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Let's Solve Water

Case study
Condition assessment

Lake Huron and Elgin Area Primary Water Supply Systems, Ontario, Canada

RISK-BASED ASSET MANAGEMENT APPROACH PREVENTS PCCP FAILURES AND SAVES UTILITY OVER CA$1 MILLION

The Lake Huron and Elgin Area Primary Water Supply Systems located in southwestern Ontario draw from Lake Huron to the north and Lake Erie to the south. Together, they provide water for approximately 500,000 residents across 15 municipalities, including the City of London. The Lake Huron Primary Transmission Main is a 60-kilometer (37-mi) pipeline that transports up to 340 million liters per day (90 MGD). This critical pipeline connects the water treatment plant on the shores of Lake Huron to a terminal reservoir north of the City of London.

Over the past 55 years, the main has experienced four catastrophic failures. Since the most recent failure in 2012, Lake Huron Primary Water Supply System (LHPWSS) has adopted a proactive asset management plan that incorporates condition assessment and continuous monitoring data. Using this approach, LHPWSS has avoided failures, minimized disruptions, improved maintenance and capital planning, and achieved significant cost savings for reinvestment in this regionally significant infrastructure.

Challenge

LHPWSS constructed the original Lake Huron Primary Transmission Main in 1965. The main is comprised of prestressed concrete cylinder pipe (PCCP) that is 1200 millimeters (48 in) in diameter.

The pipeline experienced failures in 1983 and 1988. Due to these failures, LHPWSS undertook a major capital project to create redundancy along the pipeline by twinning it in three high-pressure areas. Then, in 2010 and 2012, the transmission main failed again in sections that were not twinned.

These failures disrupted the supply of drinking water to a significant portion of southwestern Ontario. The failures also caused serious flooding. Soil erosion and deposition across multiple farms affected approximately 70 hectares (173 ac) of prime agricultural lands.

LHPWSS decided to take an innovative, proactive approach to managing risks associated with the Lake Huron Primary Transmission Main. The utility started with assessments to better understand the main's

PROGRAM HIGHLIGHTS

- Electromagnetic inspection and continuous pipeline monitoring inform proactive replacement of eight pipes
- Each proactive repair represents a 5:1 return on investment compared to the cost of a catastrophic failure
- Remaining useful life calculations for each pipe support asset management planning

SERVICES PROVIDED

- SmartBall® leak and air pocket detection
- PipeDiver® condition assessment
- SoundPrint® acoustic fiber optic monitoring
- Structural evaluation services
- Transient pressure monitoring

Pipe Material: PCCP
Inspection Length: 60 kilometers (37 mi)
Diameter: 1200 millimeters (48 in)

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baseline condition. Their goal was to monitor the pipeline continuously after establishing a baseline.

Solution

In 2012, LHPWSS partnered with Pure Technologies, a Xylem brand, to conduct an acoustic leak detection inspection with the **SmartBall® platform** and an electromagnetic inspection with the **PipeDiver® platform**.

Both inline, free-swimming tools can inspect in-service pipelines and cover long distances in a single deployment. This was important for the critical Lake Huron Primary Transmission Main, as shutdowns cannot last longer than 24 hours. The main also runs within easements across agricultural properties, with long distances between access points.

The SmartBall platform detected three acoustic anomalies that sounded like leaks. Once investigated, two turned out to be off-take valves passing water during the inspection. The third anomaly was caused by an air release valve.

Despite previous failures, only a small fraction (0.5 percent) of the nearly 10,000 pipes assessed with electromagnetic technology showed signs of deterioration. In PCCP, broken prestressing steel wire wraps are the primary sign of deterioration – the more broken wire wraps, the greater the pipe distress. Most of the distressed pipes identified had low level damage. However, the inspection revealed some sections with signs of significant pipe wall deterioration.

Using electromagnetic inspection data, Pure Technologies evaluated the risk of failure for each distressed pipe. Finite element analysis performance curves help inform decisions about the point at which a distressed pipe should be replaced. Based on the inspection data and structural analysis, LHPWSS proactively replaced six pipe sections.

For LHPWSS, the next step toward reducing risk and providing a higher level of service was to continuously monitor the Lake Huron Primary Transmission Main using acoustic fiber optic (AFO) technology. In 2015, Pure Technologies installed the **SoundPrint® AFO** platform into the transmission main, without removing it from service. The monitoring platform detects and locates wire breaks in near real time, providing an advanced warning system to avert potential failures. Using this technology, LHPWSS has reduced the risk of service failure at a fraction of the capital cost of building further redundancy into the system.

Since 2015, LHPWSS has replaced two distressed pipe sections in response to increasing wire break activity detected by the AFO platform. The most recent instance occurred in early 2020. The monitoring system alerted LHPWSS to an issue near the joint of two neighboring pipes. It was not clear whether the wire breaks were spread across both pipe sections, but a single pipe with that number of wire breaks could be dangerously close to its yield limit. The utility took a conservative approach and decided to proactively replace the pipe.

The SoundPrint AFO monitoring platform identified increasing wire break activity on this pipe in early 2020. LHPWSS' decision to replace the pipe prevented a potential catastrophic failure.

"The Lake Huron Primary Water Supply System uses inspection and monitoring data combined with engineering analyses to identify urgent repair needs and plan future maintenance and capital projects. With this information, we are making proactive, cost-effective, and timely investments that benefit the region's municipalities and extend the serviceable life of the Lake Huron Primary Transmission Main."

Andrew J. Henry, P.Eng.
Director, Regional Water Supply
Lake Huron & Elgin Area Water Supply Systems

During replacement, Pure Technologies scanned the distressed pipes with an external electromagnetic tool to verify the monitoring results. The team confirmed that all wire breaks were on one pipe section. A large crack was visible on the pipe's underside as it was removed from the ground. The monitoring data and LHPWSS' decision had prevented a potential catastrophic failure.

Outcome

The 2012 electromagnetic assessment provided a snapshot of the Lake Huron Primary Transmission Main's condition at the time of inspection. Ongoing monitoring provides continuous information on the condition of each pipe and a view of overall pipeline deterioration.

Leveraging this information and a large database of comparable results, Pure Technologies developed a model for predicting future pipeline degradation. With information on the remaining useful life of each pipe, LHPWSS now has a better understanding of when individual pipes may fail. The projections estimate that 10 percent of pipes in the Lake Huron Primary Transmission Main could exceed their yield limit by 2045, with a probability between 30 to 50 percent. One percent of these pipes are considered high risk and have a greater than 50 percent probability of failure over the next 20 years.

Condition assessment data informs LHPWSS' short- and long-term asset management planning efforts. Using this information, the utility balances risks, asset performance, and costs to meet target levels of service for its municipal customers.

The 2012 Lake Huron Primary Transmission Main failure cost approximately CA$1.5 million. Replacement costs LHPWSS closer to CA$300,000 – a 5:1 return on investment in cost avoidance for each proactive repair. With actionable data about their assets, LHPWSS has maximized the serviceable life of its critical transmission main while avoiding failure and premature replacement costs. Pipeline condition data has also enabled the utility to make informed planning decisions that minimize service disruptions while optimizing capital, operations, and maintenance resources for this regionally significant infrastructure.

Top: With monitoring data, LHPWSS can conduct selective, proactive repairs rather than replace the entire pipeline.

Bottom: Pure Technologies removes and reinstalls the fiber optic monitoring cable in a section of repaired pipe.

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