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# Concrete Pipe Greatly Reduces Excess Soil Challenges

***Paul Imm, P.Eng.***
*Director of Engineering*
***Forterra Pipe & Precast, Ltd.***

***In December 2019, the province of Ontario announced that they were introducing a new regulation under the Environmental Protection Act that would result in a reduction in construction costs by making it easier to reuse excess soil generated during construction activities. This will ultimately minimize waste and provide clear rules for managing and reusing excess soils.***

The Ontario Ministry of the Environment, Conservation and Parks (MECP) estimates that 25 million cubic metres of excess soil is generated in Ontario every year. While most of this excess soil could be reused safely, it is often moved off-site because it can't or won't be reused at the development site. The MECP implemented the On-Site and Excess Soil Management Regulation (O.Reg. 406/19) on January 1, 2021 to help reduce negative impacts and costs from improper management of excess soil such as:

- Noise and dust
- Truck traffic and road damage
- Erosion and drainage
- Other social, economic, health and environmental concerns.

While MECP has created best practice guides and calculation tools to assist with the excess soil regulation, the Greater Toronto Sewer and Watermain Contractors Association (GTSWCA) retained WSP Canada to help its members identify opportunities for the effective and beneficial use of both excavated soils and recycled materials for buried pipe construction. A report, published in August 2020, reveals that the production of aggregate in Ontario is approximately 45 to 90 million cubic metres annually, with a growing demand over the next 25 years at unsustainable levels and an enormous carbon footprint associated with the mining and transportation of new aggregate sources.

The Executive Summary of the GTSWCA-WSP dentifies the following issues associated with disposing of excess soils:

*continued on page 2*

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# Concrete Pipe Greatly Reduces Excess Soil Challenges

*continued from page 1*

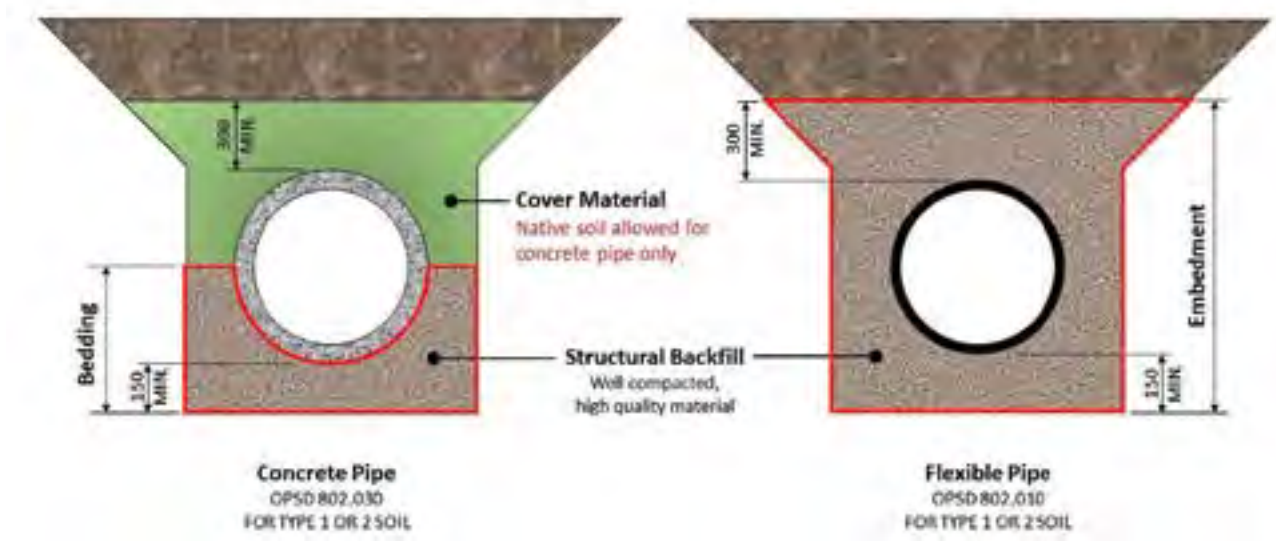
- Extra costs on many infrastructure projects
- Environmental impacts related to virgin aggregate extraction in existing agricultural and protected areas
- Additional trucking distances to import virgin aggregate materials
- Significantly larger carbon footprint related to the above issues.

The GTSWCA-WSP report also proposes the following key areas of recommendations:

- Performance requirements to ensure suitable performance of serviceability of engineered fill
- Compaction methods to improve engineering properties of fill
- Current uses and specifications on backfill material and compaction, and the need to explore reforms for more viable options
- Guidelines to help assess the suitability of excavated native soils as trench backfill
- Benefits of using recycled aggregates (or blended with RAP) as trench backfill for all weather placement
- Recommendations for restructuring public works tenders to allow for greater use of native soils and recycled materials for backfill.

Many years prior to this new MECP excess soil regulation, the Ontario Concrete Pipe Association published an article in the Fall 2013 edition Concrete Pipe Journal titled, *Concrete Pipe Installed with Recycled Aggregate: Good for the Environment and Good for the Economy*, which considers the opportunities to use recycled aggregate as a backfill material for concrete pipe, which flexible plastic or corrugated steel pipe products do not allow. The same claims can be made about using select native soils to install concrete pipe.

Ontario Provincial Standard Specifications (OPSS.PROV) 401 used by the Ministry of Transportation, Construction Specification for Trenching, Backfilling and Compacting, clearly identifies the differences between the installation requirements of a rigid concrete pipe and flexible plastic or metal pipe for sanitary and storm sewers, pipe culverts, subdrains, forcemains, and watermains. The figure below illustrates the terminology used in Ontario, with the critical backfill soil surrounding each type of pipe highlighted, often referred to as the structural backfill for the pipe.



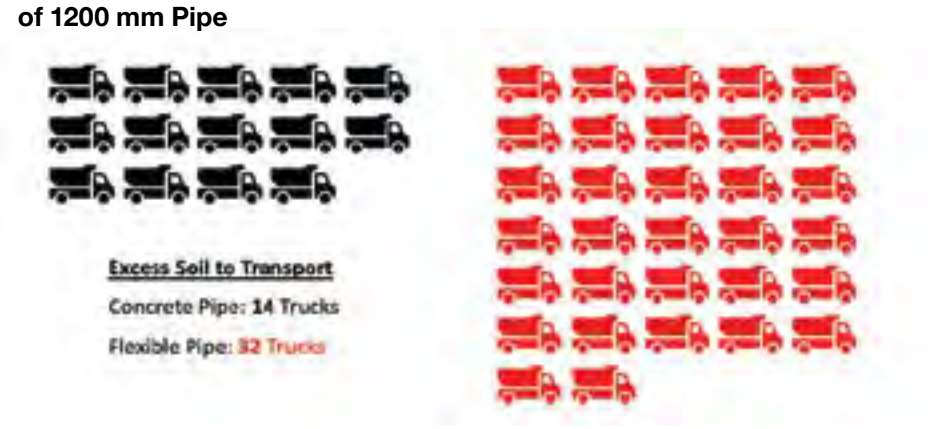

As highlighted in the figure, the structural backfill is critical for pipe-soil interaction to carry the loads imposed on the pipe and should consist of high quality material and proper compaction effort. For a rigid concrete pipe, this critical zone is limited to the pipe bedding which is from the bottom of the excavated trench to the springline of the pipe due to the inherent strength and load carrying capacity of the pipe. For a flexible plastic or metal pipe, the entire soil envelope from the bottom of the excavated trench to a minimum of 0.3 m above the pipe is required to allow the pipe to transfer the loads into its surrounding soil.

**Comparison of Excess Soil Generated by Pipe Structural Backfill**

| | Concrete Pipe | Flexible Pipe |
|---|---|---|
| Pipe Size | 1200 mm | 1200 mm |
| Outside Diameter | 1511 mm | 1374 mm |
| Minimum Trench Width | 2.51 m | 2.37 m |
| Structural Backfill Required | 1.38 m²/lin.m | 3.24 m²/lin.m |
| Soil per 100 m of pipe | 138 cubic metres<br>241 metric tonnes<br>14 dump trucks | 324 cubic metres<br>566 metric tonnes<br>32 dump trucks |

An assessment of these two very different installation details results in a plastic or metal pipe requiring more high quality backfill material and generating more than twice as much excess soil than a concrete pipe.

**Concrete Pipe Generates 18 Less Truckloads of Excess Soil per 100 m of 1200 mm Pipe**




A recent example of how concrete pipe can minimize excess soil generation and the construction costs related to meeting the new MECP regulation, the City of Ottawa along with local industry National Capital Heavy Construction Association (NCHCA) started their biennial construction specifications review in the summer of 2020. The review process divides up the City of Ottawa construction specifications and assigns working groups to each component. These working groups are comprised of City of Ottawa staff and key industry individuals. The Canadian Concrete Pipe and Precast Association (CCPPA) was asked to join the Water/Sewer Working group.

During the City of Ottawa specification review, the CCPPA proposed a change to the backfill requirement, for reinforced concrete pipe (RCP) only. The proposed change for concrete pipe installation was to allow for select native soils to be used as the cover material above the pipe springline. Currently only Granular A or Granular B required backfill for up to 300 mm above the top of the pipe for both concrete and plastic pipe. It was explained that flexible pipe systems (plastic or metal) require this embedment up to 300 mm above the top of the pipe for the flexible pipe system to have the capacity to carry the required loads. However, since concrete pipe does not rely on any structural capacity provided by the cover material above the springline, native soils could be utilised above the springline and thereby reduce the amount of excess soils generated.

This change was adopted by the City of Ottawa and is included in the 2021 City of Ottawa Construction Specifications dated March 1, 2021.

With this continuing evolution in specifications, locally produced concrete pipe provides governments and developers with a tremendous opportunity to reduce the excess soils generated, increase the use of properly processed recycled aggregates, and itself can be 100 per cent recycled at the end of a very long service life.

# Precon Supplies Lined Vaults for Twin Sanitary Sewer Upgrade in Calgary

***Mark Draper, P. Eng.***
*Regional Solutions Lead – Conveyance and Storage,*
***Jacobs***
*Calgary, Alberta*
*Precast Producer:* ***Precon***

The project located in Calgary, Alberta, consisted of twinning the existing reinforced concrete pipe (RCP) sanitary sewer. As part of this project, a flow balancing chamber would be required to balance the flow between the existing RCP sewer and new RCP sewer.

The initial design for the chamber called for either cast-in-place or a precast concrete chamber. Given the substantial cost relating to the diversion pumping required, an accelerated construction solution was critical to keep the project both on time and on budget. A precast concrete structure was selected as it would provide the shortest construction time.

Jacobs (CH2M) worked closely with Precon's engineering team to design the chamber. It was decided that the chamber should be fabricated in two separate structures and connected together once installed on site. This would provide safe and effective transport of each of the elements as well as provide rapid assembly on site. The size of the assembled chamber was 8 m x 4.6 m x 7.3 m high.

Some design features incorporated into the chamber were:

- Chamber designed to meet CL-800 traffic loading
- Cast in HDPE liner on all chamber elements. Liner was designed to be field welded around each joint and pipe penetration to ensure proper seal
- Chamber connection details were designed by Precon

*Last riser installed on lined chambers*

*First half of lined chamber installed*

- Stainless steel flume to be installed to provide the required flow balancing. Precon worked closely with the general contractor, Standard General, to ensure that the installation of the flume would be quick and hassle free. Special care was taken to ensure that the HDPE lining of the chamber would not interfere with the flume.

One of the most challenging constraints on the projects was the need to construct a large-scale sanitary bypass. By selecting a precast solution, the required timeframe for the bypass to be operational was reduced to approximately a three week duration at a cost of approximately $1 million. Construction of the bypass took nearly a month to get set up and operational. Standard General along with United Rentals set up 12-18 inch pumps (6 primary & 6 backup) with 3-24 inch HDPE discharge lines running approximately 400 feet to the discharge location to bypass estimated flows of 2800 l/s. Due to the size and quantity of suction points required, the existing 1500mm RCP pipe was exposed in 3 separate locations and the top half of the pipe carefully cut and removed to allow 4-18 inch suction points to be installed at each location. These pipe tops were carefully reinstalled on the existing line after the bypass was decommissioned and removed from site. This operation proved very challenging due to the congested work area within a City of Calgary park in very close proximity to Nose Creek, a feedermain as well as an active CPR rail line ROW.

Precon also worked closely with the general contractor, Standard General, to ensure each of the chamber elements were delivered sequentially as the space, on site, was limited.

Jacobs (CH2M) would like to thank Precon for their precast concrete proficiency in terms of engineering, production and logistics. Precon was able to address the challenges associated with the balancing flow chambers and ensure that a high-quality product was produced, delivered and quickly assembled on site.

# CCPPA Technical Resources Manager - Alberta & British Columbia

*Trevis Hanson, C.E.T.*

The Canadian Concrete Pipe & Precast Association is pleased to announce that Trevis Hanson, C.E.T., has been appointed to the position of CCPPA Technical Resources Manager - Alberta & British Columbia.

Trevis graduated from Lethbridge Community College in 1995 with a diploma in Civil Engineering Technology. He has over twenty-five years of experience, including employment with consulting engineers and contractors. His most recent position was as a Bridge Operations Technologist with the City of Calgary since 2014. Prior to that, Trevis was a Sales Representative with Armtec Engineered Precast Concrete from 2012 to 2014. This position involved promoting sound wall systems and mechanically stabilized earth retaining wall systems. He currently resides in Okotoks, Alberta.

Please join us in welcoming Trevis to the Canadian Concrete Pipe & Precast Association.

# Forterra Provides Microtunneling Solution for Twin Culvert Replacement

***Greg MacDonald, P.Eng.***
*Senior Structural Engineer, Principal*
***Harbourside Engineering Consultants***
*Calgary, Alberta*
*Precast Producer:* ***Forterra Pipe & Precast, Ltd.***

Harbourside Engineering Consultants (HEC) was retained by Construction Demathieu and Bard (CDB) to develop the structural design and temporary construction works required for the Calamity Creek Culvert Replacement Project, just north of New Liskeard, Ontario. The purpose of the project was to replace and decommission an existing cast-in-place reinforced concrete, single cell box culvert having a cross section of approximately 3.05 m wide x 2.45 m high, running 270 m long. The existing structure was also situated up to 8 m below the grade of the roadway, which added to the project's challenges. Ministry of Transportation of Ontario (MTO) project specifications required twin 2.1 m inside diameter (I.D.) pipe culverts to meet the predetermined hydraulic capacity requirements. The MTO contract also required that the project be completed without causing significant disruptions to the traffic along Highway 11.

Forterra recommended that the concrete microtunneling pipe would be produced using the "drycast" process, which allows for higher production rates compared to the "wetcast" process. It was designed with a typical microtunneling joint consisting of a 13 mm thick galvanized steel ring. In addition to the steel end ring, the joint also featured a confined tapered profile gasket that provides a hydrostatic capacity of 30 psi. Forterra's engineering team provided the structural designs for the pipe which were reviewed and accepted by Harbourside Engineering and the MTO.

*Arial view of Highway 11 project*

*Launch shaft for microtunneling pipe*

The 2.1 m microtunneling pipe also needed to meet several quality assurance and certification standards, including the requirements of the Canadian Precast Concrete Quality Assurance (CPCQA) certification program. Pipe segments were also assessed using the requirements of the D-Load test and hydrostatic test, which were performed by Forterra at their manufacturing facility. The D-Load (or Three Edge Bearing test - 3EB) is a physical test used to ensure the pipe will provide the required structural capacity.

The tunneling contractor that was selected for this project was CRS Tunnelling. They selected an Earth Pressure Balance Tunnel Boring Machine (EPBTBM) for this project. The EPB allows soft, wet, or unstable ground to be tunneled safely with speed. This TBM was equipped with face control doors and chamber access in case the crew needed to go into the cutting head chamber for maintenance or inspection. The latter would prove important as the TBM did hit a major underground obstacle of wood debris during the first drive.

The twin pipe culverts were installed in two drives. Each drive would run the entire 270 m length. As mentioned above, the project did encounter a delay due to the debris, during the first drive but was able to finish. The delay resulted in the second drive occurring during a cold spell with some morning temperatures hitting -40°C. Both the concrete microtunneling pipe and the TBM continued to operate throughout this very cold temperature. The second drive broke through the receiving shaft on December 12, 2019. The project, which included the decommissioning of the existing culvert, was completed in October 2020.

Forterra's concrete pipe/precast engineering expertise was a key part of this project's success. Their contribution in terms of design and production of the microtunneling pipe solution along with their collaboration throughout the project exceeded expectations.

# Stanley Park's Beaver Lake Utilises Custom Box Culverts with Fish Ladders to Improve Ecosystem

***Jason Omelaniec***
*Technical Marketer*
*Precast Producer:* ***Langley Concrete Group***

The iconic 405-acre Stanley Park borders downtown Vancouver, British Columbia, and sits pristinely on Burrard Inlet offering visitors a unique glimpse at what the natural setting of Vancouver looked like before urbanization. Nestled inside Stanley Park is Beaver Lake, which is one of the very few freshwater lakes existing in Vancouver, and the outlet Beaver Creek is one of only three remaining riparian waterways in the city of Vancouver.

The Beaver Lake Restoration Plan includes an effort to improve the ecosystem of the lake, and in Phase 1 the use of precast concrete Box Culverts with fish ladders and custom Headwalls to upgrade the lake's outlet stream was conceived. By improving the flow of freshwater to Burrard Inlet and thereby enhancing the channel characteristics of the outlet, it is hoped that many native species will be encouraged to pass through and thereby populate the lake.

Precast concrete box culverts supplied by the Langley Concrete Group, which are designed in accordance with ASTM C1433M specifications, were selected with inside spans of 3.35 m and internal rise of 1.52 m and in lengths of 2 m weighing 17,560 kilograms each. In each of the five sections, variable-height custom fish ladders with staggered rectangular low-flow notches were cast at the inverts of the precast box culverts. Pooling waters flowing between the seven fish ladders should facilitate the necessary water for fish to pass the vertical incline from Burrard Inlet to Beaver Lake. At each end of the run of precast concrete box culverts, Langley Concrete Group also supplied 4.1 m span headwalls for both inlet and outlet control structures.

*Completed structure*

Jack Tupper, Landscape Architect - Park Development (City of Vancouver) provided a project write-up. The following is an excerpt from his report:

"In the fall of 2020, as part of the Beaver Lake Enhancement Masterplan, the City of Vancouver worked with a team of consultants and contractors to install Phase 1 of the project; a newly improved Beaver Lake Outlet.

"With dramatic fluctuations in water levels, this new larger and more robust outlet is able to balance lake levels throughout the year and provide continuous flow into the adjacent Beaver Creek. Even the growing population of beavers, that inhabit the appropriately named lake, struggle to block the new structure entirely.

The new outlet is the first step in rejuvenating Beaver Lake and its ecological health."

# Proform Utilises 3D Modeling, of a large box culvert project, for a New Residential Development in the City of Calgary

***Brock Dyck, P.Eng.***
*Project Engineer*
***Urban Systems Ltd.***
*General Contractor:* ***Blue-Con***
*Precast Producer:* ***Proform***

With communities seeing more and more surface flooding due to larger intensity storms and inadequate underground infrastructure, the City of Calgary is being proactive in mitigating flood waters in new upcoming communities. Anticipating flooding at the design stage not only adds future savings to homeowners but also has a big positive environmental impact on future communities.

Springbank Hill Phase 3 is one of these new communities to undergo large scale storm retention at the design and construction stage to mitigate future flooding and the need to upgrade existing underground infrastructure in the future, thus saving costs and negative environmental impact.

*Maintenance hole and culvert connection*

In order to maintain the community layout and clearances to sanitary and other services, the storm sewer lines were placed in the middle of a winding road. This resulted in the requirement of having a 1200 mm x 2400 mm precast concrete box storm water retention line to follow the "S" curve shape of the road.

In conjunction with Blue-Con (the general contractor), Proform's engineering team produced a 3D model showing the location of each of the 100 precast box units that would be providing the stormwater retention system. In addition, this model was used to determine the location of each of the maintenance holes, ensuring that they would not be located between two ends of a box unit and providing the most effective use of each precast box unit. There were also a number of beveled, reinforced concrete pipes (1050 mm inside diameter) included in this storm sewer system.

Logistical coordination was also enhanced by the 3D model. The large majority of the box units were beveled to produce the required curvature and ensure that they would follow the roadway centerline. The 3D model was used to colour-code each of the boxes belonging to their appropriate radius and confirm that the proper beveled box was installed in the proper location and radius.

Given the high production demands, Proform was able to produce these box structures using the "dry cast" method which allows for higher production than the wet cast.

Approximately four to six boxes were produced per day. Using the modeling, Urban Systems, Blue-Con and Proform were able to coordinate production and ensure that the required boxes were produced and delivered to the site without causing unnecessary delays. This was key to ensuring that the project remained on schedule and in line with the design requirements.

I would like to thank both Blue-Con and Proform for their contribution to the success of this project, and highlight that a significant amount of effort was put into the design stage of this project with Urban Systems, Blue-Con and Proform working together. Through this early collaboration, we were able to identify and address a number of issues prior to the installation phase of the project to make this a successful project for generations to come.

*Box culvert designed and manufactured with a required radius*

# Cast in Collaboration

***Russell Sleaper***
*Project Coordinator*
***TULLOCH***
*Precast Producer:* **DECAST**

“TULLOCH understood the need to collaborate early,” says Dan Haggerty of DECAST.

“I received the initial call from John McDonald. He knew that consulting with those who would build and install the components would make the design and project planning processes efficient. And it ensured his design would consider all the challenges associated with this complex project.”

So began the Fort Creek Aqueduct Replacement project in Sault Ste. Marie, Ontario, with tight collaboration as the foundation for a complex, time-sensitive project in a busy commercial corridor.

Sault Ste. Marie’s Fort Creek watershed has a total catchment area of 1,516 hectares. It runs approximately 8 km to its outlet south of Bay Street West. A flood control dam intercepts run-off from the watershed; and the aqueduct channels it through a heavily urbanized area, known as Steelton, south to St. Mary’s River.

TULLOCH Engineering Inc. had completed a Class Environmental Assessment for the City of Sault Ste. Marie, to determine the hydraulic capacity required of a replacement aqueduct to meet current stormwater standards. Its hydrologic analysis of the watershed determined that the aqueduct must be designed to accommodate the highest flows generated by the Timmins Regional Storm.

Parts of the original structure, a cast-in-place concrete box storm sewer, were over one hundred years old and required replacement to ensure the safety of motorists and pedestrians. The City of Sault Ste. Marie engaged TULLOCH again to undertake detailed design and tendering for construction.

The project divided naturally into two phases based on scope and challenges. Phase 1 replaced a significant length of aqueduct under Wellington Street West, one of the main roads bringing traffic into the city. Phase 2 solved the specific challenge of replacing an aged box culvert running beneath a narrow laneway road with several utilities overhead.

*Hydraulic lift for open bottom culvert installation*

*Fort Creek Aqueduct project arial view*

Safety, time and space were key considerations for both phases. Phase 1 had to be implemented with two of Wellington Street’s four lanes always open for traffic. Sanitary laterals beneath the existing aqueduct also had to be replaced without interrupting sanitary and water services. The key project challenges suggested that a precast solution would be the best option. The tendering process created a credentialed team to execute it, bringing together TULLOCH, DECAST Ltd., and Avery Construction Ltd.

The team designed standard, 2.44-metre-long precast box sections to be installed beside the existing aqueduct. At various points along Wellington Street, sections were tailored. Some sections included lateral pipe connections to carry water from the old to the new aqueduct, thereby allowing the old structure to be abandoned in phases and would switch the flow between barrels of the twin cell closed box section. Where possible, sections were made wider to maximize the size of the opening. These meticulous design details optimized the hydraulic performance of the aqueduct. They required TULLOCH to collaborate continually during the design process; from DECAST’s constructability assessments and tight dimensional tolerances for precasting, to the exacting installation by Avery Construction. The benefits to Sault Ste. Marie were clear at the end of Phase 1: a critical infrastructure project completed safely, with minimal impact to traffic and significant budgetary savings.

Phase 2 presented more complexity, yet again, the TULLOCH-DECAST-Avery collaboration found smart solutions. TULLOCH’s John McDonald described the challenge:

“Part of the existing aqueduct was a cast-in-place box culvert from the early 1900s. Its lid formed the road surface for a laneway parallel to John Street. It had failed a few times and become a burden on city maintenance and a public safety hazard.”

Property limits in the laneway approached the edge of the old aqueduct, leaving the team with little space to work in. A web of overhead utilities and an irregular shape through the cross-section compounded the challenge. The team looked at liner options during TULLOCH’s design but the shape, hydraulic and structural concerns demanded a robust structural solution with sufficient hydraulic capacity. TULLOCH and DECAST devised a three-sided precast culvert that would sit on new footings within the existing structure. While avoiding demolition and removal of the old culvert, the solution left a restrictive area that would determine the size of new precast items. The structural design called for 45 MPa concrete to achieve thinner precast walls and an interior shape to accommodate maximum stormwater volumes. Each section would then slide into place with only 50 mm of buffer space at its sides and 25 mm above. Avery Construction’s custom hydraulic cart answered the challenge of lifting the precast sections 25 mm above the foundation’s keyway, moving the sections along the aqueduct line, and then lowering them into place.

The team designed and constructed 95 per cent of the Phase 2 structure this way. The remainder, where the aqueduct crossed John Street, benefited from extra space. It allowed a full demolition of the existing structure. The replacement precast sections were tied into a secondary bypass aqueduct, twinning the overflow structures in the middle of the street.

Precast was undoubtedly the right choice for this project, however, its design was just one of several collaborative initiatives that combined to deliver an exceptional piece of infrastructure for the City of Sault Ste. Marie. Open communication in design, manufacture and installation were crucial. The team shared its expertise freely and all partners clearly took a conscientious approach to service, contributing to early completion within agreed budgets.

# Retirement Announcement: Grant Fraser

*Grant Fraser*

After entering his 48th year of extraordinary service in the steel and wire reinforcing industry, Grant Fraser announced his retirement as of April 2, 2021. Grant held various positions at Stelco, Frost Fence, LEC Steel, Laurel-LEC Steel and most recently at Nucor-Laurel Steel.

Grant was also a very active member of multiple trade associations including the OCPA and CCPPA. His contributions were always focused on improving the industry.

Although Grant has retired from day-to-day work life to spend time with family and riding his road bike, he will continue to provide consulting support to the Nucor-Laurel Steel team.

Please join us in congratulating Grant on his distinguished career, contributions and accomplishments.

# Retirement Announcement: Bernard Grégoire

*Bernard Grégoire*

Bernard Grégoire, President and COO of Hamilton Kent, had announced his retirement as of May 2021.

Bernard dedicated his entire career to serving the manufacturing industry. With a background in engineering, he always searched for creative and innovative solutions. As stated by Bernard, "During my twenty-six year tenure, I feel as though Hamilton Kent has made significant contributions to enhancing the resiliency of underground infrastructure by providing innovative and reliable watertight seals."

During his time at Hamilton Kent, Bernard was responsible for two acquisitions: IPS in 2006 and NC Rubber in 2001. Additionally, Bernard expanded Hamilton Kent's manufacturing base with the commissioning of a new manufacturing facility in Winchester, Tennessee in 2007.

Please join us in congratulating Bernard on his prominent leadership role during his career, as well as his various contributions to our industry.

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## Precast Manufacturing Equipment and Accessories

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