Linear Asset Management

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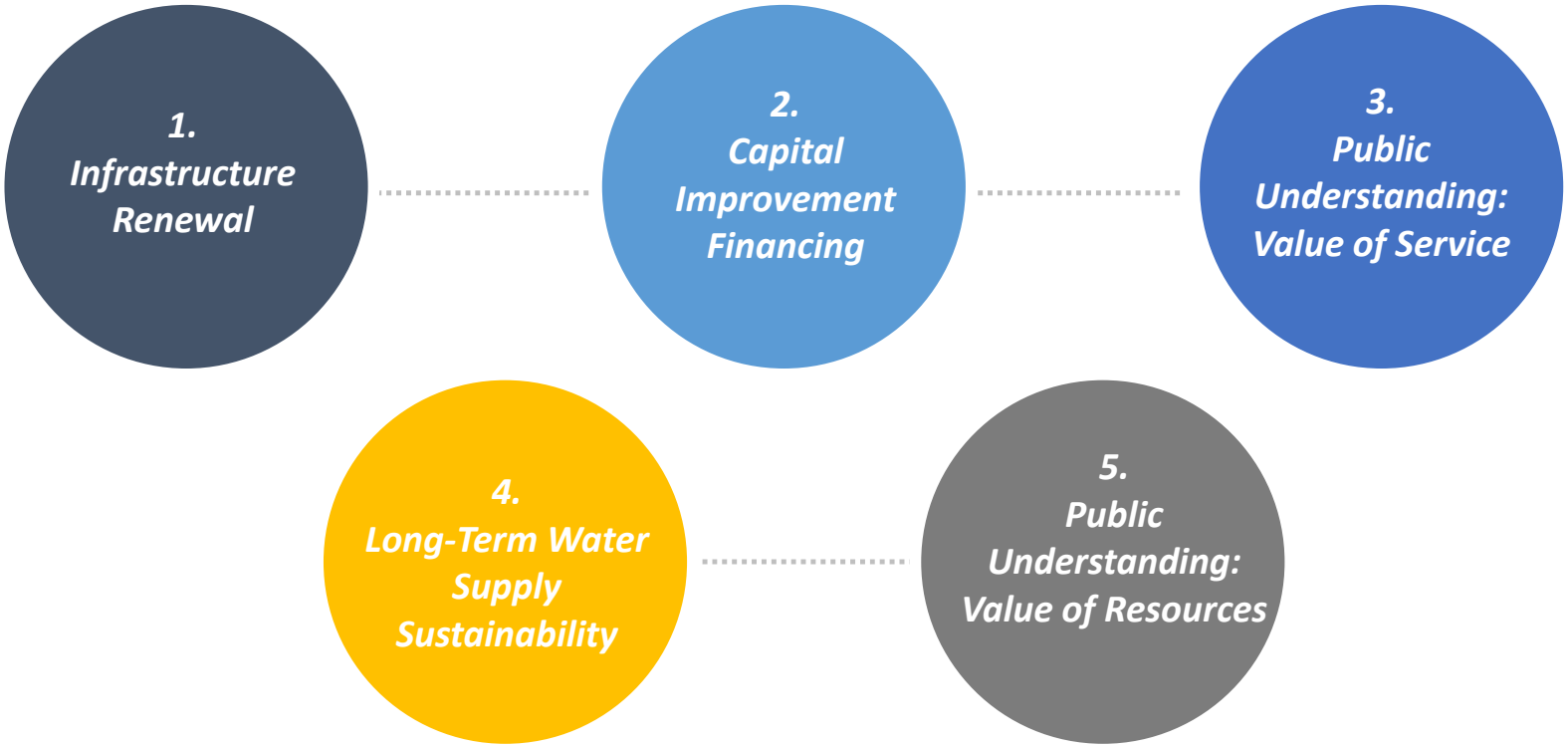
Pure Technologies

Utility Goals

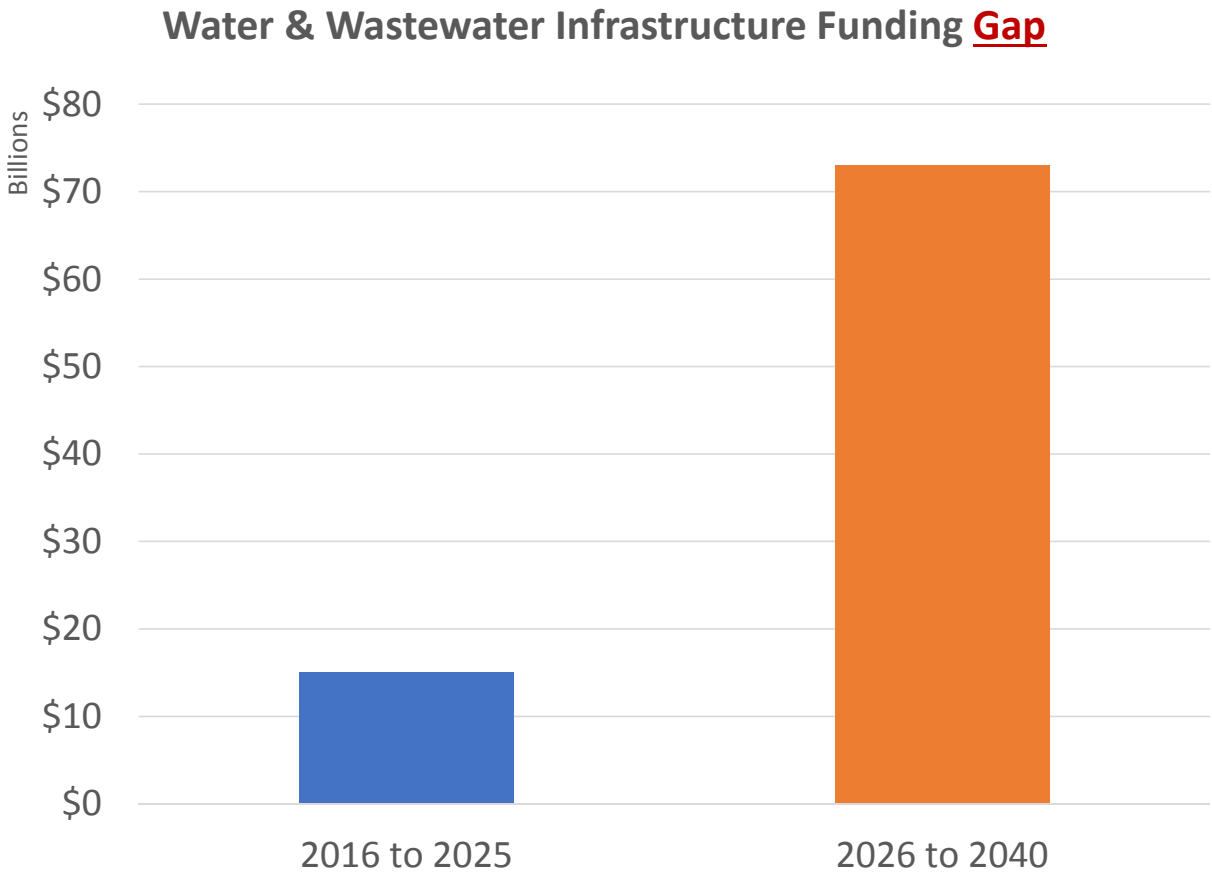
- Reduce Failures
- Optimization of Capital Spend

Top Water Industry Challenges



1. Infrastructure Renewal

2. Capital Improvement Financing



Why Not Just Replace?

1. *Desktop risk evaluations naturally conservative*

2. *High risk often driven lack of or poor data quality*

3. *Risk analysis should drive condition assessment, not renewal*

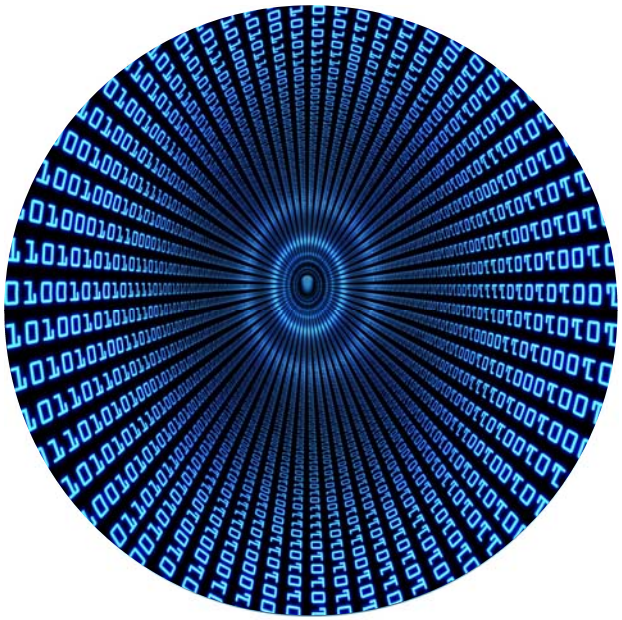
A Better Way…

Move beyond age and failure focus

- *Age rarely correlates with condition (Water Research Foundation)*

70% to 90% of replaced pipelines have remaining life (US EPA)

Best-in-class renewal programs renew 1% of system per year



How to Get There?

Use Risk Assessments to drive condition data collection

Use advanced analytics to produce high value information

Update Risk with real-time data and analytics to empower precise decision making through tools and reporting

Risk

- Probability of Failure
- Consequence of Failure

Potential to gain or losing something of value

PoF – What is the likelihood a pipe will fail in a given time period?

Pipe Condition

- *Material quality*
- *Manufacturing*
- *Design*
- *Environmental*
- *Operational*
- *3rd party damage*
- *Installation*
- *Age*

CoF – What is the Impact of Pipe Failures?

Social

- *Loss of trust*
- *Traffic disruption*

Environmental

- *Creeks and rivers*
- *Sensitive areas*

Economic

- *Repairs*
- *Damage*
- *Loss of product*

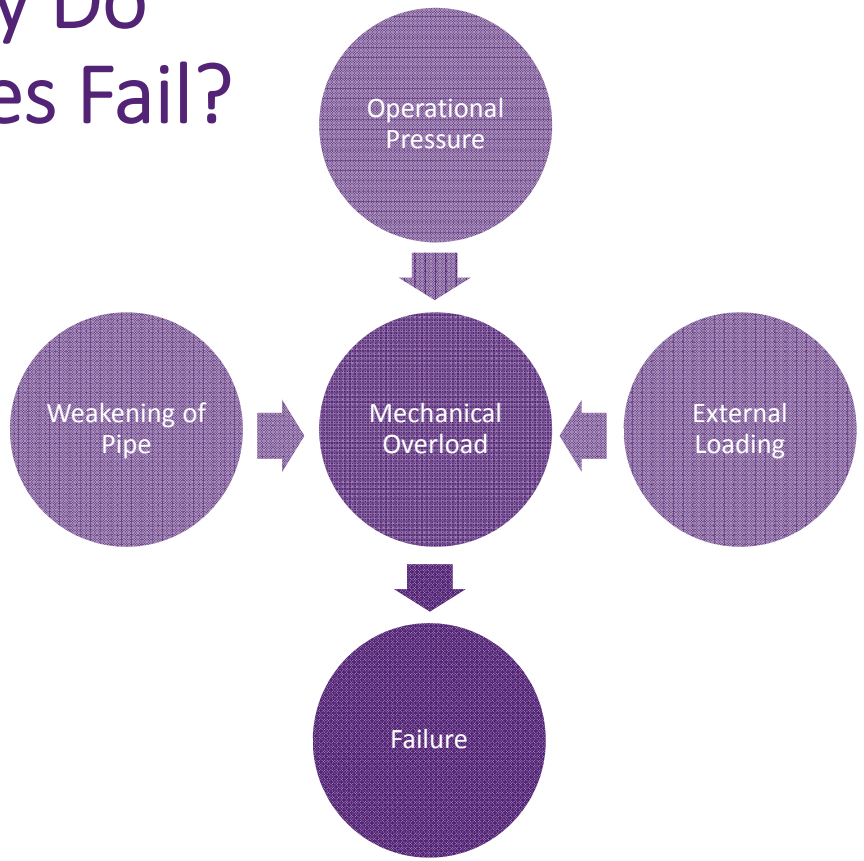
Using Risk as a Guide

Risk Rank	Risk Score	Mile	Pipeline Name
1	11.1	5.3	Montebello/Herring Run
2	11.0	2.6	Fullerton
3	10.3	8.1	Moravia East
4	10.3	10.5	Moravia South
5	10.2	8.3	Mays Chapel to Towson
6	10.0	3.9	Leakin Park Route
7	9.9	3.0	Towson East
8	9.7	6.5	Ashburton
9	9.6	8.6	Pikesville North
10	9.6	5.9	Howard
11	8.4	7.2	Short Sections
12	8.3	11.4	Pikesville South
13	7.8	2.9	North Point Blvd

Before condition assessment

After condition assessment

Why Do Pipes Fail?



Cast Iron Pipes

- Cracking from joints (leadite)
- Longitudinal or circumferential cracking
- Graphitization, corrosion and pitting

Ductile Iron Pipe

- Broad areas of corrosion
- Internal or external

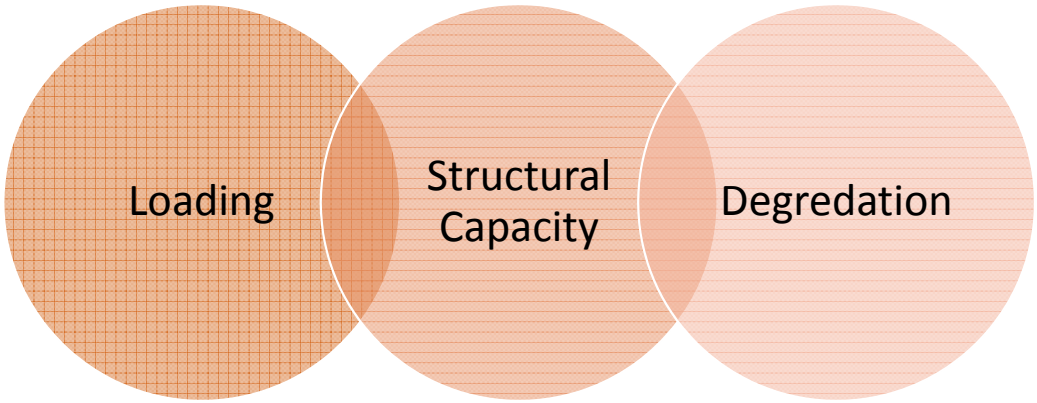
Steel Pipes

- Corrosion pitting
- Leaking
- Buckling

*No **single** technology or technique can identify **all** of the indicators of pipe deterioration.*

*Therefore, a **holistic**, risk based approach should be used.*

Probability of Failure



Pressure Pipe Assessment Technology Matrix

TECHNOLOGY										TEST CONDITIONS	
Name										**Parameter Tested**	
Acoustic/Leak Detection Tools											
Acoustic Leak Detection (tethered)	Pure Sahara	10" and Up					Tap available			Leak detection, air pockets	Hot inserted and retrieved thro air pockets
Acoustics Leak Detection (surface mount)	Echologics RTLeakListener	All Sizes						pothole for accelerometers		Leak detection only	Install accelerometers on exp not validated yet on force mair
Free Swimming Acoustic Leak Detection	PURE SmartBall	8" and up								Leak detection, air pockets	Hot inserted and retrieved thro bonnets and retrieved at manh for air pockets
Acoustically Sensitive Fiber Optic	PURE Soundprint AFO	All Sizes					Out of service during installation around valves, fittings			Now - software only for PCCP wire breaks Future - Leak detection, air pockets	Permanent installation
	Echologics LeakMonitor	All Sizes								Leak detection	Expected to be effective
Wall Thickness/Condition Tools											
Acoustic Wall Thickness	Echologics	All Sizes			(AC)			Need to pothole for		Remaining wall thickness in DI, CI and ST	Echologics recently tested in Beach in 2010. Both require accelerometers. Initial results
	Pure Sahara with PWA	10" and up						Need to pothole for		Average Remaining wall thickness	
Broadband Electromagnetic (Internal Pig)	Rock Solid Group allied with several testing firms in US	All Sizes								Remaining wall thickness in CI and DI and ST	Pipe must be drained, expose
Broadband Electromagnetic (External HSK)											Pipe exterior must be exposed
Magnetic Flux Leakage (External scanner)	AESL	All Sizes								Wall Thickness testing/profiling	Pipe exterior must be exposed
Remote Field Eddy Current/MFL	PICA	4" to 24" (to 36" in future)					If inserted thru pig launcher	If inserted thru pipe opening	If pulled thru on a tether	Internal test for metal wall loss, corrosion in DI, CI and ST	Pipe must be drained, expose
Ultrasonic (External)	NDT Corp, MacTec, others	All Sizes			(AC?)					External test for wall thickness	Local only along pipe wall. Ne calibrated to material.
Ultrasonic (Internal)	NDT Corp, Rosen, other									Internal test for wall thickness	Developed in Germany for Ste pilot in NYCDEP not successf
Magnetic Tomography	Transkor-K	All Sizes								External test of wall thickness and active corrosion	Used from the surface
Prestressing Wire Condition Assessment Tools											
Remote Field Eddy Current / Transformer Co	Pure Technologies	Varies by tool					Pipe Diver	Pipe Crawler	Crawler, Walker	Internal test for wire breaks in PCCP	Can hot insert from 24 to 36". and opened
Other/Ancillary CA Program Components											
Closed Interval Potential Survey	PPT	All Sizes								External test of pipe coating failure (soil corrosion)	Requires pipe to be electrically
Soil & GW Corrosion Testing	Many Firms/Local Labs	All Sizes								Take soil & groundwater samples for lab analysis	Indicator only of soil corrosion constantly so data is of only n
Pipe Coupons or Sampling	Many Firms/Local Labs	All Sizes								Take coupons or pipe samples for analysis	Take samples from pipe to co strength, flexural strength, mic universal indicator for AC

Multi-Pipe Level

Corrosion Surveys

Gas Pocket Detection

Pressure Monitoring

Pipe Level

Pipe Wall Assessment

Pulsed Eddy Current

Pit Level

Electromagnetics

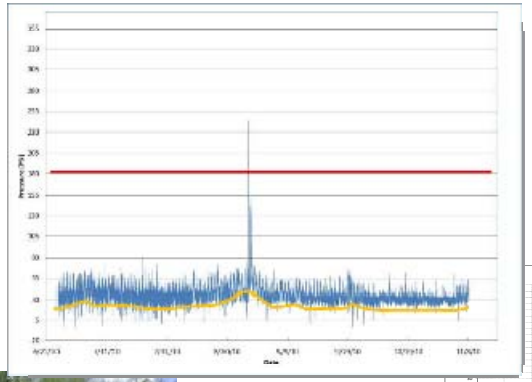
MFL

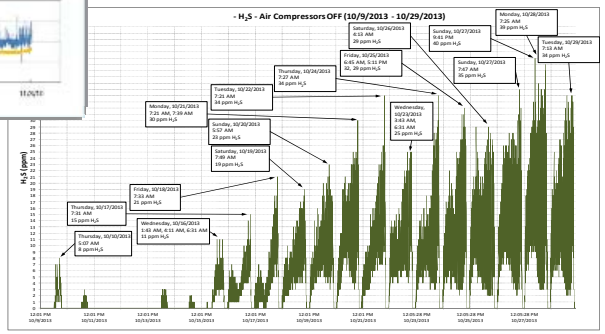
UT and BEM

Multi-Pipe Level Technologies

Technologies

- Leak Detection
- Gas Pocket Detection
- Acoustic Pipe Wall Assessment
- Pipe Penetrating Radar
- Soil Corrosivity
- H_2S Monitoring
- Pressure Monitoring





From Multi-Pipe Level to Pipe Level

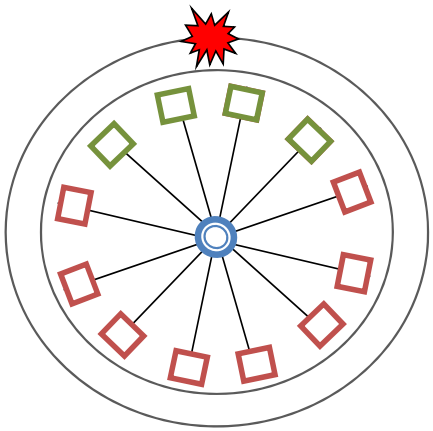
- Screen and prioritize pipes in a network

- Apply higher resolution technologies in a cost effective manner

Pipe Level Technologies

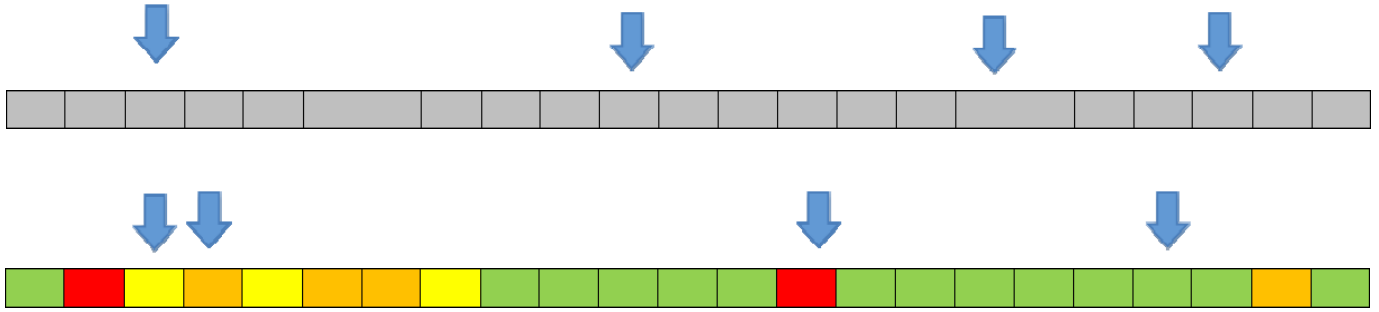
Technologies

- Pulsed Eddy Current
- CCTV
- SONAR/Laser



From Pipe Level to Pit Level

- Pipeline condition assessment with test pits



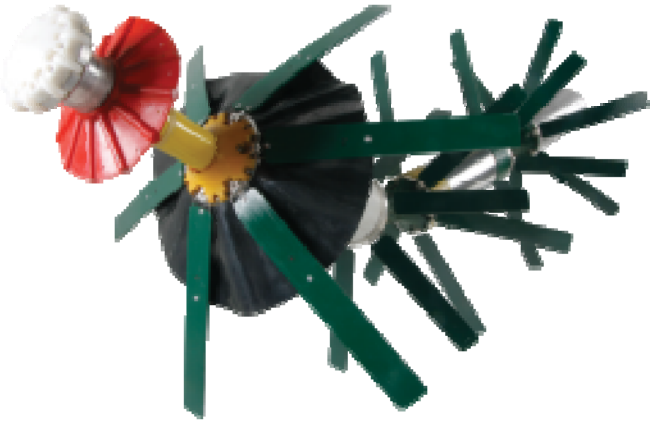
From Pipe Level to Pit Level

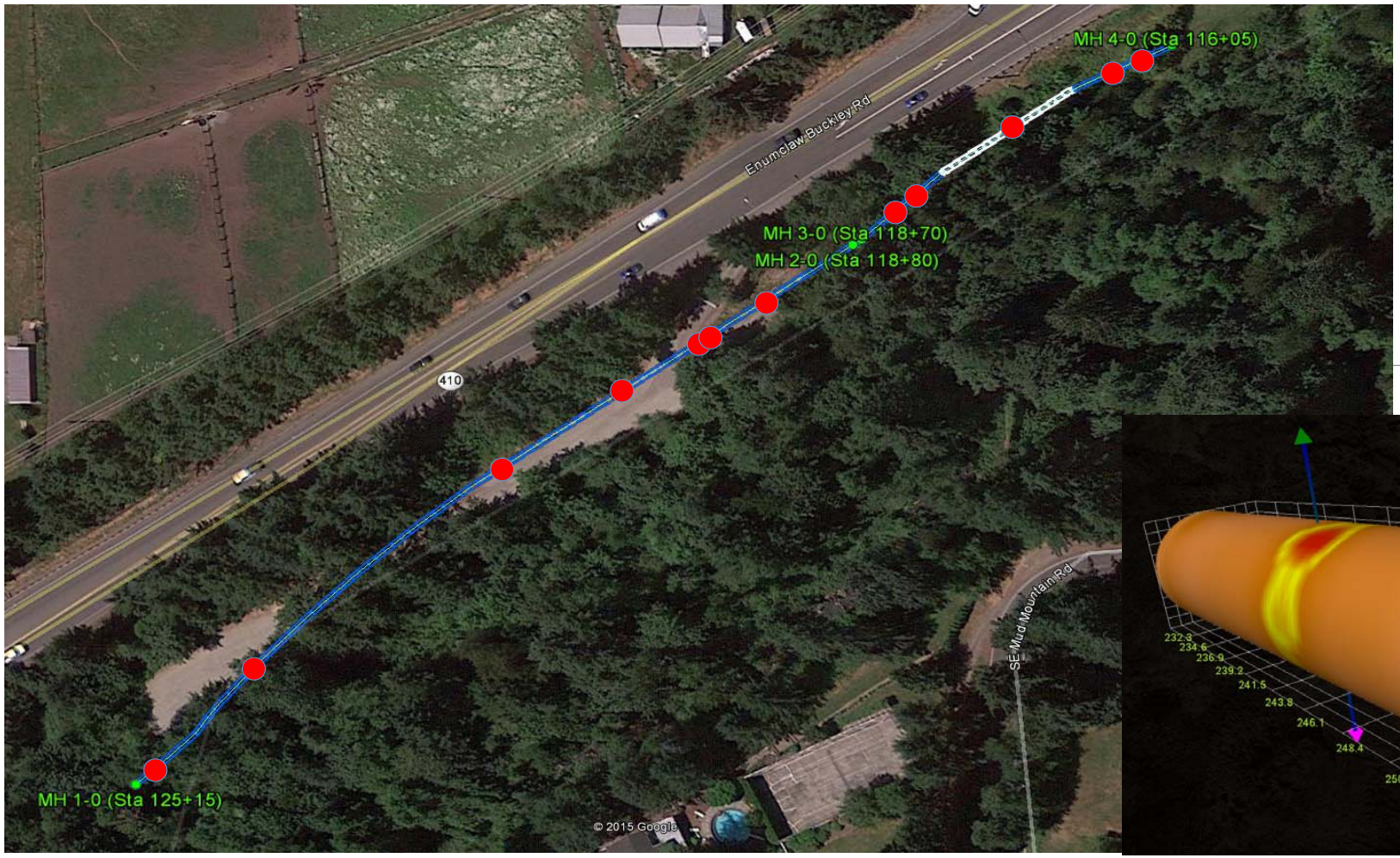
- Extensive pitting
- 12-in CIP

Pit Level Technologies

Technologies

- Electromagnetics
  - Inline
  - Test Pit
- BEM or UT
  - Test Pit
- MFL
  - Inline
  - Test Pit




MH 4-0 (Sta 116+05)
Enumclaw Buckley Rd
MH 3-0 (Sta 118+70)
MH 2-0 (Sta 118+80)
410
SE Mud Mountain Rd
MH 1-0 (Sta 125+15)
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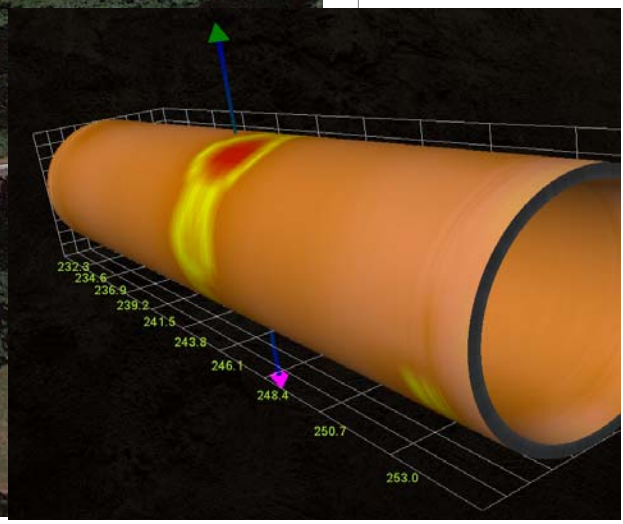
232.8
234.6
236.9
239.2
241.5
243.8
246.1
248.4
250.7
253.0

Condition Assessment Pilot (PCA) Results

Costs of Recommended Action	
Re-Inspection	$1.1M
Cathodic Protection	$0.93M
Rehab & Replacement	$2.8M
Sub-Total	$4.8M
PCA Pilot	$0.99M
TOTAL PILOT COST	**$5.8M**

Full Pilot Area Replacement Cost ~$12.0M

Renewal Pilot

- Evaluation of 6 rehabilitation technologies
  - ***CIPP***
  - ***Pipe Bursting***
  - Close-Fit Sliplining
  - Spray-On Lining
  - CFRP Lining
  - Internal Sleeves

Repair vs. Replace

Less than 10% of pipelines surveyed have indicators of distress,

while even fewer require repair or replacement to extend their useful life

The cost of condition assessment can be less than 8%

of the cost of full-scale replacement programs

Questions?

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