Cast Iron Pipes in the Water Distribution System Making Informed Decisions on Renewal Plans

Innovative Pipeline Management

Presented by
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June 30th , 2021

Agenda

- Introduction and Safety Minute
- Why To Establish A Cast Iron (CI) Reliability Analysis Frameworks
- What Inspection Tool to Use ?
- Understanding Cast Iron Distress Status
- Converting Assessment Findings Into Asset Management
- Incorporating Inspection Findings into AWWA M28 Pipe Renewal Decision-Making Tree
- Questions & Answers

01

Introduction and Safety Minute

Introduction

Start

Project Manger (Public Sector) — 1 Years

Director of Linear Infrastructure (Public Sector) — 3 Years

Condition Assessment Technical Lead (Private Sector) — 3 Years

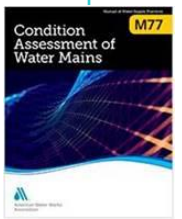
Director Linear Infrastructure

Linear Infrastructure Designer (Private Sector) — 8 Years

Program Manger (Public Sector) — 2 Years

Sr. Project Manger (Condition Assessment Vendor) — 3 Years

First Pipeline Condition Assessment using advice Technologies

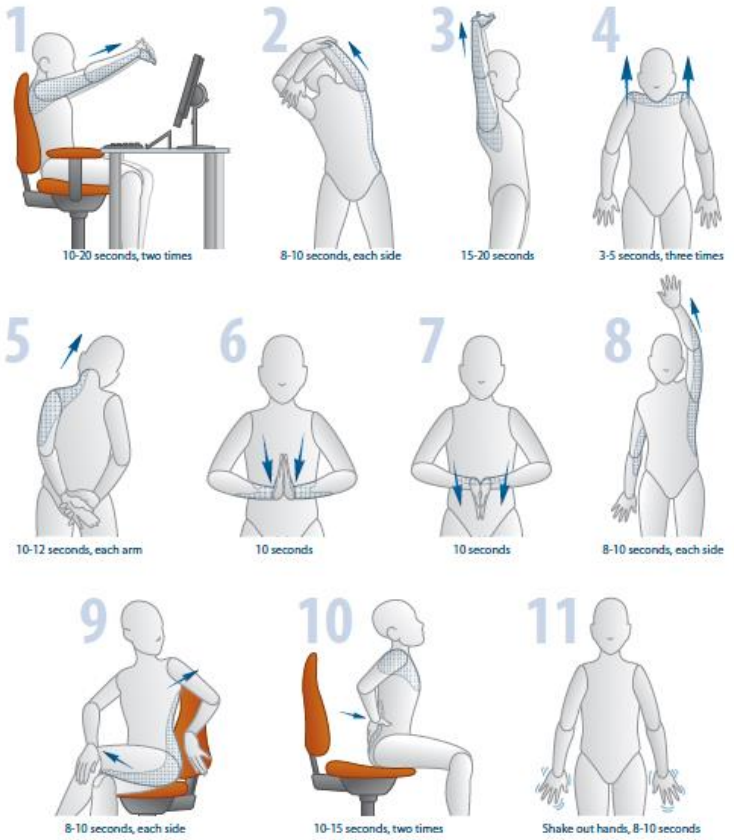


Committee Member
AWWA M77
Watermain Condition Assessment

Safety Minute – Computer & Desk Stretches

Sitting at a computer for long periods often causes neck and shoulder stiffness and, occasionally, lower back pain

Do these stretches every hour or so throughout the day, or whenever you feel stiff

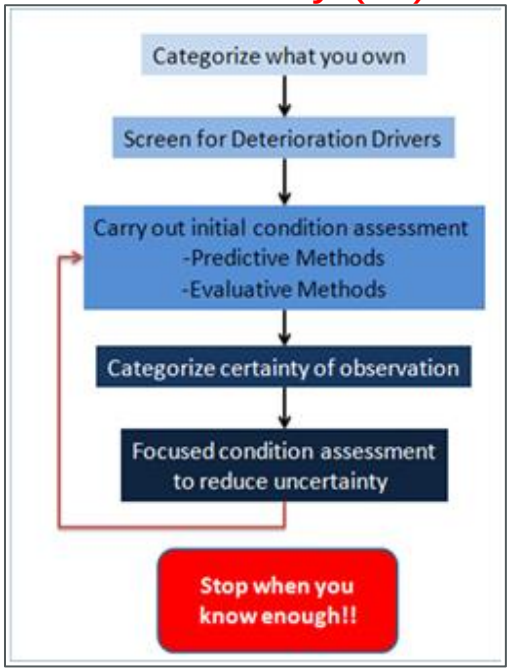


02

Why To Establish A Cast Iron Reliability Analysis Frameworks

The Classic Approach - A Condition Assessment Oriented Approach

Asset
Inventory (CI)



Distress indicators for CI

Remaining Wall Thickness

Desktop Assessment

Physical Assessment

Wall Thickness Loss	Condition
Less than 10%	Good
Betweeen 10% and 30%	Moderate
Greater than 30%	Poor

What Is Next……

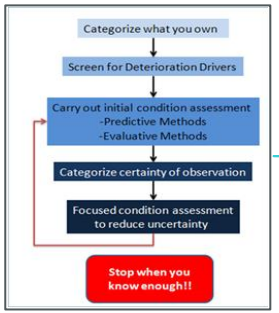
An Innovated Approach - Condition Assessment As Part Of Asset Management

Pipe owner (via **Asset Management**) needs to ensure pipes are operated **safely** and **reliably** on a **continual basis**

Level of Service LOS

Pipe Material	Abbreviation	Manufacturer's Service Life (Years)	Anticipated Service Life (ASL)
Cast Iron	CIP	50-100	75
Ductile Iron	DIP	75-125	100
Galvanized Iron	GALV	40-60	50
Steel	STL	30 - 75	40
PVC	PVC	50-150	100
Composite (Techite)	COMP	50 -150	50
Asbestos Cement	ACP	75-125	100
unknown	-	50-150	50

Devera, 2013



A **condition assessment program** can identify the **gaps** between the *desired* levels and the actual state condition

What is the Estimated Remaining service Life?

Capital work program can be developed
Renewal: Replace vs. Rehabilitate

Asset Value

03

What Inspection Tool to Use

Prioritizing Pipe For Assessment

Failure Modes:

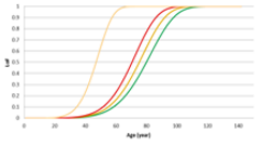
Structure, Hydraulic,*Water, Quality*

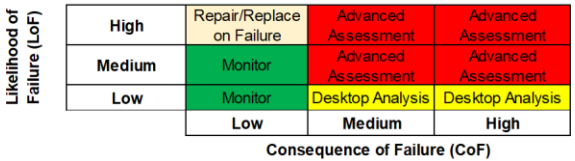
Deterioration Driver:

Deterioration Driver are distress indicators ← *Corrosion*

that influence pipe condition

Prioritize Pipes for Assessment:





Desktop Assessment Tools

Based On Breakage History

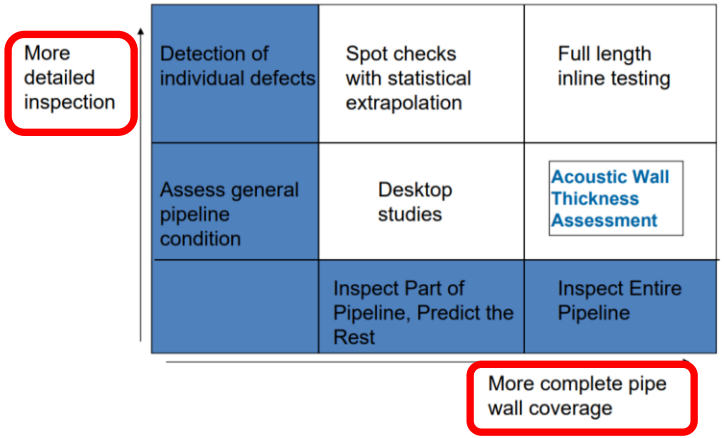
Based On Empirical Models

Based On Strength Reduction Models

Inspection Tool?

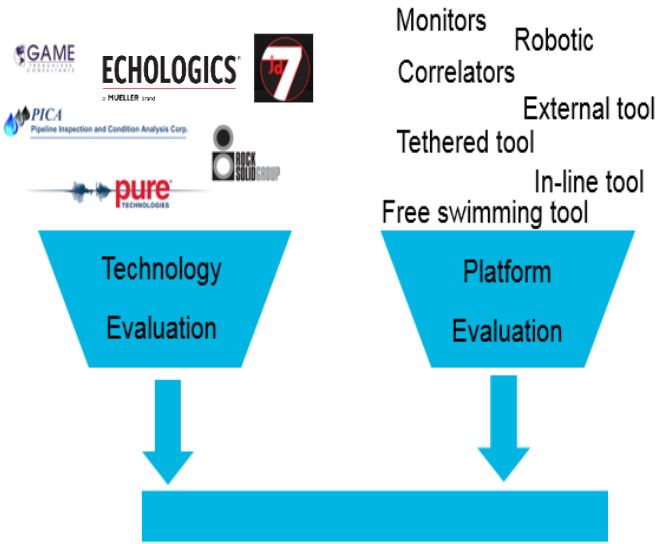
Desktop Assessment Tools

What Inspection Tool to Use? ……The Traditional Approach



However, this Matrix is based on
1. Pipe Length Coverage
2. Inspection Accuracy

What Inspection Tool to Use?



Evaluation Criteria (Samples)

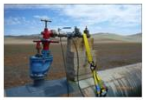
Inspection Risk
Enabling Works Required
Lateral Conditions during Inspection
Water Quality Risk
Accuracy of Defects
In-Service vs. Out of Service

Develop weight for each Evaluation Criteria (Pairwise Approach)

An **Optimal Inspection Tool** Based on the Client Set of Criteria

Technologies – Remaining Wall Thickness

Technology	Technology Function	Screening Criteria
	Leak Detection	Localized
	Wall Thickness	Segment
Pitting depth measurement	Wall Thickness	Localized
Electromagnetic Principal	Wall Thickness	Segment
Wave Principal	Wall Thickness Leak Detection	Segment
Ultrasonic	Wall Thickness	Segment
Radiographic	Wall Thickness	Localized
CT Scans	Wall Thickness	Localized


p-CAT

SONAR


PipeScan+


ePulse

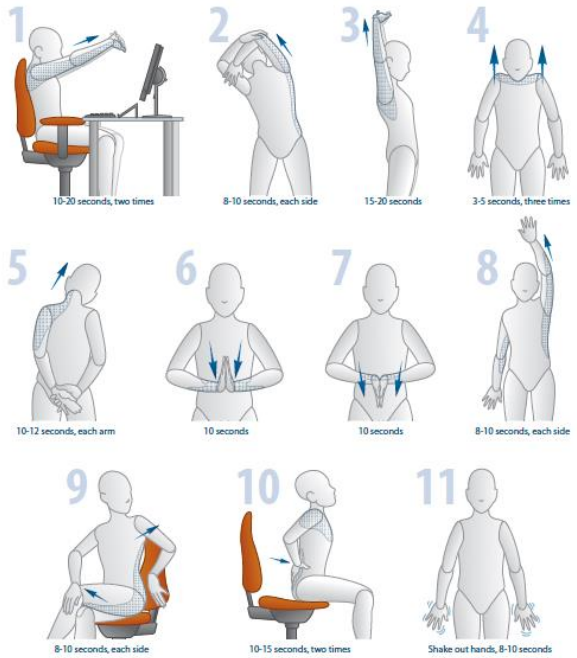

Slimline PIG

C.E.L.P


SeeSnake

Leak Detection

It is time to do
stretches



04

Understanding Cast Iron Distress Status

Describing CI Distress Status

Based on number of Defects Occurrence

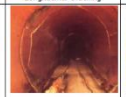
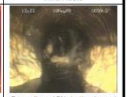
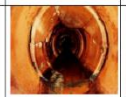
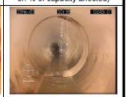
Minor Defect
Leak or
Hydraulic limitation

Major Defect
Main Break

Defect Identification	
More than two major and 5 minor defects	5
Up to two major and 5 minor defects	4
no more than one major defect, and 3 minor defects	3
up to 1 minor defect identified	2
no defects identified	1

Fix it when it break!

NASSCO PACP® Coding System applied in Gravity Sewers

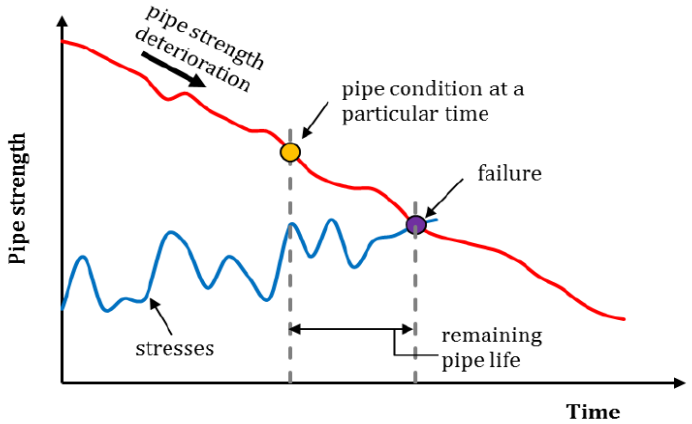
Rating	Importance	Likelihood of Failure	Structural Rating Example	O&M Rating Example
1 Excellent	Minor defects	Failure unlikely in the foreseeable future		
2 Good	Defects that have not begun to deteriorate	Pipe unlikely to fail for at least 20 years	 Longitudinal Cracking	 Fine Roots
3 Fair	Moderate defects that will continue to deteriorate	Pipe may fail in 10 to 20 years	 Multiple Fractures	 Deposits = 15% (rating based on % of capacity affected)
4 Poor	Severe defects	Pipe will probably fail in 5 to 10 years	 Broken Pipe	 Infiltration – Runner (rating based on flow estimate)
5 Immediate Attention	Defect requires immediate action	Pipe has failed or will likely fail within the next 5 years	 Collapsed Pipe	 Root Ball (> 50% of capacity)

A **systematic** method to produce **consistent** and useful information, including **rating** pipes that **correspond to intervention** strategies and renewal methods

Can We Implement NASSCO Methodology In Cast Iron

Unlike Sewer Inspections Inspection is NOT the entire Picture

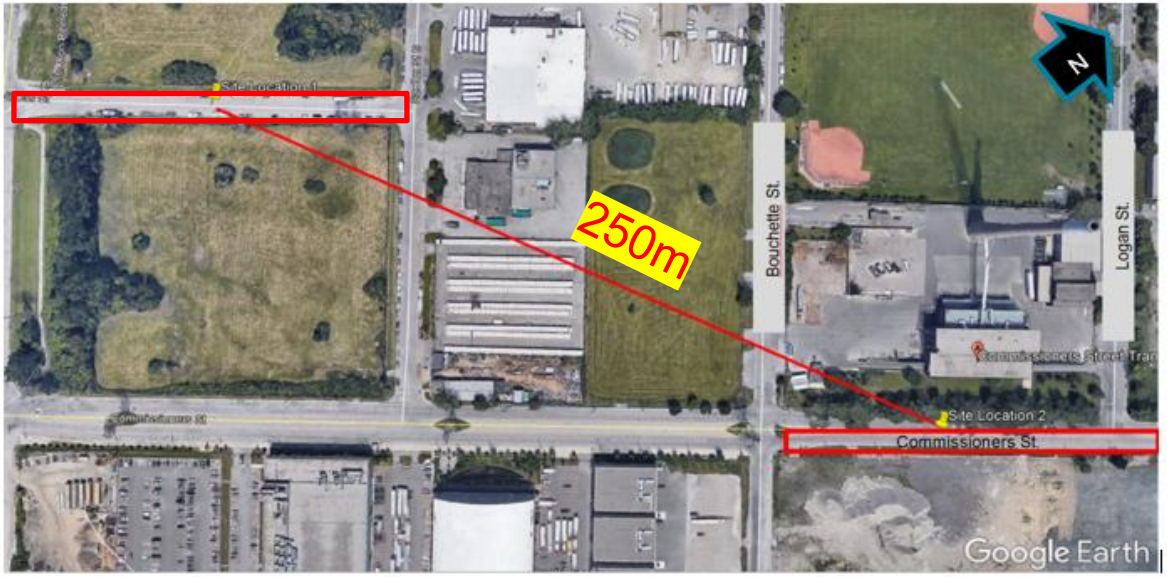
Rigid Pipe Failure



Condition Rating System For Watermains

Based on Remaining Wall Thickness?

12” CI
1919
28% Wall Lost



12” CI
1921
26% Wall Lost

Maybe Poor Condition!

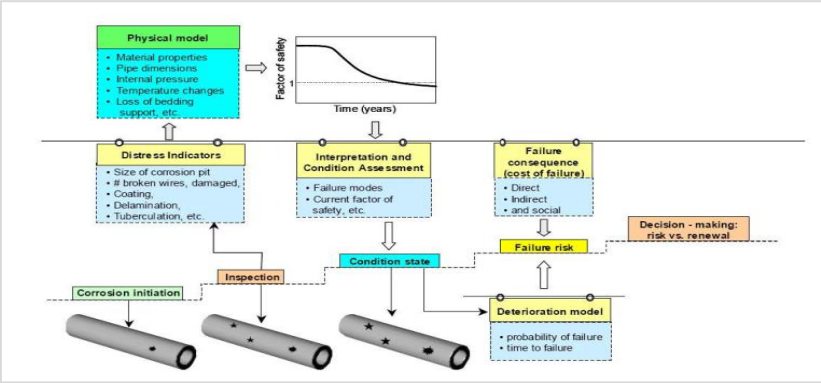
Wall Thickness Loss	Condition
Less than 10%	Good
Betweeen 10% and 30%	Moderate
Greater than 30%	Poor

Condition Rating System For Watermains

Should be Based on Wall Thickness (Deterioration Rate) and **Imposed Loads**

The **Relationship** Between Wall Thickness and Imposed Loads is Defined in **Design Standards**

Balvant et. al 2000 – Residual Factor of Safety Methodology for CI Pipe



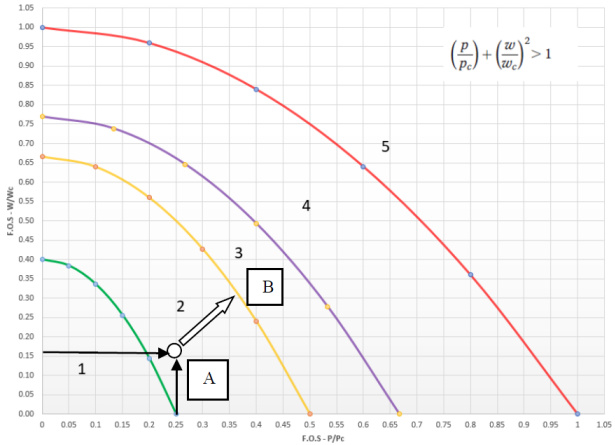
Condition Rating System For Watermains

Inspection Findings → Distress Status In terms of Condition Grading (1-5)

Wall Thickness Loss	Condition
Less than 10%	Good
Betweeen 10% and 30%	Moderate
Greater than 30%	Poor

"A": point on the curve is a Distress status

Nondimensional Condition Grading Curve for CI Pipes



"B": Inspection Frequency (Using Deterioration Model)

05

Converting Assessment Findings Into Remaining Service Life

Remaining Service Life

Given the material variability, in addition to changes in the local environment that influence corrosion rates, understanding pipe behavior and predicted service lifetime will exhibit **uncertainty** **regardless of the inspection accuracy**

Calibrated Deterioration Curve

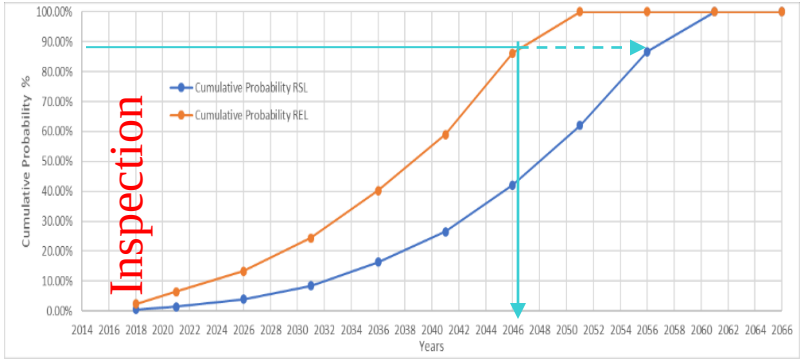
Asset Value (Sample CI Installed in 1956)

Pipe Material	Abbreviation	Manufacturer's Service Life (Years)	Anticipated Service Life (ASL)
Cast Iron	CIP	50-100	75
~~Ductile Iron~~	~~DIP~~	~~75-125~~	~~100~~
Galvanized Iron	GALV	40-60	50
Steel	STL	30 - 75	40
PVC	PVC	50-150	100
Composite (Techite)	COMP	50 -150	50
Asbestos Cement	ACP	75-125	100
unknown	-	50-150	50

Devera, 2013

75 Years → 2031

Regardless of Surrounding Environment



Asset Depreciation in an Appraisal

2046-2054 (Based on operating Pressure/Pressure Rating)

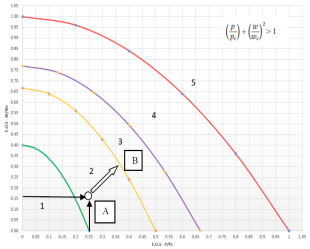
06

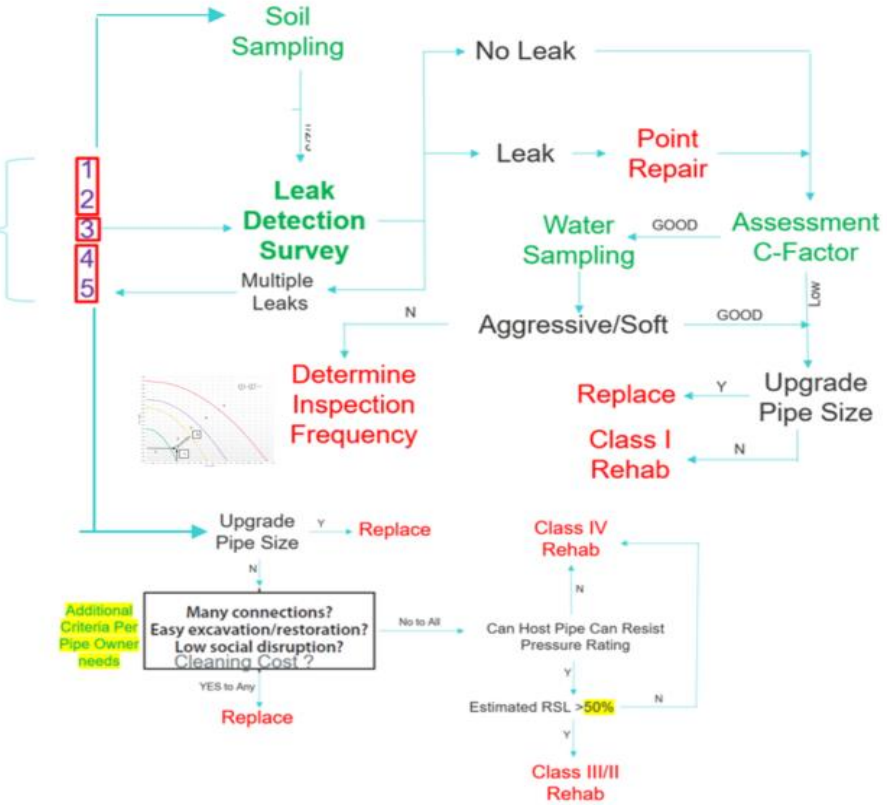
Incorporating Inspection Findings into AWWA M28 Pipe Renewal Decision-Making Tree

Capital Planning – Decision Making Tree

Field Measurements

1. Wall Thickness Measurement
2. Soil Sampling
3. Water Sampling
4. C-Factor Test
5. Leak Detection
6. TPM





Questions & Answers

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