

OUT OF THE BOX INTO A PIPE: Use of Large Diameter HDPE Pipe in Place of Channels

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Introduction

The Harmony Creek Water Pollution Control Plant (WPCP) is operated by the Regional Municipality of Durham (Durham Region) and is located in Oshawa, Ontario. It provides wastewater treatment to the City of Oshawa and the urban areas of Courtice. This WPCP consists of two separate plants: Plant 1 and Plant 2. Plant 1 was constructed in 1952 and Plant 2, in its current configuration, was completed in 1974.

Plant 2 was originally intended to be a primary plant, but an expansion in 1974 added secondary treatment processes. Flow from Plant 1 has recently been diverted to the newly constructed Courtice WPCP and Plant 1 has subsequently been removed from service. Plant 2 remains in operation, and is required to do so for an additional 15 to 20 years until a planned expansion of the Courtice WPCP will allow Courtice to process Plant 2 flows.

However, several of the major pieces of equipment in Plant 2 have reached, or are about to reach, the end of their service life. Durham Region, therefore, has embarked on a Major Maintenance Project to upgrade or replace crucial components in Plant 2 to ensure that the plant will continue to operate successfully for the additional 15 to 20 years.

Primary Clarifier Bypass Overview

Since Plant 2 was originally intended to be a primary treatment plant, design of the plant's only primary clarifier did not include a means of diverting flow around the clarifier to facilitate maintenance activities that require a clarifier shut-down. To perform such maintenance activities, the options available included a bypass of all of Plant 2 or construction of a bypass for the primary clarifier. Since a complete plant bypass of Plant 2 could lead to a violation of the plant's Certificate of Approval, it was decided to construct a primary clarifier bypass. This bypass would also benefit the Major Maintenance Project, which includes replacement of the primary clarifier's travelling bridge sludge collection mechanism, and will require a shutdown of the primary clarifier.

Typically, concrete channels are used to bypass such major unit processes; however, the handrails and gratings required as part of a channel would have impeded access to the primary clarifier. Clear access to the clarifier will be needed during the travelling bridge mechanism replacement and any future maintenance. As a result, it was decided to look at using a buried pipe for the bypass, as a buried pipe would not require any above-grade structures.



Pipe Evaluation

Four types of pipes were considered: reinforced concrete sewer pipe, concrete pressure pipe, high-density polyethylene (HDPE), and steel pipe. Factors such as performance, ease of installation, and cost were evaluated. Results of the evaluation showed that corrugated HDPE pipe was the best option as it met the performance requirements for physical fit and its ability to withstand vehicular loadings with minimal ground cover, and was also the least costly option.

The HDPE pipe chosen was the N-12® WT corrugated HDPE pipe, as supplied by Advanced Drainage Systems Inc. (ADS). This pipe had an annular corrugated exterior for strength and a smooth interior wall to maximize flow capacity. A 1200 mm diameter pipe was chosen to accommodate a flow up to 2.0 m³/s. Although classified as a drainage pipe, it can be, and was, supplied with bell and spigot joints with a proprietary sealing gasket to provide water-tight connections.

Under normal flows, the HDPE pipe would see gravity flow. However, at times, the flow could be sufficient to full the pipe. Under such conditions, the pipe would operate under a small amount of pressure.

One of the design considerations with using buried pipe was the pipe's ability to withstand vehicular loading with minimal cover. The bypass installation area will also be the access area for heavy equipment during the travelling bridge replacement. The pipe's invert elevation was 1800 mm below grade, and the 1200 mm diameter pipe required no more than 600 mm of cover over the pipe. According to ADS' literature, with 600 mm of cover, the N-12® WT corrugated HDPE pipe system is capable of withstanding an E-80 load, which is equivalent to loadings used in the design of railway lines.

HDPE pipe was significantly less costly than the other types of pipe. The installed cost of approximately 58 m of 1200 mm diameter corrugated HDPE pipe was \$134,000. This was significantly lower than the estimated \$250,000 (minimum) cost of installing a channel or the other types of pipe. The difference in cost was a result of the low supply cost of HDPE compared to the other types of pipes, and the pipe's relative ease of installation.

A concern associated with using HDPE pipe in this application was that once filled with water, the pipe might heave due to its minimal weight. During construction, this possibility was tested during a leak test. Once the HDPE pipe was installed, the area was backfilled and compacted to 98% SPDT. The pipe was then filled to capacity with water, and left to stand for approximately 20 hours. After this time, the area was inspected. No heaving was observed.

HDPE Pipe Installation

Installation of the HDPE pipe was straight-forward. There were, nonetheless, two instances where unforeseen events occurred. During the first event, a heavy, night-time rainfall caused sand and silt from the banks of an open excavated section of the HDPE pipe to flow into the excavated area. The spacing between the ribs of the corrugations allowed the sand and silt to flow under the pipe, and the light weight of the HDPE allowed the accumulated sand and silt to lift the pipe.

The excavated area was at a 90° elbow (two 45° bends with a bell and spigot joint), and the heaving caused the joint to separate. When the result of the rainfall was discovered, the excess soil was excavated, and the joint was easily reassembled. The results of the subsequent leak test showed that the integrity of the joint was not compromised by the heaving.

Nonetheless, this incident brought to light an important consideration when using the corrugated HDPE pipe: measures must be taken to divert heavy rainfall away from pipe sections that have not yet been backfilled.



The second unexpected event occurred during leak testing. When the leak test was first performed, a small leak was observed at the connection point between the HDPE pipe and the newly constructed concrete effluent chamber at the HDPE pipe's outlet end. The system was emptied, but when workers entered the concrete chamber repair the leak, they observed water pouring out of a small hole in the corrugated portion of the HDPE pipe. A closer inspection revealed a small channel (approximately 5 mm in diameter) that ran along the length of the exterior of the smooth inner pipe, and connected all of the ribs of the pipe (see Figure 1).



Figure 1: 5 mm diameter channel on exterior of HDPE pipe



Figure 2: 5 mm diameter channel termination at end of pre-fabricated pipe segment.

The HDPE pipe is supplied in pre-fabricated segments of equal lengths (with bends and manways supplied separately). In each pre-fabricated segment, a 5 mm diameter channel runs through the ribs and is terminated and sealed at the last rib to prevent fluid from entering the ribs (see Figure 2). However, for the bypass installation, the pre-fabricated segments at the inlet and outlet of the bypass needed to be cut in the field to fit the pipe segments to the required length. Cutting the pipe segments also cut through the small channel, which allowed water to flow from the influent and effluent chambers into the first and last ribs respectively.

Having water in the ribs of the HDPE pipe was not desirable as it posed the risk that, if the water were to freeze in winter, the resulting expansion might cause the pipe to crack. To remedy the problem, the channel was sealed using construction foam, and then covered with Blueskin® (a high-performance, self-adhering, waterproofing underlayment) to prevent water from entering.

Once the sealing was done, the leak between the pipe and the concrete chamber was fixed and the leak test repeated. The system passed the leak test, and another important consideration about installing the HDPE pipe in this application was discovered.

At a later date, the manufacturer was asked about purpose of the small channel, and they indicated that the channel is needed in the manufacturing of corrugated HDPE pipe to vent hot air from the corrugations.

Conclusion

For the Harmony Creek WPCP, the corrugated HDPE pipe was an ideal solution for addressing issues associated with future construction requirements and minimal ground cover. It met the design requirements and was the least costly option.