Condition Assessment Technologies for Water Transmission and Sewage Conveyance Systems

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Pure Technologies Ltd

Executive Summary

This project explores condition assessment technologies suitable for Metro Vancouver's Water Services and Liquid Waste Services linear assets. Metro Vancouver is currently performing condition assessments on gravity sewer mains using closed-circuit television (CCTV) inspections. Due to constraints including pipe access and flows, the condition of water mains, forcemains, and marine crossings cannot be easily assessed.

This project involved researching and categorizing condition assessment technologies for water and sewer mains. The summary table provided in 'Detailed Summary of Condition Assessment Technologies' section includes a definition of different available technologies, their pros and cons, suitable pipe material and diameter range, inspection accuracy, cost and applicability to the Utilities. A cost estimate was prepared for two sample projects: Cambie Richmond No. 2 water main (marine crossing) and Columbia forcemain.

The recommended condition assessment technologies for each Utility are summarized in Table 1.

Table 1. Recommended condition assessment technologies for each Utility

Utility	Pipe	Technology	Tool	Vendor
Water	Mains	Acoustic Inspection	SmartBall or Sahara	Pure Technologies Ltd
		Electromagnetic Inspection	See Snake	Russell NDE System Inc.
			PipeDiver	Pure Technologies Ltd
	Marine Crossings	Acoustic Inspection	SmartBall	Pure Technologies Ltd
		Electromagnetic Inspection	See Snake	Russell NDE System Inc.
			PipeDiver	Pure Technologies Ltd
Liquid Waste	Gravity Mains	Visual Inspection	CCTV	various
	Force Mains	Acoustic Inspection	SmartBall or Sahara	Pure Technologies Ltd
		Electromagnetic Inspection	See Snake	Russell NDE System Inc.
			PipeDiver	Pure Technologies Ltd
	Marine Crossings	Acoustic Inspection	SmartBall	Pure Technologies Ltd
		Electromagnetic Inspection	See Snake	Russell NDE System Inc.
			PipeDiver	Pure Technologies Ltd

Table of Contents

List of Tables

Scope

The purpose of this project is to determine the suitability of condition assessment technologies for assessing the condition of Metro Vancouver's water transmission and sewage conveyance systems, including water mains, forcemains, and marine crossings.

Overview

Current State

Metro Vancouver is currently assessing the condition of water mains using indirect methods (remotely assessing pipe condition) including desktop studies, leak reporting, risk-based condition assessment strategy, corrosion monitoring and visual inspection such as excavation. A direct method is currently used for gravity sewer mains (CCTV inspections). There are constraints to be considered for selecting condition assessment technologies for Metro Vancouver such as no interruption of water service and no pipe dewatering. To overcome the problem, non-destructive field inspection methods of condition assessment are required.

Methodology

The method of determining the best suitable condition assessment technology for Metro Vancouver's water and sewer mains included:

- Review of internal documents and reports
- Research and review of journal articles
- Interviews with vendors
- Suitability analysis
- Sample projects cost estimates
- Recommendation

Condition Assessment Technologies

A review of existing practices used by Metro Vancouver to assess the condition of Water Services and Liquid Waste Services linear assets shows that technologies other than CCTV assessment are currently not widely used but are under review.

The following tables outline available condition assessment technologies for linear assets. Only non-destructive technologies were selected since they are more reliable and provide direct results. Table 2 lists condition assessment technologies and examples of each technology for Water Services, and Table 3 for Liquid Waste Services. A more detailed summary of condition assessment technologies is provided in Appendix A, including a short description of the technology, its pros and cons, applicable pipe material and diameter range, accessibility, accuracy, and cost estimate. The tables are constructed based on reports prepared by the United States Environmental Protection Agency (EPA): "Condition Assessment Technologies for Water Transmission and Distribution Systems" (2012) and "Condition Assessment of Wastewater Collection Systems" (2009).

Table 2. Available Condition Assessment Technologies for Water Transmission Systems

Condition Assessment Technology	Description	Examples of Technology
Pitting depth measurement	Measures the corrosion pit depth of ferrous pipes	• Pointed micrometer • Needle-point depth gauge • Ultrasonic spot measurement • Automated ultrasonic scanner • Laser range measurement
Visual inspection	Assesses the condition of the internal or external surface of the pipe by a visual inspection	• Person entry inspection • Closed-circuit television (CCTV) • Video endoscope • 3D optical scanning • Laser profiling • Handy scan 3D
Electromagnetic inspection	Inspects ferromagnetic pipes using electromagnetic technology	• Magnetic flux leakage • Remote field eddy current • Broadband electromagnetic • Pulsed eddy current • Ground penetrating radar • Ultra-wideband pulsed radar
Acoustic inspection	Uses sound waves to determine the location and extent of flaws in pipe	• Sonar profile • Impact echo • Acoustic emission • Leak detection
Ultrasonic testing	Externally or internally screens pipes for corrosion/ erosion at discrete locations	• Continuous measure • Discrete measure • Phased array • Seismic pulse echo
Assessment of soil properties	Indirectly measures corrosion rate using an electrochemical reaction with a weak electrical current	• Linear polarization resistance • Soil properties • Soil corrosivity • Soil resistivity • Pipe to soil potential survey
Emerging sensor technologies and sensor networks	Advanced sensor technology and sensor networks for inspection, monitoring leak detection, and condition assessment of buried pipes	• Corrosion rate sensor • Magnetostrictive sensor • Conformable and flexible eddy current array • Flexible ultrasonic transducer • Damage sensor • Microwave back-scattering sensor • Fiber optic sensor corrosion and bending monitoring

Condition Assessment Technology	**Description**	**Examples of Technology**
		• Fiber optic acoustic monitoring network • Wireless Sensor network •

Table 3. Available Condition Assessment Technologies for Sewage Conveyance Systems

Condition Assessment Technology	**Description**	**Examples of Technology**
Pitting depth measurement	Measures the corrosion pit depth of ferrous pipes	• Pointed micrometer • Needle-point depth gauge • Ultrasonic spot measurement • Automated ultrasonic scanner • Laser range measurement
Visual inspection	Assesses the condition of the internal or external surface of the pipe by a visual inspection	• CCTV • Zoom camera inspection • Digital scanning •
Electromagnetic inspection	Inspects ferromagnetic pipes using electromagnetic technology	• Electrical leak location method • Eddy current testing and remote field eddy current technology • Magnetic flux leakage detection
Acoustic inspection	Uses sound waves to determine the location and extent of flaws in pipe	• Leak detectors • Acoustic monitoring systems • Sonar and Ultrasonic testing
Ultrasonic testing	Externally or internally screens pipes for corrosion/ erosion at discrete locations	• Continuous measure • Discrete measure • Phased array • Seismic pulse echo
Laser Profiling	Generates a profile of a pipe’s interior wall	• Active 3D laser scanning, • Coolvision, • Laser profiler-CUES, • Envirosight, R&R Visual
Flow Meters	Directly measures depth and velocity	• Various flow meters equipment with wireless receiver
Innovative Technologies	Includes commercially available technologies and assessment technologies currently under development	• Gamma-Gamma logging • Ground penetrating radar • Infrared Thermography • Micro-deflection • Impact echo/spectral analysis of surface waves

While most inspection technologies can be used for both potable water and wastewater pipes, there are some exceptions, as the wastewater may interfere with certain technologies and the condition assessment results.

Suitability

Based on the suitability analysis presented in Appendix B, acoustic and electromagnetic inspections are recommended for Metro Vancouver's linear Water and Liquid Waste assets.

Acoustic and electromagnetic inspection are commercially available technologies that can be used while mains are in service, so pipe dewatering is not required. They can be used to assess both water and sewer pressurized mains, and both water and sewer marine crossings as long as there are insertion and extraction access points available for the section of pipe requiring inspection. The insertion and extraction access points can be as small as a valve, and for bigger pipes, a vertical service chamber can be used. If access points are not available, then excavation is required to allow person and instrumentation access to the pipe at the inspection limits.

The current condition assessment practice for sewer gravity mains (CCTV inspection) is adequate.

For acoustic inspection, SmartBall from Pure Technologies Ltd is recommended for assessing water mains, forcemains and marine crossings. The tool uses sound waves to detect leaks and air pockets. The tool is equipped with acoustic sensors as well as an accelerometer, magnetometry, ultrasonic transmitter, and temperature sensors. It is suitable for use with any pipe material. SmartBall works for pipe diameters greater than 200 mm and it is a free-swimming tool. SmartBall can detect a leakage as small as 0.11 litres/min and has a leak location accuracy of 1.8 m. The inspection runs for approximately 21 hours. Sahara also can be considered for water mains and forcemains. Marine crossings are not applicable because a ground receiver is mandatory (ground cover of up to 10 m). Sahara uses similar technology to SmartBall, but it is tethered. Sahara is suitable for use with pipe sizes greater than 50 mm and any pipe material. Sahara is equipped with vision aid, and can therefore film the inside of the pipe while it is in operation. Sahara can detect leaks as small as 0.19 litres/min with a location accuracy of 0.5 m. It can inspect a pipe up to 1.8 km with a single deployment.

For electromagnetic inspection, PipeDiver from Pure Technologies Ltd and See Snake from Russell NDE System Inc. are recommended for assessing water mains, forcemains and marine crossings. Both methods use remote field eddy current technology to measure remaining wall thickness, areas of corrosion, defective surface area (length and width) and stress. The tools swim freely through the pipe (including elbows and butterfly valves) to inspect the pipe without interrupting service. PipeDiver can inspect average lengths of 5-8 km (farthest record of 50 km) from one launch point, while See Snake can only travel up to 10 km. PipeDiver travels at roughly 90% of the flow speed of the water, while See Snake's swim rate is 1-2 km/hr. PipeDiver works for pipe diameters greater than 300 mm and See Snake works for pipe diameters from 75 mm to 762 mm.

A combination of acoustic and electromagnetic inspection technologies to assess pipe condition would be ideal. Acoustic inspection technology is approximately one third the cost of electromagnetic inspection technology ($30,000/km versus $100,000/km, in 2017 Canadian dollars and excluding the cost of excavating access points). Cost estimates are provided for two sample projects in Appendix C. These two inspection technologies are in the moderate to high relative cost category due to the utilization of advanced technology, a high degree of accuracy and no disruption of service.

Summary and Recommendation

Upon review of existing condition assessment practices, Metro Vancouver is assessing the condition of Water and Liquid Waste linear assets primarily using indirect methods, with the exception of CCTV inspection of gravity sewers. To improve on condition assessment information, Metro Vancouver should use a combination of two or more direct, non-destructive field inspection methods.

For water mains, forcemains and both water and sewer marine crossings, either electromagnetic – remote field eddy current (See Snake by Russell NDE System Inc. or PipeDiver from Pure Technologies Ltd), acoustic (SmartBall by Pure Technologies Ltd) or a combination of both inspection condition assessment technologies is recommended due to the high degree of accuracy and no disruption to service.

For sewer gravity mains, continuing with visual inspection (CCTV) condition assessment technology is recommended since the current practice is adequate. Higher resolution or multi-angle cameras are options for better CCTV results.

The recommended condition assessment technologies are provided in Table 4.

Table 4. Recommended Condition Assessment Technologies

Utility	Pipe	Technology	Tool	Vendor
Water	Mains (Land)	Acoustic Inspection	SmartBall or Sahara	Pure Technologies Ltd
		Electromagnetic Inspection	See Snake	Russell NDE System Inc.
			PipeDiver	Pure Technologies Ltd
	Mains (Marine Crossings)	Acoustic Inspection	SmartBall	Pure Technologies Ltd
		Electromagnetic Inspection	See Snake	Russell NDE System Inc.
			PipeDiver	Pure Technologies Ltd
Liquid Waste	Gravity Mains	Visual Inspection	CCTV	various
	Force Mains	Acoustic Inspection	SmartBall or Sahara	Pure Technologies Ltd
		Electromagnetic Inspection	See Snake	Russell NDE System Inc.
			PipeDiver	Pure Technologies Ltd
	Marine Crossings	Acoustic Inspection	SmartBall	Pure Technologies Ltd
		Electromagnetic Inspection	See Snake	Russell NDE System Inc.
			PipeDiver	Pure Technologies Ltd

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Appendix A: Detailed Summary of Condition Assessment Technologies

Table 5. Detailed Summary of Condition Assessment Technologies for Water Transmission and Sewage Conveyance Systems

Condition Assessment Technology	Description	Pros	Cons	Pipe Material Suitability	Pipe Diameter Suitability	Access	Accuracy *	Cost **	Waster/ Liquid Waste
Pitting depth measurement	Measures the corrosion pit depth of ferrous pipes	• Direct measurement • Provides good insight into condition • Easy to use • Exposed pipes do not need to be taken out of service to perform external assessment	• Only samples, so requires sophisticated statistical analysis to evaluate condition of entire pipe • Only works for exposed pipe sections • Existing coating needs to be removed • Pipe must be taken out of service to perform internal assessment	Metal	Large diameter with a person access	A person access	High	$	Both
Visual inspection	Assesses the condition of the internal or external surface of the pipe by visual inspection	• Relatively simple and inexpensive • Provides good insight into condition • Data can be stored for future use • Exposed pipes do not need to be taken out of service to perform external assessment	• For internal assessment, pipe must be taken out of service (most of the time) and dewatering required • Internal inspection is suitable only for relatively large diameter pipes for big vision aid technology (smaller versions are also available) • External inspection can be difficult, disruptive and expensive • Under low resolution, defects are difficult to spot • Results are qualitative • If no access points are available, involves exposing a segment of pipe	Any	Large diameter with person access for person entry inspection 150 – 1525 mm (6 – 60 in.)	A person access or equipment access, service chamber	Accuracy is dependent on skilled personnel and assessment equipment (Generally, low to moderate)	$	Mostly liquid waste

Condition Assessment Technology	Description	Pros	Cons	Pipe Material Suitability	Pipe Diameter Suitability	Access	Accuracy *	Cost **	Waster/ Liquid Waste
Electro-magnetic inspection	Inspects ferromagnetic pipes using electromagnetic technology	See below for various technologies	See below for various technologies	See below for various technologies	See below for various technologies		High	$$$	Both
a) Magnetic Flux Leakage	Identifies and measures metal loss due to corrosion in ferrous pipes	• High degree of accuracy for wall thickness measurement • External surface inspection does not require service interruption • Can be used inside pipe or outside exposed pipe	• Close contact with pipe wall is required • Surface of pipe must be clean	Iron, Steel	50 – 1400 mm (2 – 56 in.)	Direct access to pipe wall	High	$$$	Both
b) Remote Field Eddy current (See Snake, PipeDiver)	Inspects ferromagnetic pipes and ferromagnetic components of composite pipes	• Inspection of in service pipes is possible • Inspection systems are available for different pipe sizes • Direct contact with wall is not required • Can be used for other applications (detect broken wires)	• Data interpretation needs experience and skill	Iron, Steel, prestressed concrete cylinder pipe (PCCP)	≥ 75 mm (3 in.)	Service chamber, cut- ins, hot tap connection, submerged tank	High	$$$	Both
c) Broadband Electromagnetic	Detects and quantifies wall thickness, as well as the effective conductivity of the complex through-wall components of ferrous pipes	• Does not require contact with metallic pipe wall • Not sensitive to the corrosion product • Can scan through coatings, linings, and insulation	• Measurement is an average thickness in area under sensor's footprint • Cannot detect pin-hole failures or isolated pits • Requires pipe cleaning	Iron, Steel, PCCP	≥75 mm (3 in.)	Full bore access	Low	$$$	Water
Acoustic inspection	Uses sound waves to determine the location and extent of flaws in pipes	See below for various technologies	See below for various technologies	See below for various technologies	See below for various technologies		See below for various technologies	$-$$$	Both
a) Impact Echo	Determines the location and extent of flaws, such as depth and width of surface cracks, delamination, voids	• Can be applied to various materials (No metal) • Easy to carry out • Works with paints, coatings and tiles	• Frequency domain analysis is complicated when information other than thickness and geometry is needed	PCCP, concrete, polyvinyl chloride (PVC)	Large diameter with person access, > 1.5 m (5 ft)	A person access	High degree of accuracy with proper calibration	$$	Both

Condition Assessment Technology	Description	Pros	Cons	Pipe Material Suitability	Pipe Diameter Suitability	Access	Accuracy *	Cost **	Waster/ Liquid Waste
	and other damage by hitting the surface of a pipe with impulse hammer	• Only one side of structure needs to be accessible for testing • Not limited by pipe size							
b) Acoustic Emission	Monitors the acoustic emission when a sudden appearance or propagation of a microscopic crack occurs within a material under load, or the break of prestressed wires in PCCP	• Real time online monitoring	• Can only detect what is happening during monitoring period • Installation of sensors may require interruption of service • Qualitative information	PCCP	Not available	Access to pipe interior	Not available	$$	Both
c) SmartBall	Detects leaks and air pockets in medium and large diameter pipes	• Can be used for any pipe materials • Can be used in medium and large diameter pipes • Can survey long pipelines (recorded 25km) with a single deployment • Can detect very small noise disturbances • Can be used while in service	• May not work in very high water pressure (>400PSI) • For very long pipe length, may require a surface sensor • Estimation of leak magnitude is qualitative • Intrusive technology	Any	≥ 200 mm (8 in.)	Insertion and extraction points, valve, hot tap connection	High	$$	Both
d) Leakfinder RT	A computer based system for locating leaks in all types of pipes	• Non-intrusive tool • Can be used for any pipe material • Effective for small leaks and for situations with high background noise	• Leak size is not detectable from the test • Sensor spacing is different for each pipe material and size	Any	400 – 2250 mm (16 – 90 in.)	Not required	High degree of accuracy with proper setup	$	Both (Mainly for water)
e) Permalog	Continuous monitoring and leak detection for water distribution systems	• Can be permanent, semi-permanent, or survey • Responds to new leaks and breaks • Non-intrusive tool • No disruption in service • Low-cost tool	• Monitoring length varies based on pipe material • Requires different spacing for each pipe material • Background noise can create issues in monitoring result	Any	No restriction	Access to pipe surface	Moderate to High	$	Water

Condition Assessment Technology	Description	Pros	Cons	Pipe Material Suitability	Pipe Diameter Suitability	Access	Accuracy *	Cost **	Waster/ Liquid Waste
f) Sahara	Inspects in-service water mains for leaks, gas pockets, visible defects, and wall thickness of metallic pipe using tethered equipment	• Sensitive to small leaks • Surface tracking can map the pipeline under inspection • Can be used for any pipe size that greater than 150 mm • No disruption in service	• Intrusive technology • Requires access points (insertion point) • Ground cover up to 10 m	Any	≥ 150 mm (6 in.)	One insertion point	High	$$	Both
Ultrasonic testing	Used externally or internally for screening of pipes for corrosion/ erosion at discrete locations	• Inspection from a single probe position is possible • Provides instantaneous result	• Difficult to inspect non-homogeneous or irregularly shaped pipe • Cannot distinguish between internal and external corrosion • Not applicable for heavily coated pipes	Ferrous, PCCP	Not available	Access to pipe interior	Moderate to High	$	Both
Laser Profiling	Generates a profile of a pipe's interior wall	• Potential to show the early signs of pipe degradation by corrosion • Measures cross-sectional area • Can be applied in a wide range of pipe sizes	• Tuberculated pipes need to be scrubbed and cleaned prior to inspection • Pipeline needs to be de-watered	Any	No restriction	Access to pipe interior	High	$	Both
Flow Meters	Directly measures depth and velocity	• Near time (close to being real time) communication with a flow meter and the laptop/receiver • Software automatically analyzes flow data • Data Incorporates with GIS functionality	• Indirect method of determining a condition of a pipe • Operates by battery and replacing batteries are required.	Any	No restriction	Access to pipe surface	Not available	$	Both
Assessment of soil properties	Indirect way to measure corrosion rate using an electrochemical reaction with a weak electrical current	• Inexpensive method • Measures all soil parameters relevant to deterioration of buried pipes • No excavation required	• Not a direct measurement of pipe deterioration rate • Only measures soil parameters relevant to deterioration of buried pipes	Any	No restriction	Access to embedment	Not available	$	Both
Emerging sensor	Advanced sensor technology and sensor networks for	• Usually a low cost for long-term monitoring	• May require excavation, depending which sensor is used	Depends on which	Not available	Access to pipe interior	New technology, accuracy	$-$$	Both

Condition Assessment Technology	Description	Pros	Cons	Pipe Material Suitability	Pipe Diameter Suitability	Access	Accuracy *	Cost **	Waster/ Liquid Waste
technologies and sensor networks	the inspection, monitoring and condition assessment of buried pipes			sensor is used			has not been verified		

*H = High degree of accuracy (approximately >80%), M = Moderate degree of accuracy (approximately 50%), L = Low degree of accuracy (approximately 10%)

** Relative Cost

Appendix B: Suitability Analysis

Based on Metro Vancouver's inspection challenges, each technology is compared against the following:

Hard Constraints (required):

- Works with pressurized systems (water mains and forcemains)
- Accessibility of inspection tool
- In-service inspection (including no dewatering and cleaning)
- Works with river crossings
- Works with MV pipes (e.g. diameter and material)

Soft Constraints (desired):

- Accuracy
- Relative Inspection Cost

Table 6. Suitability Analysis Table

Condition Assessment Technology	Works with pressurized systems? (Y/N)	In-service inspection ? (Y/N)	Works with River Crossings? (Y/N)	Works with MV Pipes? (Y/N/P)	Accessibility of inspection tool (E/D)	Accuracy (H/M/L)	Relative Inspection Cost ($ - $$$)
Pitting depth measurement	N	N	N	Y	D	H	$
Visual inspection (CCTV)	N	P	P	Y	E	L-M	$
Electro-magnetic inspection							
a) Magnetic Flux Leakage	N	N	Y	P	D	H	$$$
b) Remote Field Eddy current (See Snake, PipeDiver)	Y	Y	Y	Y	E	H	$$$
c) Broadband Electromagnetic	N	N	N	P	D	L	$$$
Acoustic inspection							
a) Impact Echo	N	N	N	P	D	H	$
b) Acoustic Emission	Y	P	N	?	D	?	$
c) SmartBall	Y	Y	Y	Y	E	H	$$
d) Leakfinder RT	Y	Y	N	P	E	H	$
e) Permalog	Y	Y	N	Y	D	H	$
f) Sahara	Y	Y	N	Y	E	H	$$

Condition Assessment Technology	Works with pressurized systems? (Y/N)	In-service inspection ? (Y/N)	Works with River Crossings? (Y/N)	Works with MV Pipes? (Y/N/P)	Accessibility of inspection tool (E/D)	Accuracy (H/M/L)	Relative Inspection Cost ($ - $$$)
Ultrasonic testing	N	N	N	?	D	M-H	$
Laser Profiling	N	N	N	Y	D	H	$
Monitoring inspection							
Flow Meters	Y	Y	Y	Y	D	?	$
Assessment of soil properties	?	?	?	?	D	?	$
Emerging sensor technologies and sensor networks	?	?	?	?	D	?	$-$$

Note: Y = Yes, it works, N = No, it doesn’t work, P = Works with exceptions, E = Easily accessible, D = Difficult to access, H = High degree of accuracy (approximately >80%), M = Moderate degree of accuracy (approximately 50%), L = Low degree of accuracy (approximately 10%), ? = Not available

Based on Table 6, See Snake and PipeDiver electromagnetic inspection technologies (remote field eddy current) and SmartBall acoustic inspection technology are recommended. The reason is these technologies meet Metro Vancouver’s hard constraints. Sahara is another option for acoustic inspection of sewer forcemains and water mains with a maximum depth of cover of 10 m, but cannot be used for marine crossings.

Appendix C: Cost Estimate for Sample Projects

Cost Estimate for Cambie Richmond Main No. 2 Condition Assessment (water main/marine crossing) and Columbia Forcemain (sewer forcemain) sample projects. Both estimates are prepared by Pure Technology Ltd.

Cambie Richmond Main No. 2 Sample Project Details

- Pipe Characteristics: 1050 mm/900 mm diameter steel, 8 mm wall thickness
- Length: approximately 1.25 km from valve chamber near Heather Street and Marine Drive in Vancouver to south side of Fraser River near River Road and Oak Street in Richmond
- Insertion Point: potentially at valve chamber near Heather Street and Marine Drive
- Extraction Point: valve chamber on the south side of Fraser River was decommissioned, but there may be an appurtenance or feature to extract. Otherwise, pipeline modifications may be required.
- Condition assessment approach:
  - SmartBall inspection (inline acoustic inspection for leak and air pocket detection – inspects while main in service)
  - PipeDiver inspection (inline electromagnetic inspection to identify areas of corrosion and wall loss – inspects while main in service)
  - Transient Pressure Monitoring
  - Structural analysis to determine individual pipe sections requiring rehabilitation
- Cost Estimate: Total of CAD 225,000 (assumes there are existing access points for insertion and extraction of tools; excludes any civil work; includes planning, mobilization, inspection, reporting)

Columbia Forcemain Sample Project Details

- Pipe Characteristics: 600 mm diameter, PVC
- Length: approximately 2 km
- Insertion Point: assumes adequate access (100 mm for SmartBall) for insertion and no pipeline modifications or special requirements
- Extraction Point: assumes adequate access (100 mm for SmartBall) for extraction and no pipeline modifications or special requirements
- Condition assessment approach:
  - SmartBall inspection (inline acoustic inspection for leak and gas pocket detection – inspects while main in service)
- Cost Estimate: Price:
  - SmartBall Inspection: approximately, CAD 60,000 (includes planning, mobilization, inspection, reporting)