Sewer Chris Sivesind, Akkerman
9:50 AM	10:15 AM	Trenchless CP/CN Crossings - Relocation Enmax Utilities for Green Line LRT Remco Kleinlugtenbelt, Thurber Engineering	Addressing The Shortcomings of a Sampling Strategy in CIPP Quality Assurance Programs Tony Araujo, Paragon Systems Testing	East Brampton Trunk Sewer Twinning Cian McDermott, Associated Engineering
10:15 AM	11:00 AM	**Coffee Break**		
11:00 AM	11:25 AM	BC Chapter Project of the Year	Groat Road Storm Trunk Sewer Rehabilitation Phase 2 Dave Krywiak, Stantec Consulting	Pressure Transfer Between Reinforced Concrete Jacking Pipe in Microtunneling Cyrill Althuser, Jackcontrol
11:25 AM	11:50 AM	GLSLA Chapter Project of the Year	Experimental Investigation of a Steel Ellipse Rehabilitated With Reinforced and Non-Reinforced CIPP Robert Cichocki, Queens University	Long Distance Microtunneling With Direct Pipe® and E-Powerpipe® Dr. Gerhard Lang, Herrenknecht AG
11:50 AM	12:15 PM	NW Chapter Project of the Year	Highland Creek Sanitary Trunk Sewer Rehabilitation Dina Kuvandykova, City of Toronto	A Challenge Packed Drive - Microtunneling Crossing of the Don River Erez Allouche, Stantec
		TRACK 1 PM Pipe Ramming/Auger/Case Boring and More	**TRACK 2 PM** Lining/Sliplining/Coating	**TRACK 3 PM** Microtunneling/Pipe Jacking
12:15 PM	1:45 PM	**Lunch (Inside Exhibit Hall)**		
1:45 PM	2:10 PM	Ryan Creek Mitigation Project Kate Wallin, Bennett Trenchless Engineering	A Mechanical Fitting Eliminates the Requirement for Adhesion in CIPP Internal Service Reinstatement George Bontus, Insituform Technologies Limited	Feedermain Relocation by Microtunnelling Downstream of the Glenmore Dam and Reservoir Gabriel Jean, Associated Engineering
2:10 PM	2:35 PM	Tunnelling-Induced Deformations and Risk of Damage to Adjacent Structures Heinrich Heinz, Thurber Engineering Ltd	NATS Trunk Sewer Rehabilitation Kevin Bainbridge, Robinson Consultants	Construction Impact Assessment Associated with a New Subway Station Above a Major Trunk Sewer Hiva Mahdavi, Aldea Engineering Services
2:35 PM	3:00 PM	Performance of Water Pipe Joints Subjected to Differential Ground Motion Anderson de Oliveira, Queen's University	Halifax Water Northwest Arm Trunk Sewer Rehabilitation Ken Foster, Insituform Technologies Limited	Eastern Service Area Secondary Connection Project Matthew Wallin, Bennett Trenchless Engineers
3:00 PM	3:45 PM	**Coffee Break**		
3:45 PM	4:10 PM	Injection Grouting in Municipal Sewers With Remotely Operated Equipment Marc Anctil, Logiball Inc.	13th Avenue Watermain Lining Jeremy Charlesworth, City of Lethbridge	Valley Crossing Project Maureen Carlin, Laney Directional Drilling
4:10 PM	4:35 PM	SERTS North Rehabilitation Trevor Moningka, Stantec Consulting	North Mimico STS Rehabilitation Marya Jetten, Jacobs	Inglewood Sanitary Trunk Patrick Ilasewich, AECOM
4:35 PM	5:00 PM	Solids and Liquids Separation, Benefiting the Environment - SDTT Microtunnel Zachary Maassen, BOS Solutions	PVC Fold and Form Installations Tim Johnston, SALOC	North Interceptor Sanitary Trunk - Phase 3, Project 9 Paul Dedeluk, Associated Engineering

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REGISTRATION
IS NOW OPEN

Register now to attend the 2019 No-Dig North show at the Telus Convention Centre in Calgary, Alberta, Canada.

The show will consist of:

- Pre-event Good Practices Courses (Monday, Oct. 28, 2019)
- Two days of technical paper presentations
- Industry exhibits
- Networking opportunities
- And more!

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WEDNESDAY
OCT 30

FROM	TO	TRACK 1 AM HDD	TRACK 2 AM Inspection/Maintenance Technologies	TRACK 3 AM Pipe Bursting/Splitting Eating/Extraction
7:30 AM	8:30 AM	**Registration / Continental Breakfast**		
8:30 AM	8:55 AM	Managing the Rising Costs of Fluid Disposal Adam Bates, Vermeer Corporation	Colsman Tunnel Csaba Ekes, SewerVUE Technology	Overview of Lateral and Main/Lateral Connection Lining and Sealing Technologies Carl Marc-Aurele, NASSCO Lateral Committee
8:55 AM	9:20 AM	Undervalued Information in Underground Construction Alireza Bayat, University of Alberta	Storm Sewer Pipe Failure Gerald Bauer, Stantec Consulting	City of Redding Enterprise Sewer Pipe Bursting Edward Alan Ambler, AM Trenchless
9:20 AM	9:45 AM	Major Mackenzie Drive Watermain Bob Chisholm, Chisholm, Fleming and Associates	Local and Trunk Sewer Asset Condition Assessment Program Ghassan Saket, Andrews Engineer	Enbridge Gas/Bell Canada Project Andy Braithwaite, Hammerhead Trenchless
9:45 AM	10:30 AM	**Coffee Break**		
10:30 AM	11:10 AM	**Canadian Project of the Year**		
11:10 AM	11:35 AM	West Inter Lake District Regional Water Services Commission Phase 2 Breagh Peel, Stantec Consulting	Primary Trunk Condition Assessment Gordon Henrich, Pipeline Integrity Technology Associates	The Risks and Realities of HDD Construction -- Erez Allouche, Stantec Consulting
11:35 AM	12:00 PM	What is HD Bore (HDB)? James Murphy, UniversalPegasus International	Advanced Condition Assessment Strategy for Critical Mains: City of Calgary Case Study Justin Hebner, Pure Technologies, a Xylem brand	Spline Lock PVC Pipe by HDD and in a Casing Pipe Preston Creelman, NAPCO Royal Pipe & Fittings
FROM	**TO**	**TRACK 1 PM** HDD	**TRACK 2 PM** Inspection/Maintenance Technologies	**TRACK 3 PM** Lining/Sliplining/Coating
12:00 PM	1:30 PM	**Lunch (Inside Exhibit Hall)**		
1:30 PM	1:55 PM	Detailed 3D Modelling of Pullback Compared to Actual Samuel Wilson, CCI	UE on LRT Ophir Wainer, T2 Utility Engineers	Pipe Ramming Starts the Maxi Rig on the Right Foot Alan Goodman, Hammherhead Trenchless
1:55 PM	2:20 PM	Four Trenchless Water Main Installations Under an Active Railroad in Southeast Florida Janine Alexander, Tetra Tech	Sewer Defect Detection and Classification Using Deep Convolutional Neural Network Saeed Moradi, Concordia University	King City Siphon - Design and Construction of a Verticle Curve Microtunnel Brenden Tippets, Michels Tunneling
2:20 PM	2:45 PM	Reducing the Risk of Cross Bores Lee Schroeder, Vermeer	Sylvan Lake Regional Wastewater Transmission Line Samuel Fritz, Stantec Consulting	
2:45 PM	3:30 PM	**Coffee Break**		
3:30 PM	3:55 PM	Sensitivity of the Cavity Expansion Model to Variations in Input Parameters for Specific Soil Types Mary Neher, Bennett Trenchless Engineers	Trenchless Integrity Pipeline System Samuel Wilson, CCI	
3:55 PM	4:20 PM	Kettle River Horizontal Directional Drill Crossing: Design Approach to Reassess HDD After an Open-C Norman Joyal, McMillen Jacobs Associates	Norlite North Saskatchewan River Crossing Scott Medynski, Enbridge	
4:20 PM	4:45 PM	Alberta Products Pipeline Replacement Robin Clysdale, Stantec Consulting	SewerVUE Technology Csaba Ekes, SewerVUE Technology	

QUESTIONS? PLEASE CONTACT:

Greg Tippett, Chair, NASTT-NW
Email: gtippett@nastt-nw.com

Remco Kleinlugtenbelt, No-Dig North 2019 Program Chair
Email: rkleinlugtenbelt@thurber.ca

EXHIBITOR OR SPONSORSHIP QUESTIONS? PLEASE CONTACT:

Brittany Cline, Events Manager
Email: bcline@benjaminmedia.com
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NO-DIG NORTH

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Dave Krywiak | Principal, Stantec

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RATIONALIZATION & IMPLEMENTATION of an Upgrading Approach for the Northeast Interceptor in Winnipeg, MB

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ABSTRACT

The North End Water Pollution Control Centre (NEWPCC) handles more than 65% of the daily wastewater load for a city of 780,000. The Northeast (NE) Interceptor is one of three key interceptors that service the NEWPCC and has a critical river crossing immediately upstream of the plant.

The NE Interceptor services approximately 2,300 ha (5,685 acres) of land in the northeast quadrant of Winnipeg, and crosses the Red River in a multiple-barrel siphon configuration as its final leg prior to discharging into the Main Interceptor and NEWPCC. The original crossing is currently at capacity during wet weather flow events and has limited redundancy to facilitate inspection and future rehabilitation works. The interceptor river crossing is in need of additional capacity to permit development and reduce basement flooding risk in the upstream catchment.

This paper reviews the predesign, design, and procurement process to rationalize upgrading of this complex crossing. Horizontal Directional Drilling (HDD), Direct Pipe, and Microtunnelling (MTBM) technologies were reviewed in considerable detail to balance operational hydraulic considerations, monitoring requirements to meet regulatory compliance, and wide variances in construction uncertainty. Expected outcome analysis was used to assess anticipated construction phase variances and operational and environmental monitoring requirements had a very significant impact on the manner in which design for each alternative needed to evolve to be considered truly equal alternatives in a life cycle context. The project was eventually bid using MTBM technology in order to balance construction risk while achieving the design objectives of the project.

INTRODUCTION

The Northeast Interceptor and Red River siphon crossing were constructed in 1971 to service the growing northeast quadrant of the City of Winnipeg and convey flows to the City's North End Water Pollution Control Centre (NEWPCC). Flows from the 2,300 ha separated sewer district are conveyed by gravity through an interceptor sewer constructed via both hand mining and open cut methods using both precast and monolithic concrete pipe materials in diameters as large as 1800 mm. Figure 1 depicts the catchment area for the interceptor.

The Red River siphon crossing is located less than 0.5 km from where it discharges to the City's Main Interceptor at the

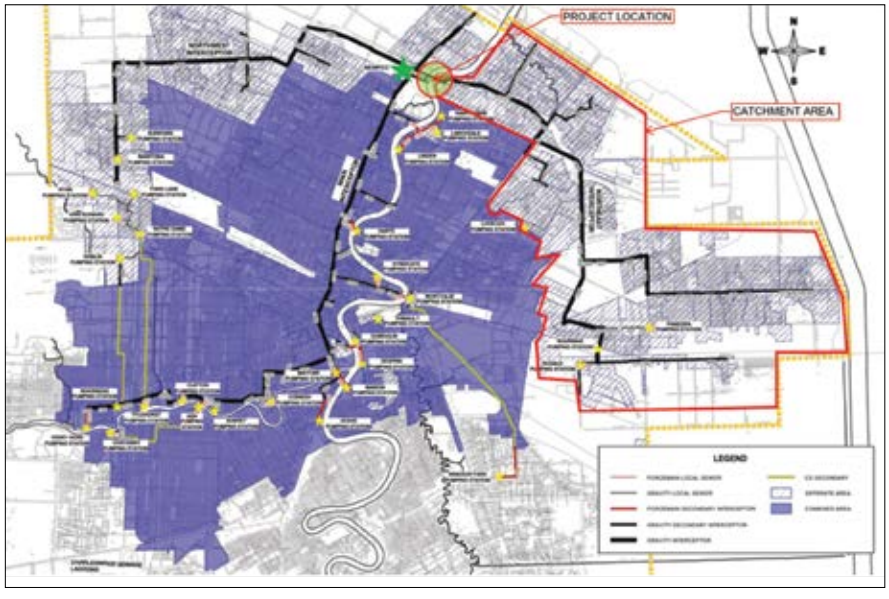

Figure 1. Northeast Interceptor Catchment Area

NEWPCC site. Immediately upstream and downstream of the siphon crossing, the interceptor consists of hand-mined, 1,800 mm monolithic concrete pipe. The existing 500 and 800 mm steel siphons were installed on the river bottom by weighing the steel pipes with concrete blocks and sinking them, likely in winter from the river ice. At the banks, the siphon pipes were installed via open cut methods and connected to the interceptor via large siphon chambers, complete with an upstream overflow to the river. Figure 2 highlights the cross section of the existing interceptor.

Since its construction, the northeast quadrant of the City has seen increased growth and currently the existing siphon crossing is at capacity during large wet weather events. Further, with the existing siphons nearing the end of their original design life, additional redundancy under dry weather conditions was required to facilitate rehabilitation. The original design and construction of the crossing included a third 900 mm sluice gate and wall penetration pipe to allow for future upgrading of the siphon via the installation of a third pipeline across the river. However, changes to environmental regulations and advancements in trenchless technologies made the completion of instream pipe installations impractical, and thus alternative means of augmenting capacity of this critical crossing were required.

FUNCTIONAL DESIGN

Functional design for the crossing was undertaken by the City of Winnipeg and Associated Engineering. Associated Engineering was engaged in 2015 to complete an options study analyzing methods to increase the capacity of the siphon crossing. Due to the constraints on augmenting capacity in accordance with the original design, the study considered five options that considered site conditions and adjacent infrastructure. The options considered were:

- Single open cut crossing following the original design concept
- Horizontal Directional Drilling (HDD) crossing (single and multiple pipes)
- Microtunnelling (MTBM) crossing (single and multiple pipes)
- Large diameter utility tunnel
- New pump station and force main on the adjacent vehicular bridge

The evaluation process included high-level hydraulics and reviews of constructability, environmental impact/regulations, maintenance, operability, security, and social impact. Utilizing stakeholder workshops and an Analytical Hierarchy process, the final recommendation was to move forward with the installation of a single 600 mm HDD siphon to augment the existing crossing.

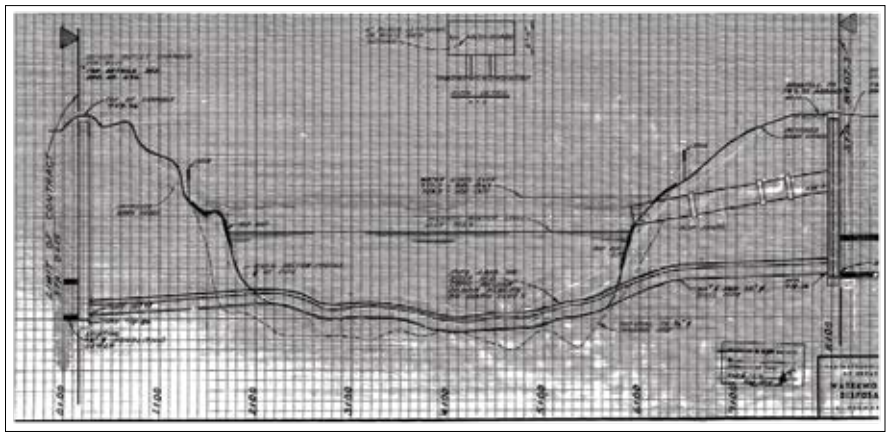

Figure 2. Existing Northeast Interceptor River Crossing

PRELIMINARY HYDRAULICS

Following completion of the functional design process, AECOM and Associated Engineering (HDD sub-consultant) were engaged by the City of Winnipeg in 2016 to undertake preliminary design, detailed design, and contract administration of a new 600 mm crossing at the site of the existing NE Interceptor Red River siphon crossing. Reviewing system hydraulics and sizing of the new siphon was a significant component to the preliminary design process and ultimately played a large role in selecting the appropriate installation technology.

The City's NEWPCC collection system utilizes a series of pump stations, force mains, and large diameter interceptor sewers to collect flows from the large number of combined sewer districts that it services, many of which predate construction of the NEWPCC in the 1930s. Configuration and operation of the NEWPCC pump station relies on the Main interceptor, Northwest Interceptor, and NE Interceptor for storage and buffering. Due to the proximity of the NE Interceptor Red River crossing to the NEWPCC, downstream water elevations are greatly affected by wet weather flows from throughout the collection system and by the NEWPCC pump station operations.

Hydraulics for the Red River crossing and the rest of the collection system were assessed utilizing InfoWorks CS software. Considerations for the hydraulic modeling and design included:

- Implementation of the City's Combined Sewer Overflow (CSO) master plan (currently in development)
- Reduction of the upstream hydraulic grade line for the 2037 design horizon under five year design rainfall event
- Review of 10 year design rainfall event and the 2067 design horizon
- Proposed works were not to create an increased risk of basement flooding or CSOs in both the near term and long term
- Ensure sufficient flushing velocities for both dry weather and wet weather events

After extensive hydraulic modeling, AECOM found a larger diameter siphon was required to meet the design objectives. This was a result of implementation of the new third siphon itself, which conveyed more water through the river crossing, and resulted in increased downstream water levels and less driving head across the siphon. Eventually, AECOM and the City settled on proceeding with a 900 mm siphon, consistent with the original design for the river crossing. The increase in siphon size resulted in a need to again review alternative trenchless technologies including: MTBM, HDD, and one that had not previously been considered, Direct Pipe.

SITE CONSTRAINTS

The area where the existing interceptor and river crossing are located has seen considerable development since its construction in the early 1970s, including a four-lane arterial road (Chief Peguis Trail) immediately north of the site and a large apartment complex immediately south of the crossing on the upstream (east) side of crossing, as shown in Figure 3. The apartment complex, which formerly permitted City access to the existing upstream siphon chamber through an adjacent parking lot, commenced an expansion project in 2016 which eliminated both the City's access to the chamber and a majority of available

Figure 3. East Side Laydown Area

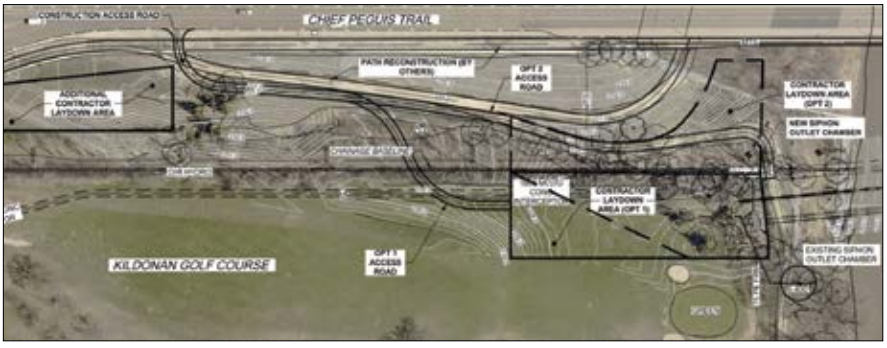

Figure 4. West Side Laydown Area

laydown area on the east side of the crossing. The east site is shown in Figure 3. The west side of the crossing is located within the City-owned Kildonan Park Golf Course, as shown in Figure 4.

In addition to the limited working space, at the time the project was going for tender the City of Winnipeg was undertaking an extension of their multiuse path network along the Chief Peguis Trail right of way within the project area.

As a result of the limited space, the need to manage two concurrent construction projects, and meet stakeholder requirements (City of Winnipeg Golf Services), options were developed for the following criteria:

- Shaft locations
- Laydown areas
- Access roads

Options were developed based on consideration of short term impact on adjacent land users, constructability, the adjacent multiuse path construction, and long-term accessibility for City crews. While the compact site was ideally suited for a MTBM crossing, which was ultimately chosen, working solutions for all trenchless technologies in consideration were developed.

GEOTECHNICAL CONSIDERATIONS

A significant amount of geotechnical information was available at the site due to the adjacent Kildonan Settlers Bridge (Chief Peguis Trail), and a 600 mm HDD feeder main crossing which had recently been completed north of the Kildonan Settlers Bridge. To supplement the existing information, three new bore holes were completed in 2016, including one within the river. The new boreholes were advanced into the bedrock to obtain rock quality information along the crossing alignment. Site conditions were found to consist of limestone bedrock (aquifer), overlain by clay/silt till, lacustrine clays, and alluvial deposits.

In addition to assisting with bore path design, the geotechnical information was utilized to model river bank stability. Assessment of river bank stability is critical for any river crossing to ensure that new infrastructure (chambers and piping) is placed outside of high risk failure zones. While the modeling found that portions of the existing crossing had a factor of safety against failure lower than what is recommended by current design practice, the placement of new chambers immediately behind the existing chambers (away from the river) in conjunction with an HDD, Direct Pipe, or MTBM tunnel alignment met the requirements for a minimum factor of safety of 1.5.

A hydrogeological investigation was undertaken during the preliminary design phase due to the presence of an underlying pressurized limestone aquifer. Limestone conditions and production rates of the limestone aquifer in the Winnipeg area can vary considerably, and the presence of nearby groundwater users necessitated an investigation to quantify the effects of dewatering, and develop contractual controls for working within the aquifer if necessary.

Friesen Drillers was engaged to undertake the study. The contractor installed two test wells at each shaft location to facilitate pump tests. In addition to facilitating the pump test, the wells were installed and positioned in such a way that would permit their use for dewatering if permitted. The hydrogeological study found that:

- Drawdown of the aquifer to permit construction of deep MTBM shafts would result in a large drawdown cone affecting numerous groundwater users
- Proximity to the Red River would likely result in a cross connection to the river, which could dramatically increase pumping rates and potentially contaminate the aquifer

As a result of the findings, the construction contract was structured to prevent drawdown of the limestone aquifer by placing limits on groundwater dewatering and making the construction of sealed construction shafts a requirement.

REGULATORY COMPLIANCE

As the Red River is considered a navigable water body, the installation of a new river crossing is subject to Transport Canada regulations in addition to requirements set out by the Department of Fisheries and Oceans Canada (DFO). As discussed in preceding sections, regulatory changes and advances in trenchless technologies has made open cut crossings a thing of the past. As the intended means of completing this crossing was through the use of a trenchless technology, regulatory submissions with respect to the crossing were limited to the risks posed to the water body itself and largely related to the risk of hydrofracture for a HDD crossing.

SELECTION OF TRENCHLESS TECHNOLOGIES

The following three trenchless technologies were reviewed as part of the design process:

- Microtunnelling (MTBM)
- Horizontal Direction Drilling (HDD)
- Direct Pipe

MICROTUNNELLING:

Microtunnelling is a steerable pipe jacking process that provides continuous support

to the excavation face and tunnel bore. Significant technical advances and increases in the utilization of microtunnelling have occurred in North America in the past decade permitting the underground installation of small to large diameter pipes in virtually all ground conditions with minimal surface disturbance. Generally, microtunnelling refers to the process of progressing a MTBM through the soil (or rock) by advancing a pipe string from a launch shaft.

Microtunnelling was considered to be a good fit for the site conditions, which required a compact construction footprint, low noise, and tunnelling through bedrock. Further, there was no issue with increases in the sewer diameter, as the need for tunnel face/MTBM access would typically dictate the installation of a 1,200 mm minimum internal diameter tunnel, regardless of the required siphon size. The biggest challenge, however, was constructing nearly 25 m deep shafts to facilitate the tunnelling process.

Pipe materials considered for use with a MTBM installation included Reinforced Concrete Pipe (RCP), steel and Glass Fibre Reinforced Polymer (GFRP) pipe. Requirements for each material were developed and included in the construction contract, allowing contractor to work with familiar materials while maintaining the long-term design intent for the crossing.

HORIZONTAL DIRECTIONAL DRILLING: Horizontal Directional Drilling (HDD) utilizes horizontal drilling equipment to bore a path from grade beneath the river and back up to grade on the other side. Once a pilot hole is complete, the process is then repeated with sequentially larger boring heads until the required size is achieved. Once the bored hole is large enough, the pipe string is pulled into place. Figure 5 depicts the proposed HDD profile for this project. This is an advantageous means of installing river crossings as it does not require the construction of shafts for installation of the pipe itself.

While HDD was originally selected as the preferred trenchless technology for installation of the siphon, the increase in pipe diameter significantly increased installation risks with the need for a larger bore diameter. Notwithstanding the increase in construction risk, the feasibility of HDD was evaluated considering both the use of steel and HDPE pipe materials. For an HDPE crossing, the applied external and construction loads dictated the use of a 1.200 mm DR 9 HDPE pipe. At the time of design, pipe of this diameter and thickness was not available from producers in North America.

The geometry of the crossing was dictated by a number of factors including pipe material, allowable pipe/drill rod bending radii, native soils, hydrofracture risk, and the crossing geometry itself. Evaluating the use of steel pipe had to take into account the allowable bending radius and development of outer fibre stress within the steel pipe wall.

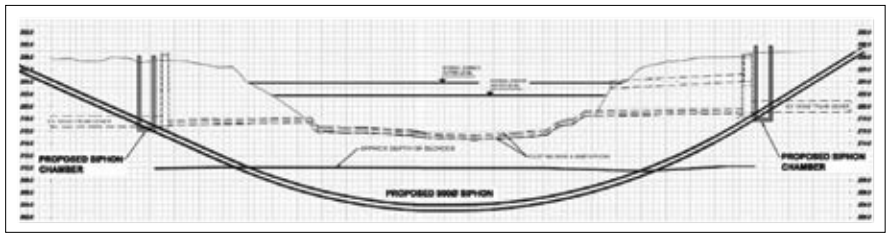

Figure 5. Horizontal Directional Drilling Profile

The analysis found that while it was technically feasible to install a 900 mm steel pipe meeting the geometric site constrains governed by the tie in locations, there was little allowance for steering misalignment.

DIRECT PIPE:
Direct Pipe is a new technology in the North American marketplace. It generally combines the features of microtunnelling and HDD. With Direct Pipe, a MTBM bore head is advanced along a bore path from surface, similar to HDD. The carrier pipe is used as the push string. This allows for installation of the carrier pipe in a single pass, as opposed to the multiple ream passes generally required by HDD. It also eliminates the expense of deep exit and entry shafts required for microtunnelling.

Direct Pipe advances the pipe string utilizing a pipe thruster. The pipe thruster is set up at a launch pit and utilizes hydraulic clamps to grip the pipe while hydraulic cylinders push the pipe string into the bore hole, advancing the MTBM. Due to the forces required to drive the MTBM and pipe string, Direct Pipe requires the use of a heavy wall steel pipe. The pipe string is pre-welded and requires relatively flat entrance angles to aide in MTBM advancement and pipe string handling, similar to HDD. However, the continuously supported tunnel bore and slurry pump system removing spoils from the hole results in significantly lower drilling pressures, as the installation utilizes drilling fluids for lubrication and soil stabilization similar to microtunnelling.

As a Direct Pipe installation would follow the same alignment as a HDD installation, it encounters the same stress development issues as the HDD option. In addition, the need to drive through both fine grained overburden soils and limestone bedrock requires a complicated MTBM cutting tool setup and may result in the need to install a casing pipe down to bedrock to permit tunnelling through the mixed face conditions.

EVALUATION:
Due to the constructability issues identified for both the HDD and Direct Pipe options, AECOM and Associated Engineering initiated discussions with qualified HDD and Direct Pipe contractors to gauge the installation risks for this crossing. The issues with tunnelling through mixed ground for the Direct Pipe installation and the limited tolerance for alignment errors for both technologies, both HDD and Direct Pipe were not recommended for use on this project. As a result, the crossing was designed and tendered as a microtunnelling crossing. A summary evaluation of each installation method is shown in Table 1.

DETAILED DESIGN

Detailed design and specification development for the crossing was completed with the goal of maximizing the flexibility of the successful contractor to utilize familiar shaft construction and tunnelling techniques while maintaining the design intent and long term performance of the completed siphon.

MTBM INSTALLATION:
The MTBM alignment was governed largely by the elevation of the limestone bedrock. Geotechnical information for the site showed the top of bedrock to be an elevation ranging from 209.5 m to 210.25 m above mean sea level.

The limestone was overlain by layers of silt, clay, and till with the river invert at approximately 214.5 m. With insufficient room to tunnel above the bedrock and the risk of encountering varying soil conditions, bedrock outcrops, and large boulders, a tunnel drive within the limestone

Table 1. Trenchless Technology Evaluation

Criteria	Microtunnelling	HDD	Direct Pipe
Technical Feasibility:	Well within the technical envelope for the technology	Technically feasible but required bore path results in minimal tolerance for drilling errors	Not practical due to issues regarding the bore path and the transition from overburden to bedrock
Construction Risk:	Lower construction risk with respect to other trenchless technologies. Risks associated with rock quality/ hardness and equipment failure.	High construction risk related to potential for miss alignment at rock interface. Potential for overstressing the steel pipe if bending radii decrease due to steering related issues.	Need for a casing through the overburden soils. Difficulty in maintaining the bore path alignment at the soil/rock interface. Potential for overstressing the steel pipe if bending radii decrease due to steering related issues.
Cost:	$10M to $11M	$8M to $9M	Not Evaluated
Recommendation:	Recommended	Not Recommended	Not Recommended

bedrock was required. Figure 6 depicts the approximate MTBM alignment with the drive completely within the bedrock.

While tunnelling within bedrock has the advantage of a consistent tunnelling medium, there are risks associated with a discontinuous bedrock surface, karstic features, and fractures within the upper bedrock strata. The geotechnical investigation found Rock Quality Designations (RQDs) within the limestone ranged from 20% to 100% with compressive strengths as high as 149.6 MPa. Typically, the top several meters of bedrock had RQD values above 75%. The downstream side of the tunnel alignment was set with a lower invert of 205.5 m, which provided approximately 1.5D of cover to top of bedrock at the end of the drive.

CHAMBERS AND CONNECTIONS:

Due to the tight space constraints and the need to construct nearly 25 m deep sealed shafts into bedrock, the final chambers were designed as circular structures. The circular structures were consistent with the anticipated shaft construction methods, including secant piles or sunk caissons. If a sunken caisson was utilized, the contractor was provided the option of incorporating the caisson as part of the final structure. For either case, the shaft would become the outer formwork for the chamber, thereby minimizing the overall shaft diameter required.

To further maximize flexibility for different shaft construction techniques, the MTBM launch/reception shafts and siphon chambers were constructed off line from the existing interceptor and siphon chambers, as shown in Figure 7.

Connections to the existing interceptor were to be completed using a cast-in-place reinforced concrete collar connection constructed around the existing monolithic concrete pipe. This was designed to be completed either by constructing a shaft at the tie-in location, or trenchlessly by tunnelling in from the MTBM shaft.

The use of circular chambers permitted a unique internal configuration where flows are piped through the chamber and into the siphon, as opposed to allowing flow to freely discharge into the chamber. The piping configuration is shown in Figure 8. This resulted in a significant reduction in head loss through the chamber and allowed for a reduction in the overall shaft size. Other unique design features of the chambers are:

- Full size (900 mm) access for cleaning and tool insertion, via a vertical launch tube
- Isolation valves (900 mm knife gates) for siphon operation and future leakage tests
- Helical drop pipe, permitting the change in flow direction from the connection to the tunneled siphon beneath the river

HYDRAULICS:

A long-term operational plan was developed in conjunction with the design that included siphon operation under both dry and wet weather flow conditions. The existing 500 and 800 mm siphons, which conveyed all flows through the crossing, were found to have sufficient cleansing velocities and sufficient capacity to convey dry weather flows through the 2037 design horizon and beyond. Thus, the new 900 mm siphon would only be utilized to convey wet weather flows.

The City's CSO master plan includes deployment of real time controls at this and other sites throughout the City, which would require the gates for the 900 mm siphon to open when levels reach a preset level, allowing flow through the new siphon. However, implementation of real time controls was not anticipated in the near term and thus physical means to control the flow was required. While traditionally this would be accomplished with a weir, however the size of the upstream and downstream chambers and the significant increase in head loss precluded their use. Taking advantage of the piped system shown in Figure 8, the

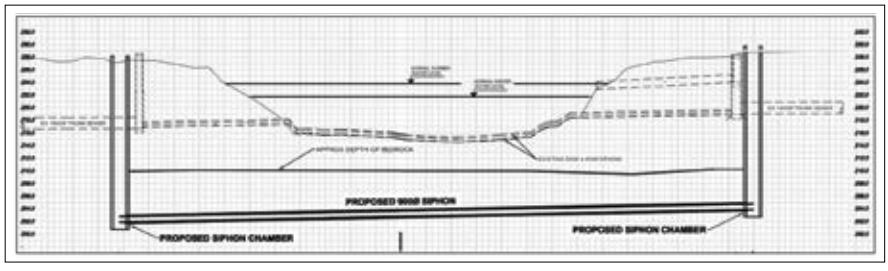

Figure 6. Microtunnelling Profile

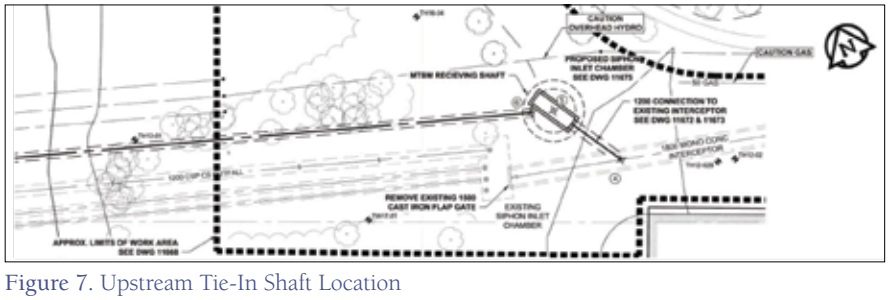

Figure 7. Upstream Tie-In Shaft Location

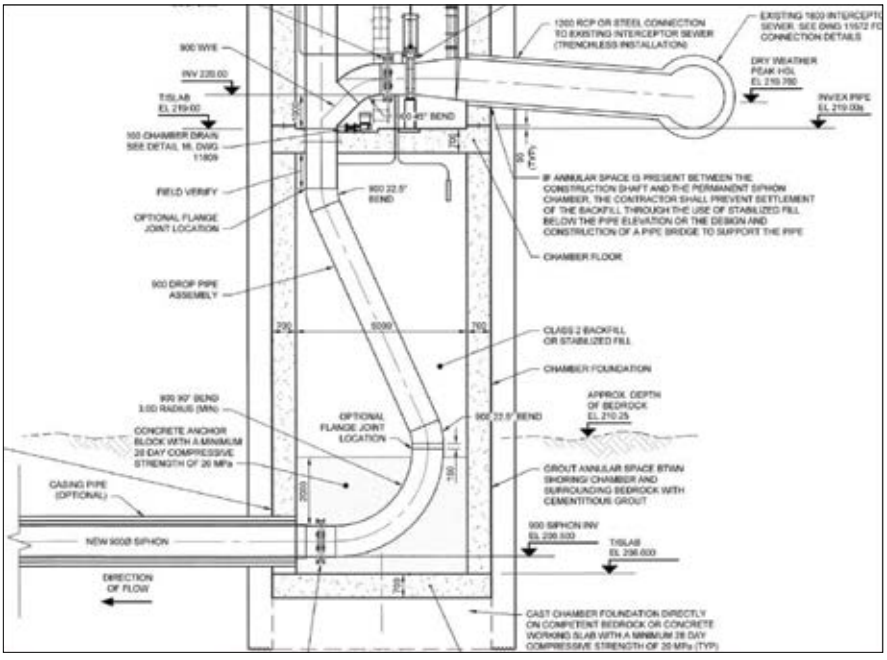

Figure 8. Chamber Piping Configuration

invert of the piping within the siphon chambers was raised 1 m above the invert of the existing interceptor. This brought the pipe invert on the upstream side of the siphon above the peak dry weather HGL for both the current and 2037 design horizon and precludes dry weather flows from entering the new 900 mm siphon.

GEOTECHNICAL BASELINE REPORT

A Geotechnical Baseline Report (GBR) was prepared for the project detailing baseline conditions for both the tunnelling and shaft construction works. The intent of the GBR and accompanying data report was to provide the contractor with all applicable geotechnical and hydrogeological information and define a contractual baseline for geological condition on site. Any claims related to changes in soil and/or bedrock conditions on site would be evaluated based on the contents and baseline set forth in the GBR.

PROCUREMENT

REQUEST FOR QUALIFICATIONS:

Due to the unique nature of the work and limited contractor base in North America a Request for Qualification (RFQ) was issued in early 2018. The RFQ focused on several key features of the proposed work:

- Microtunnelling where external intervention was not feasible (e.g., beneath a river)
- Microtunnelling through bedrock of similar strengths and quality of that found on site
- Construction of sealed MTBM launch and reception shafts
- Construction of MTBM launch and reception shafts in bedrock

A total of three contractors submitted qualifications and were all deemed qualified to complete the work.

TENDERING:

The construction contract was tendered to the three pre-qualified contractors in May 2018, with a commencement date of October 2018 and a completion date of March 2019. The targeted winter construction schedule allowed for minimal impact to the Kildonan Park Golf Course and the multiuse path construction project.

At the time of closing, only one bid submission was received for $12.1M from Ward and Burke Microtunnelling. Their submission also included an alternative bid for $10.1M based on an alternative schedule that had construction commencing in the summer of 2018 and completing in the fall of 2019 with a break for the winter.

The City accepted the alternative bid and awarded the construction contract to Ward and Burke Microtunnelling in July 2018. Construction commenced in August 2018 and at the time of writing, shaft construction is nearly complete.

CONCLUSION

The NE Interceptor and the Red River crossing are critical components of the City's wastewater collection system. Augmenting the capacity of the existing siphon with a new 900 mm siphon will reduce basement flooding risk in the upstream system and permit future rehabilitation of the existing siphons, extending their useful lifespan well into the future.

The design of the new siphon crossing from preliminary hydraulics to detailed design and tendering had to consider both functionality and constructability of every component due to the extremely constrained work sites. The constrained nature of the site resulted in the elimination of trenchless technologies that posed excessive construction risk and the design of unique siphon chambers.

The construction contract was developed with the intent of maintaining as much flexibility as possible for the Contactor to select their means and methods while protecting existing infrastructure and meeting the project requirements for long-term performance. Examples of this include tendering multiple acceptable microtunnelling pipe materials and designing siphon chambers compatible with a wide range of shaft construction techniques.

Ultimately, the construction contract was tendered successfully and awarded to Ward and Burke Microtunnelling. Construction commenced in August of 2018 and is expected to be complete in the fall of 2019.

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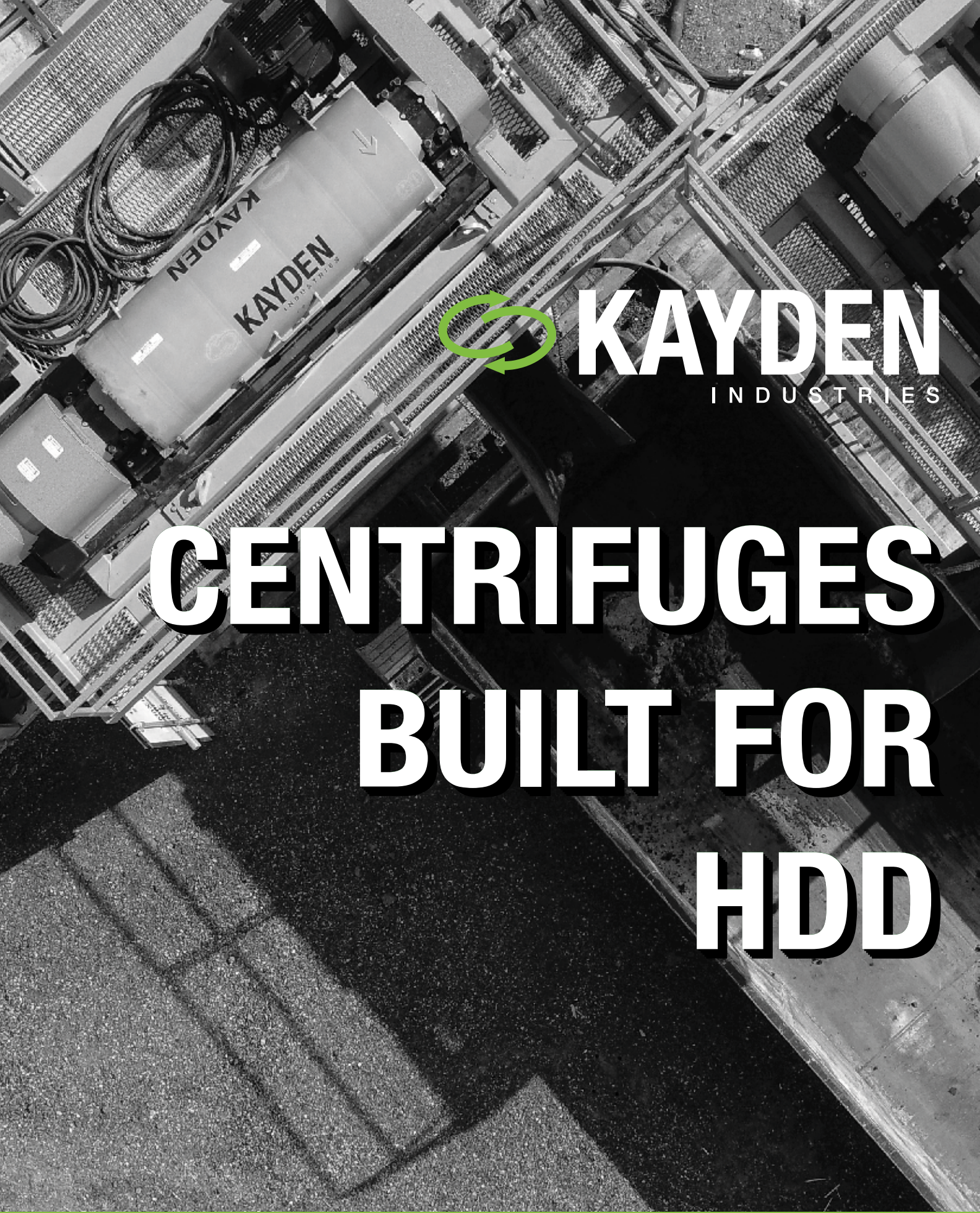

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