2017

TRENCHLESS SANS TRANCHÉE Journal

THE OFFICIAL PUBLICATION OF THE NORTH AMERICAN SOCIETY FOR TRENCHLESS TECHNOLOGY
Great Lakes, St. Lawrence & Atlantic Chapter | Chapitre des Grands-Lacs, du Saint-Laurent et de l'Atlantique

WATER MAIN REHABILITATION IN NOVA SCOTIA

PM #40065075

- Hamilton, ON & Halifax, NS CIPP Best Practices Recap
- Quality Control for Sewer Lateral Rehabilitation
- Detailed Under Water Inspection Without Dewatering

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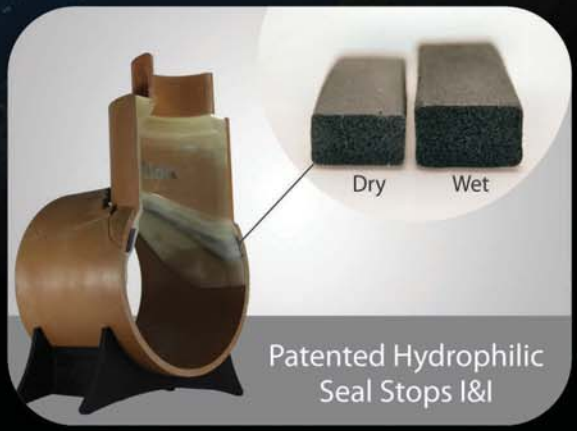

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ON THE COVER: Downtown Halifax and harbour, Nova Scotia. © Sfagnan

TRENCHLESS SANS TRANCHÉE
Journal
2017

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Frank Firsching, *NASTT Chair*

Dedicated to Trenchless Education

Hello GLSLA Chapter members! We are well into the year, and I'm excited for the future during my term as Chair of the Board of Directors. NASTT's 2017 No-Dig Show and ISTT's 35th International No-Dig Show in Washington, D.C. were very successful on all accounts. The exhibit hall was a sell-out once again and we experienced excellent attendance. We were thrilled to host delegates from all over the globe!

NASTT exists because of the dedication and support of our volunteers and our 11 regional chapters. There are many GLSLA Chapter members who serve on our No-Dig Show Program Committee and volunteer their time and industry knowledge to peer-review the abstracts. We're looking forward to the upcoming Show in Palm Springs, California next March! These 2018 committee members from the GLSLA Chapter will ensure that the technical presentations are up to the standards we are known for: Frank Badinski, Ben Cote, David Crowder, Mike Davison, Michael Kleespies, Derek Potvin, Ashley Rammeloo, Piero Salvo, and Isabel Tardif. The GLSLA Chapter is also home to some of our Session Leaders. Session Leaders are Program Committee members who have the added responsibility of managing a session of the technical program and working with the authors and presenters to facilitate excellent presentations. I would like to extend a special thank you to the GLSLA Chapter members who will also serve as Session Leaders in 2018: David Crowder and Ashley Rammeloo.

In addition to the annual No-Dig Show, NASTT provides many trenchless training courses. We are focused on trenchless education and our highly-experienced instructors are dedicated to trenchless education, providing their expertise strictly on a volunteer basis. They donate personal time to travel around North America to provide high-quality training on a host of trenchless technologies. I would like to thank GLSLA Chapter Members Kevin Bainbridge and Ian Doherty for serving as instructors this year. Kevin teaches our Trenchless 101 Seminar and our Laterals Course, and Ian teaches our Cured-in-Place-Pipe (CIPP) Course. Thank you, gentlemen!

The North American Society for Trenchless Technology is a society for trenchless professionals. Our goal is to keep our finger on the pulse of our industry and provide beneficial initiatives. To do that, we need the involvement and feedback from our professional peers. If you are interested in more information, please visit our website at *www.nastt.org/volunteer*. There, you can view our committees and learn more about these great ways to stay involved with the trenchless community and to have your voice heard. Please consider becoming a volunteer – we would love to have you get more involved.

NASTT has a very promising future because of our amazing volunteers. Thank you again for your continued support and dedication to NASTT and the trenchless technology industry.

Frank Firsching, *président de la NASTT*

La formation : une priorité

Salutations à tous les membres de la section Grands Lacs, Saint-Laurent et Atlantique (GLSLA)! L'année est déjà bien avancée, mais la perspective de ce qui s'annonce pour la suite de mon mandat à la présidence du conseil d'administration me rend particulièrement enthousiaste. Le salon No-Dig 2017 de la NASTT et le 35e salon international, à Washington, D.C., sont des succès retentissants : la salle des exposants était une fois de plus complète et les visiteurs ont été très nombreux. C'est toujours un plaisir d'accueillir des visiteurs de toute la planète!

La NASTT existe grâce au dévouement des bénévoles et de nos onze sections régionales. La GLSLA est largement représentée au comité de programme des salons No-Dig et des membres de la section mettent leur temps et leur connaissance de l'industrie au service de leurs collègues en révisant des résumés d'articles. Il nous tarde de vous voir au salon de Palm Springs, en Californie, en mars 2018. Des membres du comité organisateur représentant votre section veilleront à ce que les présentations techniques respectent les normes de qualité qui nous sont chères. Il s'agit de Frank Badinski, Ben Côté, David Crowder, Mike Davison, Michael Kleespies,Derek Potvin, Ashley Rammeloo, Piero Salvo et Isabel Tardif. D'autres seront modérateurs, c'est-à-dire qu'en plus de siéger au comité de programme, ils assureront le bon déroulement de certaines séances du volet technique, en travaillant avec les auteurs et les présentateurs pour garantir l'excellence des présentations. J'aimerais d'ailleurs remercier David Crowder et Ashley Rammeloo, qui joueront ce rôle en 2018.

> « Le bénévolat vous tente? Nous serions ravis de travailler plus étroitement avec vous. »

Outre le salon No-Dig annuel, la NASTT offre plusieurs formations sur la technologie sans tranchées. C'est d'ailleurs l'une de nos priorités. Nous sommes reconnaissants à nos formateurs chevronnés qui font gracieusement profiter leurs collègues de leur expertise et consacrent une part substantielle de leur temps à la prestation de formations de qualité sur une gamme de techniques, partout en Amérique du Nord. Je tiens à remercier notamment Kevin Bainbridge et Ian Doherty, de la GLSLA, qui ont été formateurs cette année. Kevin dirige le séminaire de base sur la technologie sans tranchées et donne le cours sur les canalisations latérales, tandis que Ian est aux commandes du cours sur le chemisage. Merci Messieurs!

La NASTT est une association professionnelle qui suit l'industrie de près afin de vous proposer des initiatives pertinentes. Nous ne saurions atteindre cet objectif sans votre participation et vos commentaires. Pour en savoir davantage sur le travail des bénévoles, visitez notre site Web, à l'adresse *www.nastt.org/volunteer*. Vous y trouverez la liste et le mandat de nos comités. Vous verrez : il y a bien des façons de contribuer à la communauté des praticiens de la technologie sans tranchées et d'exprimer votre opinion. Le bénévolat vous tente? Nous serions ravis de travailler plus étroitement avec vous.

La NASTT a un avenir très prometteur grâce à nos bénévoles d'exception. Merci une fois encore de votre appui et de votre dévouement indéfectibles envers la NASTT et l'industrie de la technologie sans tranchées.

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Kevin Bainbridge, *GLSLA Chapter Chair*

Exciting Times for the Trenchless Industry

The Great Lakes, St. Lawrence and Atlantic (GLSLA) Chapter of NASTT is please to present our 2017 issue of the ***Trenchless Journal*** magazine. This magazine is filled with lots of product and project information, NASTT updates, and some great articles including our feature article on watermain rehabilitation in Nova Scotia.

GLSLA has seen a significant increase in the application of trenchless technologies over the past several years, with projects being completed by both large and small municipalities and utilities in every province in the GLSLA Chapter area. We have also seen the introduction of many new technologies, including Manhole Rehabilitation (MH) technologies. It is an exciting time for the trenchless industry and GLSLA looks forward to continuing our mission of education and awareness of trenchless technologies.

The GLSLA Board of Directors and member volunteers are continuing to work to provide value to our members through this publication, along with training, our website, and support for several NASTT programs, including the Municipal Scholarship and silent auction. We encourage members to get involved with these programs as they provide significant value to members and the industry as a whole.

GLSLA, in partnership with NASTT and ACWWA, held two very successful CIPP Good Practices courses in Hamilton and Halifax this year. These courses were very well attended, with 35 participants in Hamilton and 23 participants in Halifax. NASTT courses provide a great opportunity for members to gain trenchless knowledge and understanding in numerous areas of practice. GLSLA will again be hosting NASTT courses in 2018 and I would encourage members to take advantage of these classes. Stay up to date on training opportunities and other events on our website, at *www.glsla.ca*.

> GLSLA has seen a significant increase in the application of trenchless technologies over the past several years, with projects being completed by both large and small municipalities and utilities in every province.

GLSLA recently held its Board of Directors election and we would like to thank all those who stood for election. The Board would like to congratulate and welcome new board member Mike Zantingh, and returning board members Sandra Gelly, Michelle Moore, Julia Noble, and Anna Polito.

We look forward to the upcoming events, including the ACWWA annual conference in Charlottetown, Prince Edward Island and the 2018 No-Dig Show in Palm Springs, California.

For more information on GLSLA, our events, and our training sessions, or to contact us if you wish to publish an article in our magazine, please visit our website at *www.glsla.ca.*

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Kevin Bainbridge, *président de la section GLSLA*

Des jours passionnants pour l'industrie sans tranchées

La section Grands Lacs, Saint-Laurent et Atlantique (GLSLA) de la NASTT est ravie de présenter le ***Journal Sans Tranchée*** 2017. Comme d'habitude, ce numéro regorge d'informations sur les produits et les chantiers, en plus de faire le point sur les activités de la North American Society for Trenchless Technology (NASTT) et de proposer d'excellents textes, dont l'article vedette sur la remise en état de conduites principales d'alimentation en eau en Nouvelle-Écosse.

La GLSLA constate la progression des technologies sans tranchées depuis quelques années : de nombreux projets ont récemment été menés à bien par des villes et des sociétés de services publics, petites et grandes, dans toutes les provinces qui composent la section. Nous avons également observé l'avènement de nombreuses technologies nouvelles, notamment la réhabilitation structurale des regards d'accès. Ce sont vraiment des jours passionnants pour l'industrie sans tranchées, et la GLSLA poursuit avec enthousiasme sa mission de formation et de sensibilisation.

Le conseil d'administration et les bénévoles de la section travaillent sans relâche pour optimiser l'adhésion des membres. Témoins : cette publication, les formations et les ventes aux enchères par écrit. Nous vous encourageons vivement à participer : ces activités sont bénéfiques pour les membres, mais aussi pour l'ensemble de l'industrie.

En partenariat avec la NASTT et l'Atlantic Canada Water and Wastewater Association (ACWWA), la GLSLA a offert cette année deux cours couronnés de succès sur les pratiques modèles en matière de chemisage, à Hamilton et à Halifax. Très populaires, les cours ont attiré 35 participants à Hamilton, et 23 à Halifax. Les cours de la NASTT offrent aux membres d'excellentes occasions de mettre leurs connaissances à niveau dans de nombreux domaines de pratique. La GLSLA compte offrir à nouveau des formations de la NASTT en 2018. J'invite de tout cœur les membres à en profiter. Surveillez le programme des activités sur notre site Web, à l'adresse *www.glsla.ca.*

> « La GLSLA constate la progression des technologies sans tranchées depuis quelques années : de nombreux projets ont récemment été menés à bien par des villes et des sociétés de services publics, petites et grandes, dans toutes les provinces. »

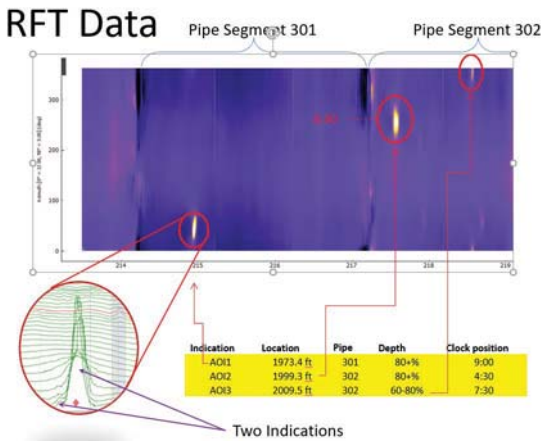
La GLSLA a récemment élu son conseil d'administration. Nous tenons à remercier tous les candidats. Le conseil félicite et accueille le nouvel élu, Mike Zantingh, et les administrateurs dont le mandat a été renouvelé, soit Sandra Gelly, Michelle Moore, Julia Noble et Anna Polito.

Il nous tarde de vous voir bientôt, entre autres au congrès annuel de l'ACWWA à Charlottetown (Île-du-Prince-Édouard) et au 2018 No-Dig Show, à Palm Springs (Californie).

Pour en savoir plus sur la GLSLA, nos activités et nos formations, ou pour proposer un article pour notre magazine, veuillez consulter notre site Web, à l'adresse *www.glsla.ca*.

AT LAST!

HIGH-RESOLUTION CONDITION ASSESSMENT OF CONCRETE PRESSURE PIPE



Gone are the days where you had to accept "average wall thickness" or "Low-Medium resolution" condition assessments of your concrete pressure pipelines!

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If you have concrete pressure pipe, even if it has been inspected by others, PICA wants to show you the PICA Hi-Rez advantage. Call us to reserve a date in our inspection calendar: 1-800-661-0127 or write to *info@picacorp.com.*

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CIPP Best Practices Course

GLSLA, in partnership with NASTT, was pleased to host two CIPP Good Practices courses this year. The first CIPP Best Practices Course was held in Hamilton, ON in January 18, 2017, and had a very good turnout with 35 attendees.

The second CIPP Best Practices Course in partnership with the ACWWA took place in Halifax, NS on May 10. It was another successful event with 23 registered participants.

The sessions where very well received with participants from a wide cross-section of the industry from municipalities, utilities, government, contractors, suppliers, and consultants.

These NASTT courses offered industry-leading knowledge of CIPP rehabilitation and included a copy of NASTT's published book on CIPP. Topics covered at both these sessions included:

- Design & construction of CIPP
- CIPP application range in trenchless technologies
- Types of pipelines used in CIPP process
- Types of CIPP materials
- Basics of how CIPP interacts with other materials
- Typical problems that can be addressed using CIPP
- Practical advice on where, when and how to apply CIPP liners
- CIPP testing
- Design considerations for gravity pipelines
- Wall thickness for a CIPP liner
- Selection of right materials & process
- Inspection & QA/QC

Special thanks to NASTT trainers Chris Macey, Ian Doherty, and Kevin Bainbridge for their expertise and time.

The GLSLA Chapter is planning courses for 2018, and will publish the dates and location of course offerings on their website at *www.glsla.ca.*

NASTT trainers Ian Doherty and Kevin Bainbridge present in Halifax.

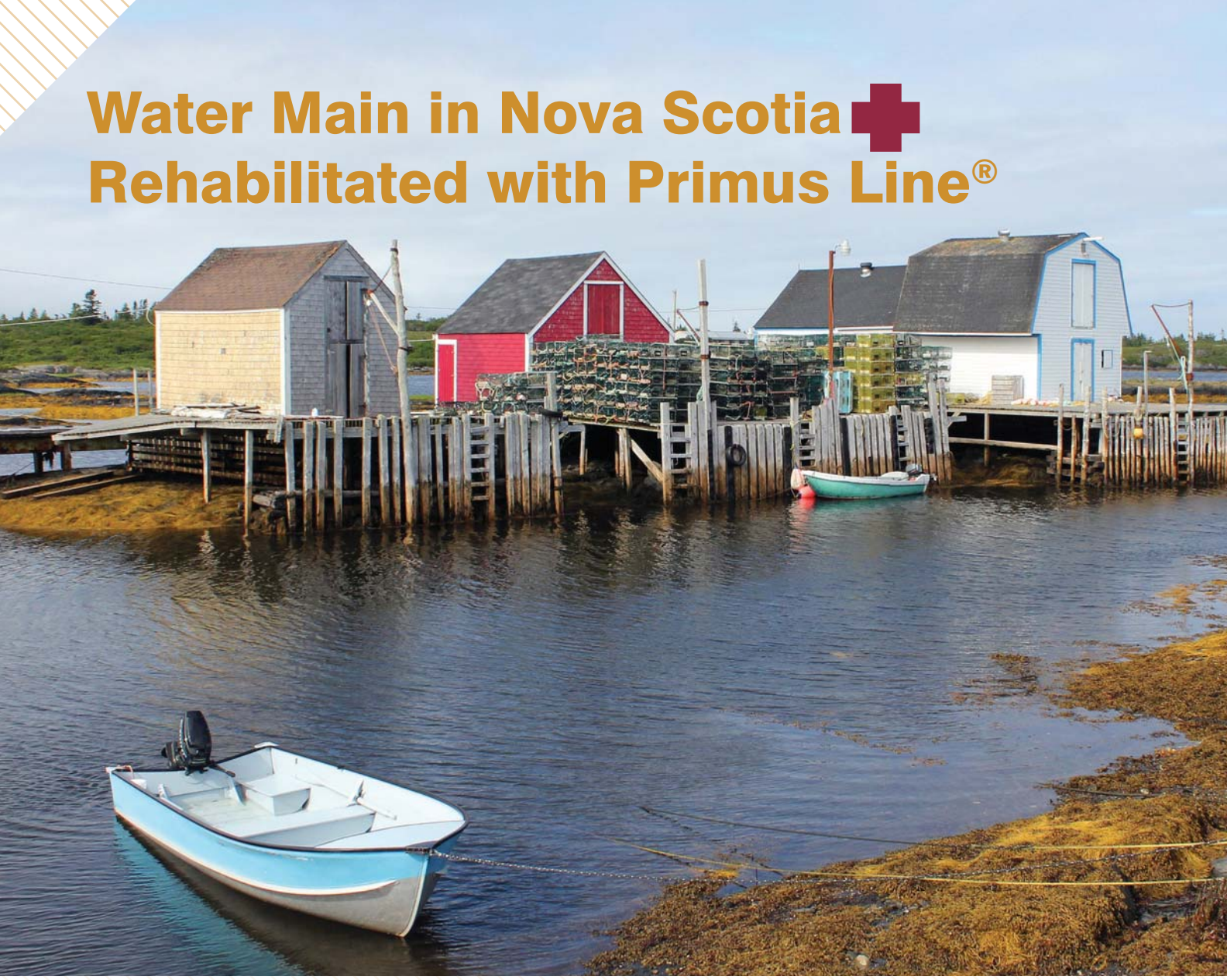
Attendees network in Hamilton.

Call for Submissions

If you would like to submit your project paper or other content and photos for an upcoming issue of this GLSLA Chapter magazine, please contact David Crowder, the Trenchless Journal Coordinator, at *dcrowder@rvanderson.com*.

Editorial submissions are welcome, and are due for the next publication by July 13, 2018.

Water Main in Nova Scotia Rehabilitated with Primus Line®



The region around the Grand Banks off the coast of Nova Scotia are rich fishing grounds. Located on a peninsula in Allendale Bay, the Town of Lockeport, a traditional Nova Scotian fishing town, is home to a number of fishing companies exactly for that reason. Operation of the local seafood processing facilities depends on a reliable supply of potable water. A 14-km-long DN 400 pipeline made of ductile iron Class 51 with an operating pressure of around 5 bar provides the town with the valuable resource.

Close to Hayden Lake, the potable water pipeline crosses under the Hayden East River. Exactly in this complex section with its vertical and horizontal bends the Nova Scotia Department of Transportation and Infrastructure Renewal (NSTIR) discovered leakages in the pipe. The department looked for a solution that was both environmentally friendly and able to restore the regular supply of water to the town as quickly as possible.

Eastpoint Engineering, a consulting firm from Halifax, narrowed the available options down to two solutions fitting the requirements: an installation of a completely new water main of high-density polyethylene pipe (HDPE) or the trenchless rehabilitation of the existing pipe with the Primus Line® system. A new water main was promptly ruled out, as this method would have required extensive excavation works on the river bed to access the bends. The environmental impact would have been extensive. The Primus Liner, however, could be fed through the existing bends of up to 45 degrees via only two construction trenches on both banks of the river, leaving the river bed unaffected.

Three different layers comprise the Primus Liner. The abrasion-resistant polyethylene (PE) outer layer protects the internal load-bearing structure during installation. Depending on the required pressure rating, the core structure consists of either one or two layers of seamless woven Kevlar® which absorbs the pulling force during insertion as well as the operating pressure. For drinking water applications, the inward-facing layer is based on PE. Due to its composition of multiple layers and a low wall thickness, the Primus Liner unites both flexibility and ultra-high material strength.

Prior to the invitation to tender, the Department for Transportation and Infrastructure Renewal had already emptied the affected pipeline sections, disconnected them from the rest of the network and bridged them with a temporary bypass system. The prime contractor Harlow Construction of Halifax prepared the construction site to such an extent that J. R. Eisener Contracting,

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Host pipe after the cleaning cycle.

The Primus Liner exits the host pipe.

A Primus Line connector during assembly.

the Certified Solution Partner of Primus Line for the Atlantic Provinces, could immediately begin with the CCTV inspection.

During the inspection process the team was not only able to locate deposits and incrustations within the host pipe but to determine the exact positions of the two leakages as well as their extent. Although there were only two small cracks, a considerable amount of river water was penetrating into the pipe.

After a cleaning cycle with high-pressure water jets and pull-through pigs, the pipeline was ready for installation. The J. R. Eisener installation team began the insertion of the two pre-folded Primus Line DN 300 PN 12 that were sent to the construction site on two transport reels. A pulling winch, capable of pulling up to 5 tons, fed both liners with lengths of 158 and 132 m into the host pipes. Due to the pre-folding technique, the necessary pulling force was reduced to a maximum of 6.67 kN.

Application of compressed air brought the Primus Liner into its circular shape – an annular space between liner and host pipe remained. Through the small cracks excess water will continue to flow into this space. However, at operating pressure the Primus Liner maintains its stability and simply pushes out the excess water. With four Primus Line DN 300 low-pressure connectors, the two segments were safely reintegrated into the water pipeline network. After successful pressure and leak tests and only four working days the rehabilitated sections went back to full operation.

Developed by experienced engineers, the system is suitable for different media as well as various other applications. Besides the rehabilitation of damaged pipelines, it can also be used to increase the pressure within existing systems, protect them from corrosion and build bypass systems or stand-alone solutions. The Primus Line® system is certified in many countries – for example Australia, the USA, Germany, Canada and Israel – and meets the highly demanding standards for the transportation of drinking water worldwide. Primus Line® is available in nominal diameters ranging from DN 150 to DN 500 and can be installed over a length of 2,500 m in one single pull.

Project Description

The rehabilitation of 290 m of pipeline took place in November 2015 and took four days. The DN 350-mm host pipe was turned off and secluded from the pipe network with a temporary bypass system that was installed prior to the tendering process.

With the re-integration of the renewed sections into the existing pipeline network, the rehabilitation works of the service water pipeline were completed successfully. The life span of the renovated section was extended by at least 50 years.

Detailed Under Water Inspection Without Dewatering

By Merry Dang (*mdang@asi-group.com*)

Underwater infrastructure inspections required for condition assessments can be challenging and costly, however safe, economical and advanced solutions are easily accessible. Development in both technology and equipment has allowed for comprehensible and safe inspection in water filled infrastructure such as pump wells, reservoir tanks, and pipelines. These advancements provide enhanced data collection for comparative surveys allowing asset mangers to make informed decisions.

Remotely Operated Vehicles (ROV) are an ideal platform for conducting underwater inspections. Inspection technology, i.e., various sonar(s) and camera(s) can be customized and mounted onto the ROV, pre-tested prior to arriving on site and can be easily deployed. In flow conditions, the ROV can swim up, down, and laterally to the inspection area, controlled by the ROV pilot. Mobilization and set up of the ROV and monitoring equipment is seamless with proper planning. Remote real-time monitoring allows for a project manager to work alongside the ROV inspection team to further investigate areas of interest.

Take, for example, a project requiring condition assessment of two butterfly valves in two 750 mm diameter pipelines, each approximately 5 m long, located in a reservoir. Each of the two pipelines are in separate compartments in pump wells at the bottom of the reservoir. The scope of work includes CCTV data regarding the visual identification of the two valves and visual assessment of both pipelines. Anomalies, accumulation of sediment/debris, and/or pipeline damage are also to be identified and documented.

The confined space environment would eliminate the option of a manned inspection. A pipeline crawler would require dewatering the pipelines thus costing additional time and money. An ROV would be the ideal solution for this inspection.

ROVs can come in all shapes and sizes, allowing for a customizable solution. They can be battery run, free-swimming or powered with a tethered umbilical. When sourcing an ROV for an inspection project, consider: will the project require unlimited power for a seamless inspection? what type of data will be most beneficial to understand the condition of the asset and for future comparison surveys? and what type of experience does the solution provider have?

When determining which company is best suited for your ROV inspection project, important decision criteria include: extensive knowledge and experience of different underwater infrastructures and water conditions (i.e., turbidity, and visibility), accurate interpretation of data, and expert on-site personnel with the ability to troubleshoot for unexpected issues. Each project will have its own unique set of challenges. Rest assured, a viable and advanced solution utilizing ROVs will minimize these challenges greatly and provide a beneficial outcome for your condition assessment projects.

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INSPECTION AND REPAIR

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Culvert Project in Ontario

Source: *www.akkerman.com*

At the end of March, LTL Directional Drilling Ltd. of Shuniah, ON completed a 280-lf. foot, 86-in. OD steel casing culvert with a Series II 720 TBM and Tunnel Boring System. The TBM system was used in a remote location on the Camp Creek Culvert project under Highway 627, in Marathon, near Huron Bay, Ontario. The project is owned by The Ministry of Transportation.

Highway 627 is the only access road in the region, so during construction one lane of traffic had to be maintained at all times. The new culvert was installed along the embankments on either side of the highway, with 70 ft. of cover above the pipe to the roadway. The culvert that was being replaced was prone to washout at the inlet and outlet points, and was buckling and rusting throughout and below its invert. The project goal was to extend the new culvert further outward along the embankments to integrate proper erosion control.

The contractor selected a closed face cutter head for the Series II 720 TBM, to prevent subsidence of the silt and sandy ground into the TBM interior. They combined the TBM with a Tunneling Boring System including a 5200 Pump Unit for hydraulic jacking and TBM supply functions with 400 tons of thrust capacity, a thrust yoke and several sizes of skid base to accommodate the 40-ft. steel casing, a 1548 Haul Unit for soil transportation and a EH2250 Bentonite Pump to lubricate the outside of the pipe.

The precarious nature of the weather created challenges at the onset of the project. During the three weeks that the contractor was on-site, the temperatures varied from a low of -31 degrees to a high of 53 degrees. An early thaw caused delays on the construction of the concrete launch shaft and reaction block. Just when everything dried out well enough to construct the shaft to launch the TBM, the region experienced extreme cold temperatures causing the moisture in the ground to suddenly freeze then thaw once again a few days later.

Wet flowing ground created immense friction around the first 40-ft. length pipe and required the crew to rethink their strategy. Their solution was to add advanced jacking tonnage to the pipe string with Intermediate Jacking Stations (IJS) positioned between each pipe joint and 40 lubrication ports throughout, supplementing the pipe string with an additional 495 tons per IJS adding an extra 2,970 tons. The method proved to be a good decision and enabled crews to complete the replacement culvert within just two-weeks' time.

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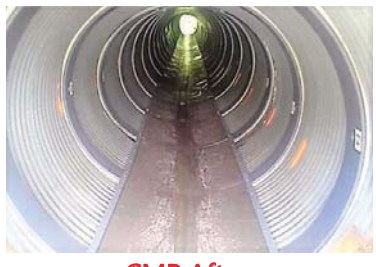
CMP Before



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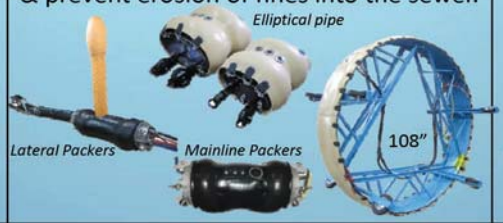

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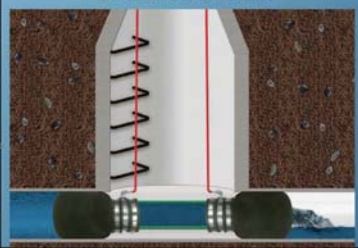

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Quality Control for Sewer Lateral Rehabilitation

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INTRODUCTION

The use of CIPP for the rehabilitation of sewer lines has been well established in North America for several decades. In more recent years, cities and utilities have begun expanding the use of CIPP for the rehabilitation of other underground pipes, including sewer laterals. While sewer laterals are very similar in many ways to mainline sewers (see setup in Figure 1), lateral rehabilitation using CIPP can be much more challenging.

There are several factors that make the use of CIPP more challenging for laterals. Primarily, these factors are access constraints, smaller diameter sizes, and quality control of installations.

It is important to appreciate that the collection of a CIPP sample from the actual installed lateral liner is extremely challenging without incurring significant cost and disruption (i.e., excavation of a portion of lateral), yet the importance of obtaining a sample is the same as with mainline sewer CIPP.

To the author's knowledge, a cost-effective way of obtaining samples from the actual installed liners has not been identified. Many utilities and municipalities simply don't collect samples for testing. While we are limited in our ability to obtain direct sample pieces from the installed line, there are alternative methods in achieving some level of quality control through inspection and sample testing of the CIPP product and process being used.

Figure 1: Installation setup for lateral liner.

HAMILTON'S LATERAL LINING PROGRAM

The City of Hamilton's lateral lining program was initiated in 2008 and set as a three-year performance-based contract. The contract was subsequently reissued in 2011 to continue with lateral rehabilitation for another three years. In 2014, the contract was overhauled to allow the City to extend the work to a five-year term, through to the end of 2019 with an annual budget of approximately $5 million capable of achieving between 650 and 700 rehabilitated laterals annually. The contract prefers that laterals are CIPP lined completely from within the mainline sewer without the requirement to install a cleanout or entering private property for any component of the process (CCTV, cleaning, prep, installation, etc.). The lateral liners are required to be one-piece integrated lateral pipe liners and connection liners referred to by the City as Lateral Liners Including Sewer Connection (LLISC) with sound engineering designs associated with both the tube liner and connection liner. The contract requires the rehabilitation lengths up to 25 metres or to the property line and be capable of lateral installation sizes of 100 mm to 200 mm within mainline sewer sizes of 200 mm to 900 mm.

QA/QC SPECIFICATION REQUIRMENTS

As with mainline sewer CIPP rehabilitation, there are two primary methods to help validate good quality CIPP lateral installations, including CCTV video inspections and product sample testing.

Video inspections are required both after the cleaning and preparation of the lateral, known as a V2, and after liner installation, known as a V3.

The V2 inspection is conducted after the cleaning and preparation of the lateral pipeline and the mainline sewer connection area have been completed. The inspection includes the full length of the lateral pipeline to be lined, the full area inside the mainline sewer over which the rehabilitation will extend, and the opening into the mainline sewer. This CCTV inspection is used to determine that the cleaning and preparation is in good order and meets the requirements of the liner installation and design.

The V3 inspection is completed after the liner installation. The inspection includes the full length of the lateral pipeline lined, the full area inside the mainline sewer over which the rehabilitation extends, and the rehabilitated opening into the mainline sewer.

The City also uses CCTV to inspect and monitor the performance of lateral CIPP installations performed at the early stages of the program. In 2016, approximately 50 laterals that were installed in 2009 were visually inspected. From the video inspection, there were no indications of deterioration observed to either the tube liner or the connection flange.

As mentioned, the quality control of CIPP lateral installations is as important and beneficial as it is for sewer mains, however, the ability to acquire samples for testing is much more challenging. The City of Hamilton has developed a method of obtaining what is referred to as a "proxy" sample of the CIPP liners being installed.

"Proxy" liner samples are taken approximately every 15–20 liner installations and are produced above ground at an actual installation site. A "proxy" sample is essentially an above-ground restrained sample made within a PVC (or other suitable material) pipe of the same size as typically installed under the City's program and are a minimum of 2 m in length. The same methods and processes for installing a below-ground sample are followed for the above ground "proxy" samples. The CIPP materials (resin, tube, etc.), curing method, installation procedures, quality assurance and quality control (QA/QC) procedures are identical to those used for actual installations (below-ground samples). An insulation blanket or other approved heat retention method may be used to better simulate a buried environment, particularly during cold outdoor ambient temperatures. Once the sample is completed, two 1-m samples are cut from the 2-m sample. The City retains one of the samples while the Contractor retains the sample for a period of one year or as otherwise directed by the City. Each of the 1-m samples must be identified, dated, and signed by the City's inspector prior to leaving the project site (see sample identification criteria below). It is also important that the samples are made in the presence of the City's inspector. Samples are delivered to the City immediately after curing has been completed.

"The quality control of CIPP lateral installations is as important and beneficial as it is for sewer mains, however, the ability to acquire samples for testing is much more challenging."

In order to establish sample integrity, it is important that the samples are properly identified. There are several key pieces of information which are required to ensure the integrity of the test sample before it leaves the site, including:

- Installation Date
- Street Name
- Contract Number
- Contractor Name
- Contractor Crew
- Special Design (if applicable)
- Street Name
- Inspector's Signature

Refer to Figure 2 for a visualization of a cured sample with all of the necessary information recorded on the sample itself.

In the case where sample test results indicate that the initial design requirements have not been met, further investigation is undertaken to determine if the liner will still perform adequately within the specification requirements for the particular installation.

In many cases this cannot be determined solely based on the test sample results, but requires a design reconciliation to be completed which involves the input of the actual field conditions and tested physical properties into the design calculations. Where the design reconciliation provides a liner sample that

Figure 2: Cured sample.

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meets the installed design requirements, the liner sample is not to be deemed deficient.

The retention of the second half of the liner sample by the contractor provides the opportunity for secondary testing in circumstances where initial test results fail to meet the specification requirements or present other issue(s).

ONSITE INSPECTION

Given that direct sample pieces cannot be obtained from lateral CIPP installations, the importance of onsite inspection and installation records for every installation becomes much more important. The City of Hamilton requires the contractor to keep detailed specific installation records for each installation. Installation records include the following information:

i. Street name;
ii. Liner size;
iii. Mix ratio;
iv. Resin lot numbers;
v. Resin volume used;
vi. Roller separation;
vii. Inversion pressure;
viii. Cure pressure;
ix. Resin mix time;
x. Resin gel time (if applicable); and
xi. Cure temperature log, including:
    (i.) Exothermic temperature
    (ii.) Truck temperature
    (iii.) Ambient temperature at the invert of the mainline sewer MH used for installation
    (iv.) Steam temperature (if applicable)
    (v.) Water temperature (if applicable)
    (vi.) Outside weather temperatures during installation.

It is also important for on-site observation of installation processes, including QA/QC processes so these can be observed to be the same processes used for the creation of the proxy sample liner for testing (see Figure 3 below). Any unnecessary changes to these processes relative to the creation to the proxy sample liner should be avoided and documented if they occur.

At the time of installation, it is the contractor's responsibility to document all pertinent information for each lateral liner installation. The City's inspector conducts their own site inspection that acts as an audit record of the contractor's compliance with the specifications. It is important for the inspector to be on site at the time of installation to establish that the required information is being documented at the time of installation. These audits validate the contractor's records for accuracy and completeness in compliance with the specifications.

The information collected in these installation records holds significant value when analyzing the overall quality of lateral liner installations and in determining the cause (or most likely cause) of sample test failures. Without installation records, the ability to monitor installation quality and take corrective action in a timely manner is significantly reduced.

Figure 3: Lateral sample creation on site with thermocouple for temperature monitoring.

CIPP SAMPLE TESTING

Testing of liner samples is completed to determine the flexural strength, flexural modulus, thickness, and any other relevant properties of the cured liner as represented by the samples. Test results must meet the values of flexural modulus and flexural strength used in the Contractor's liner design along with the design thickness. This applies to both standard design liners and special design liners.

When samples are transferred from the onsite inspector to the testing agency, a Chain of Custody form is completed. The form ensures that the sample undergoes the proper tests along with safeguarding against samples getting lost or misplaced.

Samples are tested for flexural modulus and flexural strength as per ASTM D790 and thickness as per ASTM D5813-04(2008).

The provision of testing services allows for obtaining test reports within 10 days of delivery of the sample to the testing agency. The regular submission of test results is important to ensure that any issues with liner properties as identified in the test results can be addressed in a timely manner.

The City provides the test agency with the design parameters for the liner sample as follows:

- Flexural Strength Short-term
- Flexural Modulus Short-term
- Original Design Thickness

The testing agency's report references to these values as the specified values.

"Where the design reconciliation provides a liner sample that meets the installed design requirements, the liner sample is not to be deemed deficient."

SAMPLE TEST RESULT ANALYSIS

Lateral samples collected are tested for three physical properties: flexural strength, flexural modulus, and thickness. These test results are reviewed in consideration of the installation design, tender specifications, and overall trends in tested properties. It is important to recognize that trend analysis is far more important than just the individual test results because samples are not taken from the actual installed liner rather, but rather independently created.

Lateral CIPP test results (typically four to five samples) are reported monthly and provide analysis of the physical properties and thicknesses relative to design along with design reconciliation as required. The reports track the historic trending of test results monitoring the standard deviation in the properties (flexural modulus, flexural strength, and thickness).

The City's specifications include minimums for physical properties including flexural modulus and flexural strength; along with these it states the determination of tested wall thickness, per ASTM D5813, that must be satisfied for each liner sample. The thickness must satisfy two requirements, including:

1. The average wall thickness of Types I, II, and III CIPP shall not be less than the specified thickness.
2. The minimum wall thickness at any point shall not be less than 87.5% of the specified thickness when measured in accordance with 8.1.2.

Example Lateral Lining Sample Results

Each test report undergoes an initial review and a secondary reconciliation review should the initial review identify any issues. The initial review considers the flexural modulus, flexural strength, and thickness against the liner design. If one or more of these properties does not exceed the proposed design properties, the initial review will indicate a failure related to the appropriate property(ies). In these cases, design reconciliations (redesign using tested properties) will be completed to establish if the liner still meets the required performance.

Table 1 provides an example of a summary chart for five samples received and analyzed. In this selection, four of the samples had an average flexural modulus and thickness values that met (or exceeded) the required (design) specification, with one sample that did not. The sample that did not pass initial review proceeded to reconciliation design and was found to be compliant with the specification.

In addition to the review of each sample test report, the City also tracks all test report results to establish trends in the results. These trends consider the standard deviation of physical properties (flexural modulus and thickness) in order to monitor the contractor's ability to control the variability in the physical properties from installation to installation. Again, this becomes particularly important because test samples are proxy samples and are not taken directly from the installed liner. The trend in sample test results is monitored and related to the standard deviation and average results. This relation is conducted in order to identify if the deviation is becoming too large or the average is falling close to the minimum requirements.

A large deviation and/or a low average form the proxy samples would indicate that an increased risk exists where the actual installations may be failing to meet the performance requirements (i.e., the liner's physical properties or thickness would be to low).

While it is the average of the physical properties that determine if the sample passes specification, it is equally important to review the range in flexural modulus that is present in the test reports for each of the sample specimens. Ideally, the range recorded within each specimen's flexural modulus should be within a reasonable tolerance. A large range in the values for flexural modulus should raise concerns with the consistency of the liner performance capabilities.

Figure 4 below is used to track trend history over a period of time for the lateral liner proxy samples. There are multiple sets of data shown within the trend analysis graph. The coloured lines in the graph display Flexural Modulus (MPa), the red line being the specified design minimum and the blue line being the actual

REPORT NUMBER	SAMPLE LOCATION	INITIAL REVIEW PASSED	RECONCILIATION PASSED
HAMM5008.0.2	Fairway Dr.	No	Yes
HAMM5008.0.3	Lottridge St.	Yes	Yes
HAMM501.0.1	Westway St.	Yes	Yes
HAMM5010.0.2	Colombia Dr.	Yes	Yes
HAMM5010.0.3	West 17th St.	Yes	Yes

Legend:

Sample passes	Yes
Sample fails	No

Table 1: Lateral liner sample review results.

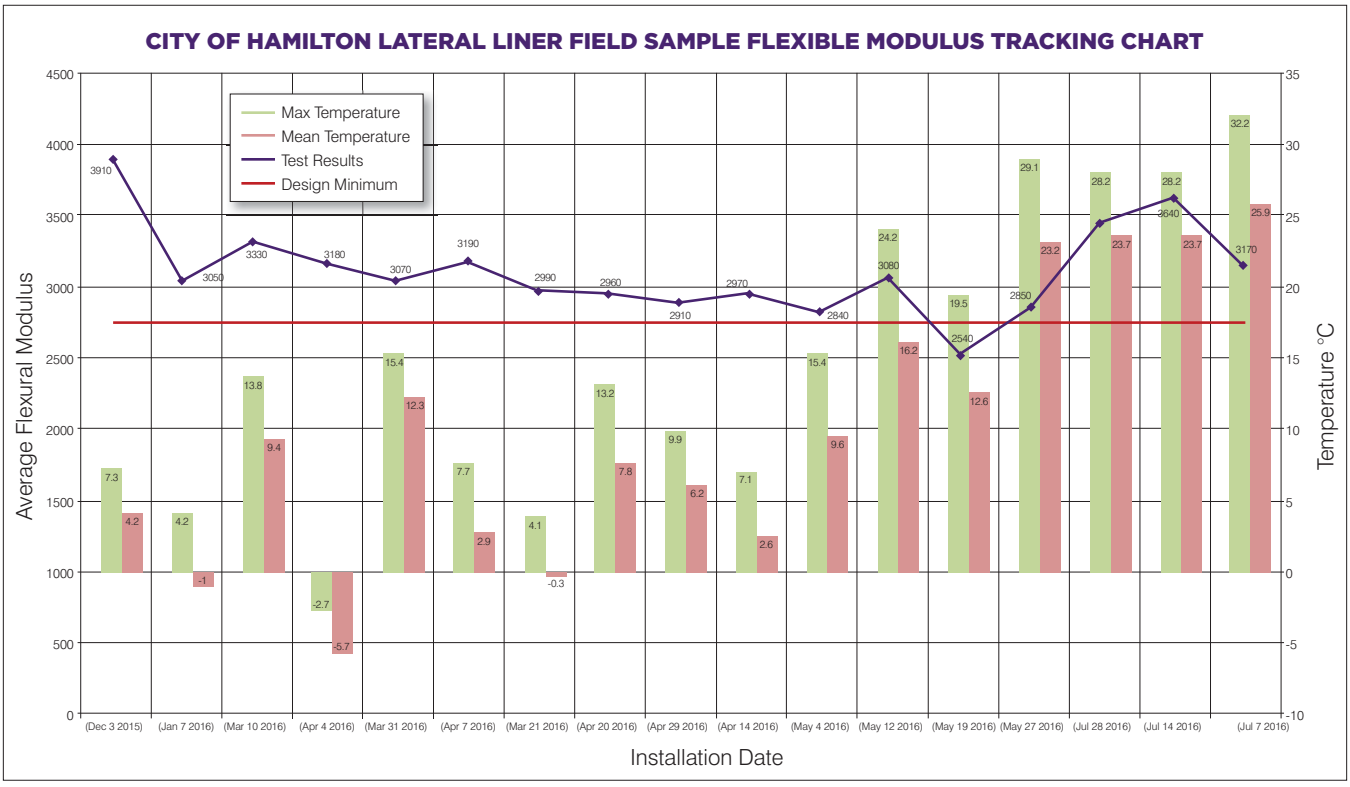

Figure 4: Lateral sample trend analysis.

tested values. The other data set in the graph as displayed by the bars is the ambient air temperature (°C) in Hamilton, the green bar being the maximum temperature of the day and the orange bar being the mean temperature over the course of the day. It is important to record and review the ambient air temperature in conjunction with the flexural modulus due to the resin's mechanism of cure. The resin used in the City's lateral lining program is ambient cure. While it is not clear if the degree to which the ambient air temperature affects the quality of cure, it is tracked to identify any correlation between air temperature and sample test results. While the City has been tracking these trends for the past year, no conclusions have been made regarding the impact of ambient air temperature relative to liner properties achieved. However, as previously mentioned it is common for insulation blankets to be used during cold temperatures.

CONCLUSION AND ONGOING IMPROVEMENT

Approximately 637 laterals were lined in 2016 with a total of 24 samples collected. The ongoing production and testing of proxy samples allow for improved trend analysis and monitoring.

The proxy above ground sample test results collected to date suggest that the liners in the ground have been installed to meet the requirements of the contract. To help substantiate the results of the above ground proxy samples, the City is considering opportunities to obtaining a number of samples from an actual installation through the excavation of lined laterals.

While the quality control of lateral CIPP installations is more challenging than mainline sewer CIPP, it is equally important in establishing that the installations are achieving the required performance. As with all trenchless technologies, continual

"As with all trenchless technologies, continual improvement in the processes and methods in the use of CIPP continues to evolve."

improvement in the processes and methods in the use of CIPP continues to evolve. It is vital that the same level of effort is put towards the processes and methods for their quality control.

The City is continuing to sustain its lateral CIPP testing in order to monitor the quality of the product being installed and to date has found good trends in the physical properties (flexural modulus) and thickness. Observed trends provide the City with confidence in the performance capability of the liners that are being installed.

It is clearly understood that the current QA/QC practices being undertaken are in the early stages of use and the City is continually reviewing these practices and methods to find opportunities to improve the ability to establish sound practices. This includes investigating the benefits of using plate samples for testing and how they could be created to more accurately reflect the lateral CIPP installations.

REFERENCES

- ASTM International (2012) – Standard Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems D5813-04, Reapproved 2012, USA.
- ASTM International (2002) – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials D790-02, USA.
- R. Vanstone, P. Moskwa, K. Bainbridge (2016) – Monthly Sewer Lateral Sample QA/QC Report, Robinson Consultants Inc., Canada.

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