Predicting The Remaining Life of Pipe:

Acoustic Condition Assessment

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Advanced Solutions

suez

Distribution Committee:

2019 Goals:

- Increase Involvement
- Update Communication
- Determine Topics for 2019 Conference
  - Seismic Resiliency
- Create additional training opportunities in underserved areas

Please contact us if:

- You are interested in getting involved
- You would like to suggest topics or presenters
- You would like to included in communications

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Overview:

- **Pipe Condition Assessment**
  - Introduction
  - The Problem
  - Condition Assessment Alternatives
  - Acoustic Condition Assessment
  - Case Study
  - Summary
  - Questions

SUEZ' HISTORY IN NORTH AMERICA

1869 — Founded as Hackensack Water Company

1974 — Integration of Infilco by Degremont

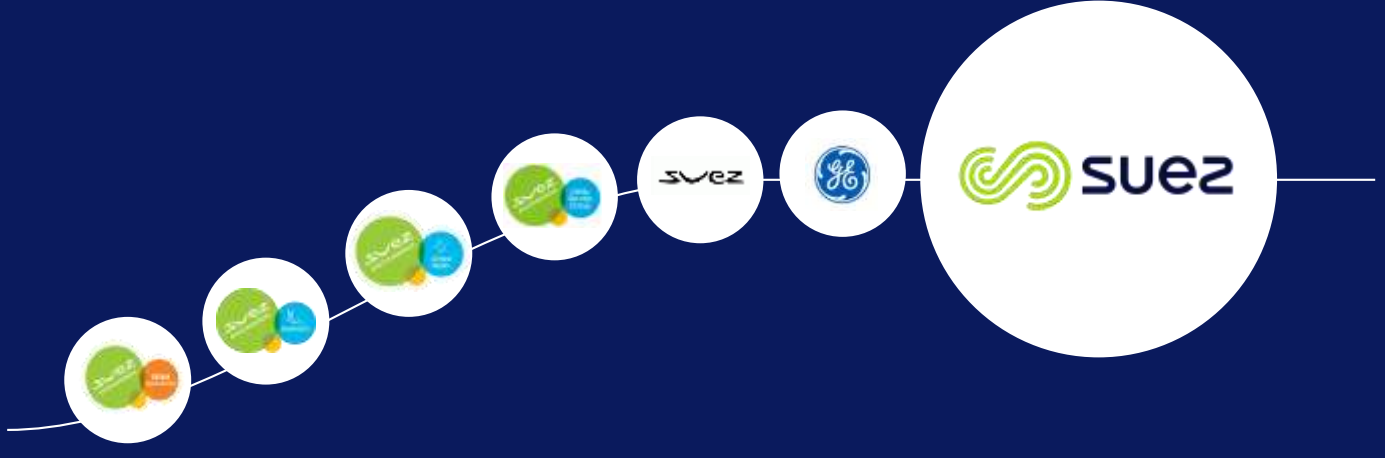
2000 — Integration of United Water

2008 — Integration of Utility Service Group

2011 — Integration of SENA Waste Services

2017 — Acquisition of GE Water & Process Technologies

SUEZ' HISTORY IN NORTH AMERICA



Suez Advanced Solutions:
Infrastructure Rehabilitation and Asset Management

Water Wells

- Condition assessment
- Maintenance program
- Pumps services
- Rehabilitation
- Drilling

Water Quality

- Asset chemical cleaning
- Mixers
- THM removal
- Ice Pigging
- Filter media replacement

Steel Water Tanks

- Condition assessment
- Maintenance program
- Rehabilitation
- Drone inspections

Concrete Structures

- Condition assessment
- Maintenance program
- Rehabilitation
- Water, wastewater and storm water assets

Network assets & Meters

- Maintenance program with AMI
- Advanced Network management (Aquadvanced)
- Network condition assessment and rehabilitation

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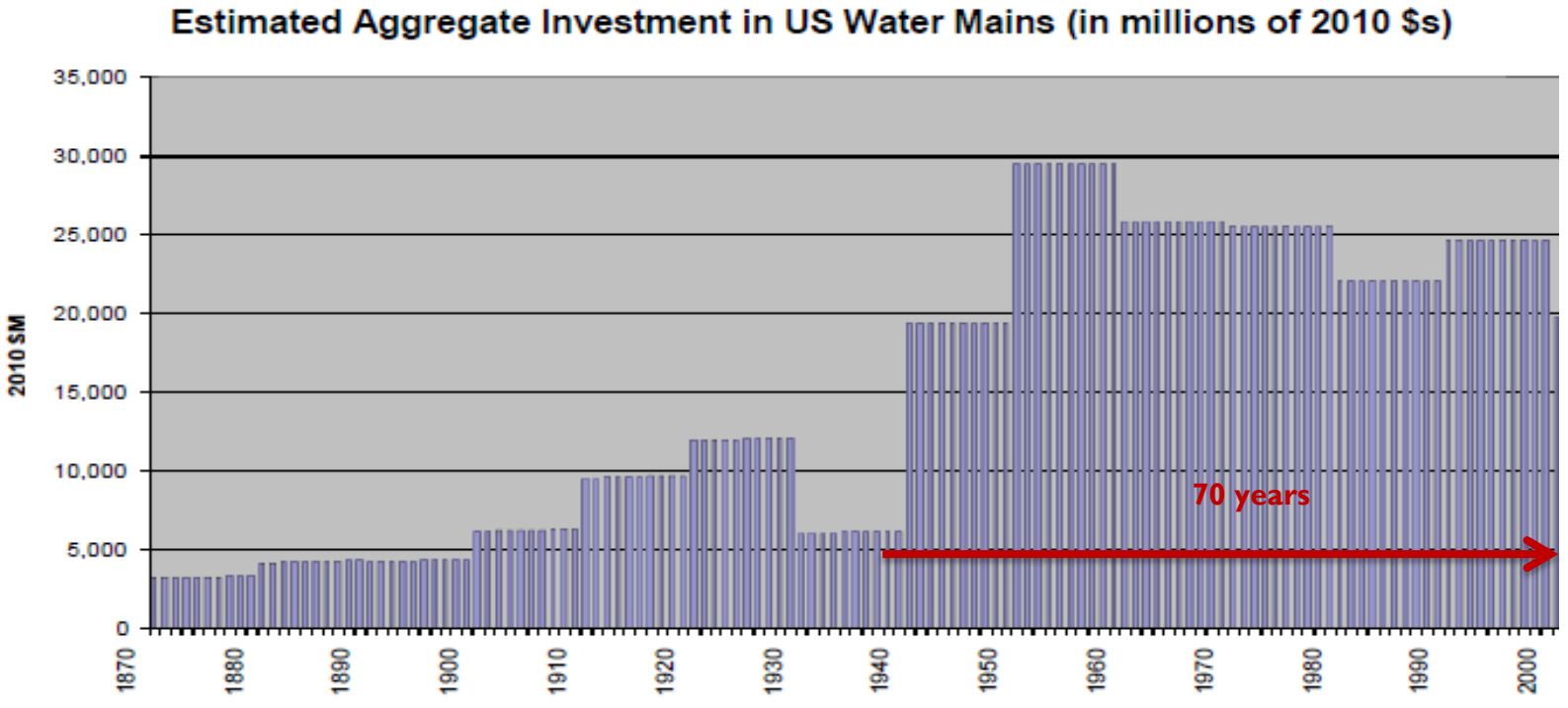
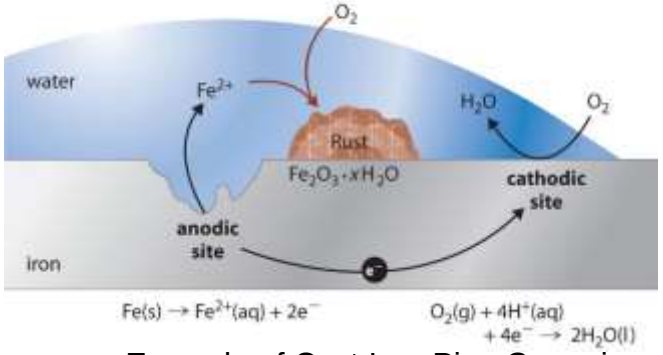
The Problem

Pipe Age:

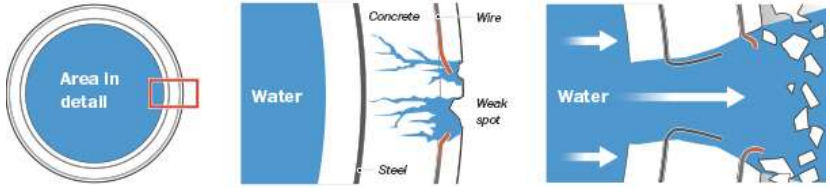


Pipes are surpassing useful life due to:

- **Internal Corrosion**
- **Tuberculation build up**
- **Loosing wall thickness**
- **Main breaks**



Example of Cast Iron Pipe Corrosion



Example of concrete water pipe failure

Pipe Replacement Decision Making

Most Replacement Decisions Based on….

Run To Failure Consequences

Water Distribution:

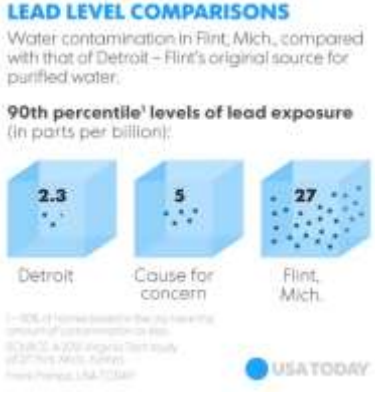
- Loss of hydraulic capacity
- Water loss
- Degradation of water quality / Poisoning
- Collapses

Collection Systems:

- Contamination due to Overflows, Violations
- Inflow & Infiltration / Pumping & treatment cost
- Collapses

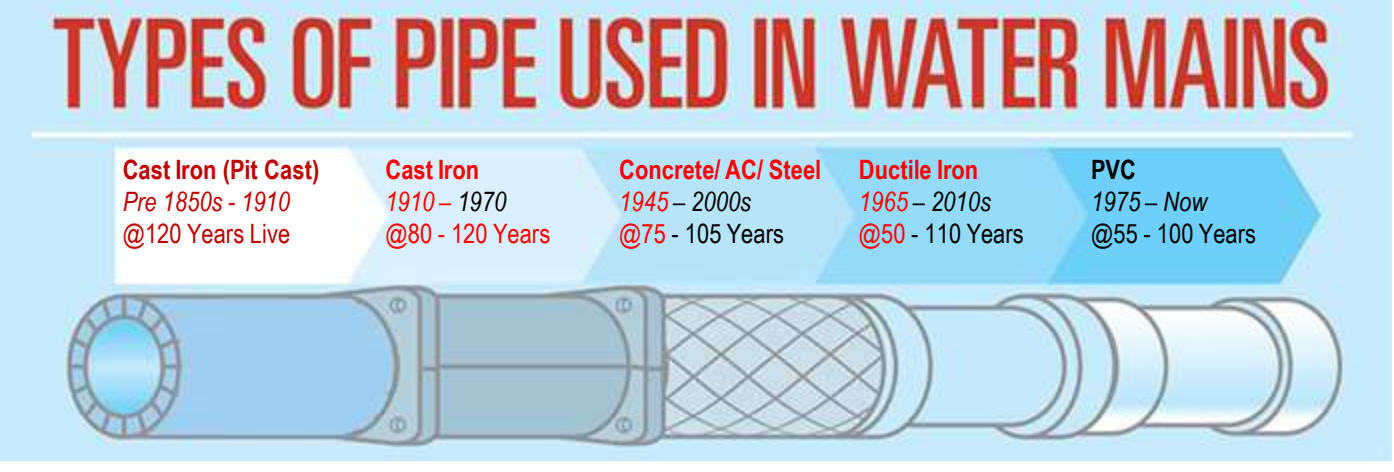
Run To Failure Approach

14th Street, Atlanta



Proactive Approach

Due to the difficulties to inspect pressurized pipes, pipe rehabilitation in distribution systems is prioritize based on pipe age and material:



Traditional Approach: The Problem

Two Pipelines Sound The Same

Pipeline 1	Pipeline 2
Installed 1860	Installed 1860
Brown sandy soil	Brown clay soil
Moderate soil corrosivity	Moderate soil corrosivity

Traditional Approach: The Problem

But Look Very Different

Pipeline 1	Pipeline 2
Installed 1860	Installed 1860
Brown sandy soil	Brown clay soil
Moderate soil corrosivity	Moderate soil corrosivity
Results: **31% degraded**	Results: **1% degraded**
Condition: **Poor**	Condition: **Good**

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Condition Assessment Alternatives

What is Available?

- Non Pressurized (Sewers)
  - Pole Cameras
  - CCTV inspection
  - Advanced Pipe Condition Assessment Systems (Redzone, Cleanflow, PPR, etc.)
  - Manual and Entry Inspection Methods

These methods require to take pipes out of service in potable water

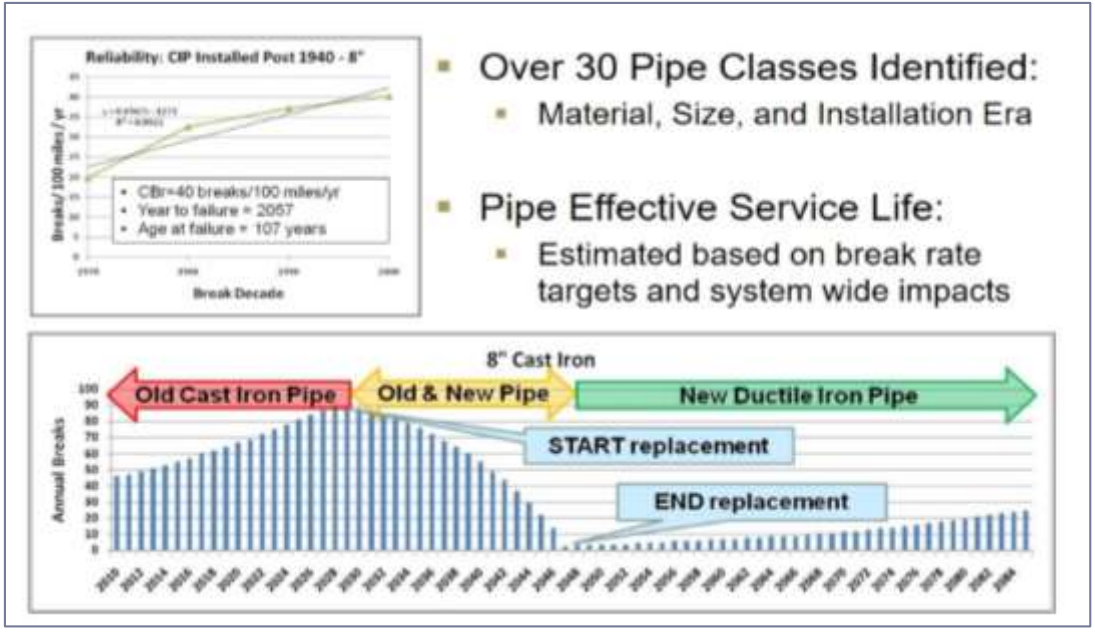
- Pressurized system (Drinking Water)
  - Desktop Studies
  - Sahara (Online / Intrusive)
  - Smart Ball (Online / Intrusive)
  - Hydrant Camera / JD7 (Online / Intrusive)
  - Acoustic (Online / Non intrusive)

Require insertion of devices in the potable water (Intrusive)

Alternatives: Traditional Approach

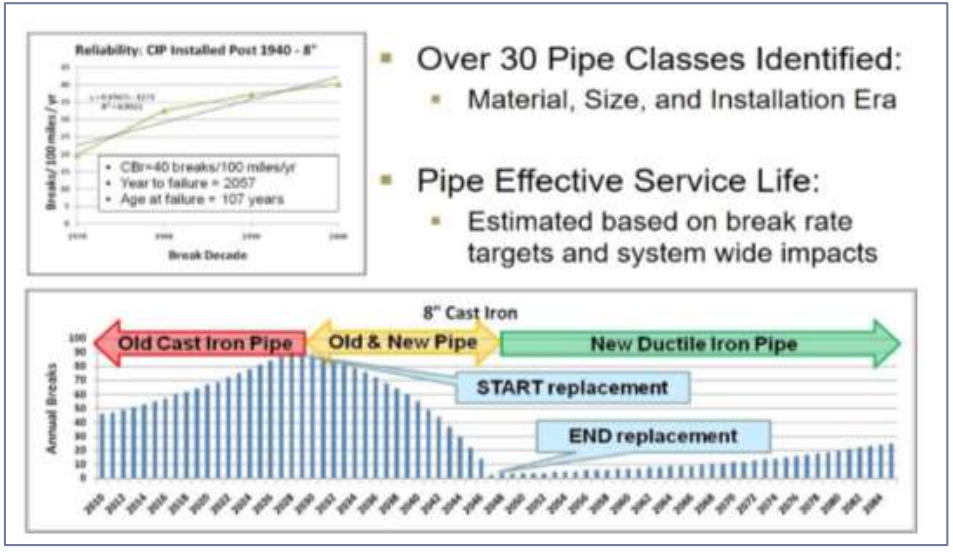
More sophisticated engineering studies include additional data to estimate the pipe condition:

- Pipe Material
- Size
- Age
- Soil Type
- History of leaks / main breaks
- Other indirect data



Alternatives: Traditional Approach

Desktop Study Alone:



Scenario:	Desktop
Desktop Study	$0.05 / ft
Error Rate	50%
Replacement Cost	$200 / ft
Error Risk	$100 / ft
Total Cost	**$100.05 / ft**

The actual cost of a desktop Study can be high when considering the cost to rehabilitate the wrong pipes

Alternatives: Intrusive Condition Assessment

Disruptive Condition Assessment: Smart pigs

Benefits:

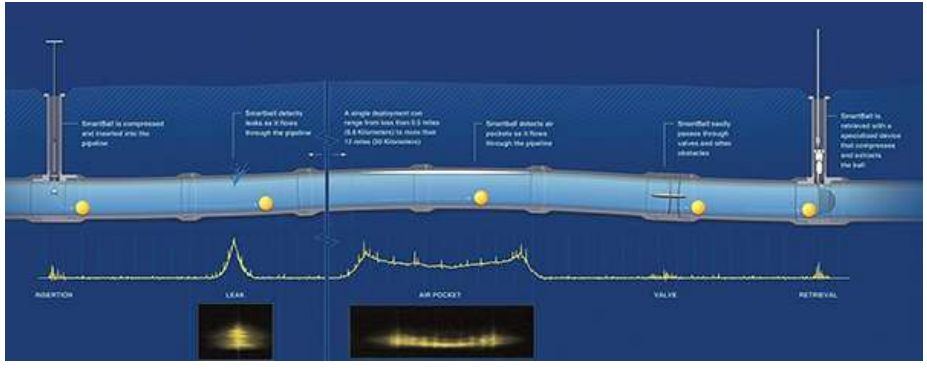
- **Very accurate**
- **Ideal for large, Critical Pipe**

Main Drawbacks:

- **Cost / Availability**
- **Application constraints**
  - Pipe diameter
  - Velocity
  - Pressure
  - Geometry
  - Deployment

Alternatives: Intrusive Condition Assessment

Disruptive Condition Assessment:



(Example)

Scenario:	Disruptive
Preparation Cost	$40 / ft
Inspection Cost	$10 / ft
Error Rate	5%
Replacement Cost	$200 / ft
Error Risk	$10 / ft
Total Cost	**$60 / ft**

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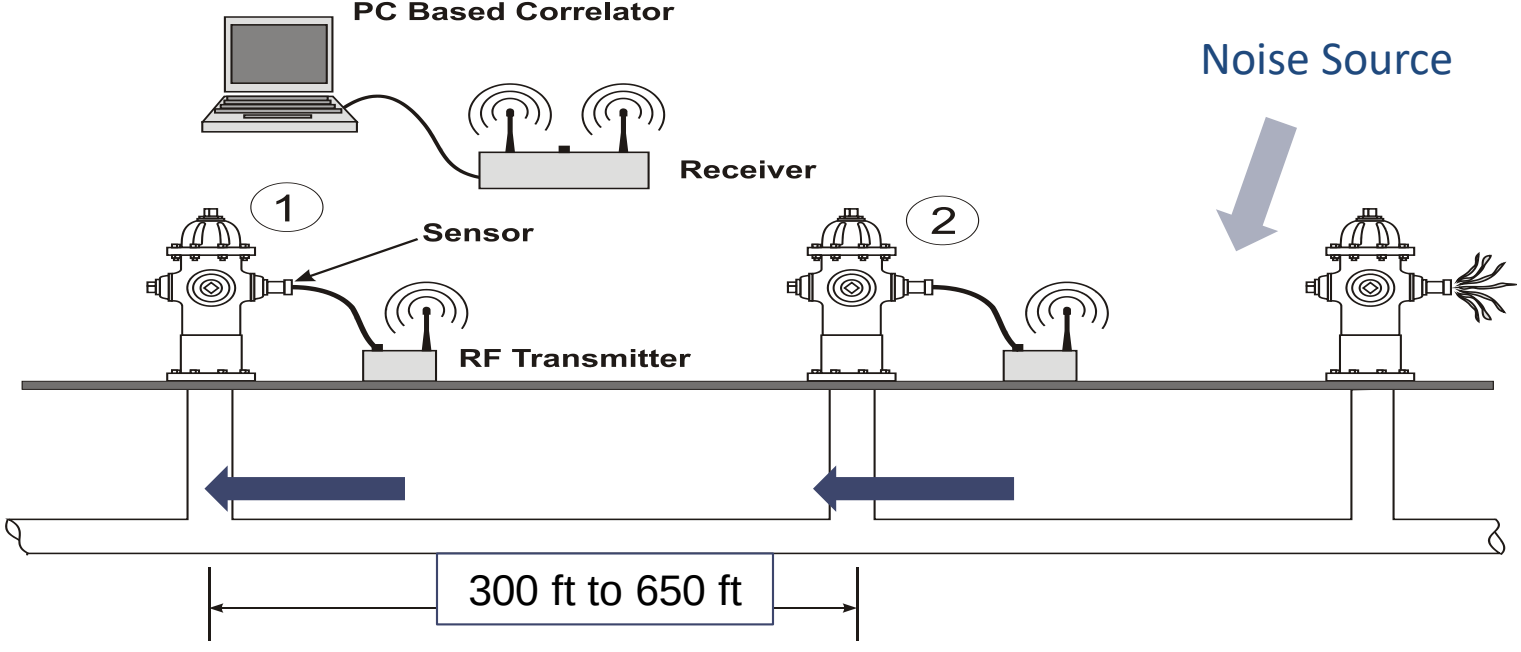
Acoustic Condition Assessment: How Does it work?

Sensors to be placed on Hydrants, valves or directly on top of the main

echologics SUEZ

Acoustic Condition Assessment: How Does it work?

Equipment Measures Average Wall Thickness Over Intervals



Acoustic Condition Assessment: How Does it work?

Testing results match best with the thinnest point around the circumference, averaged over test interval

Tuberculation and graphitized material do not contribute to structural thickness

This is the remaining structural thickness!

Acoustic Condition Assessment: Method

Method Requirements

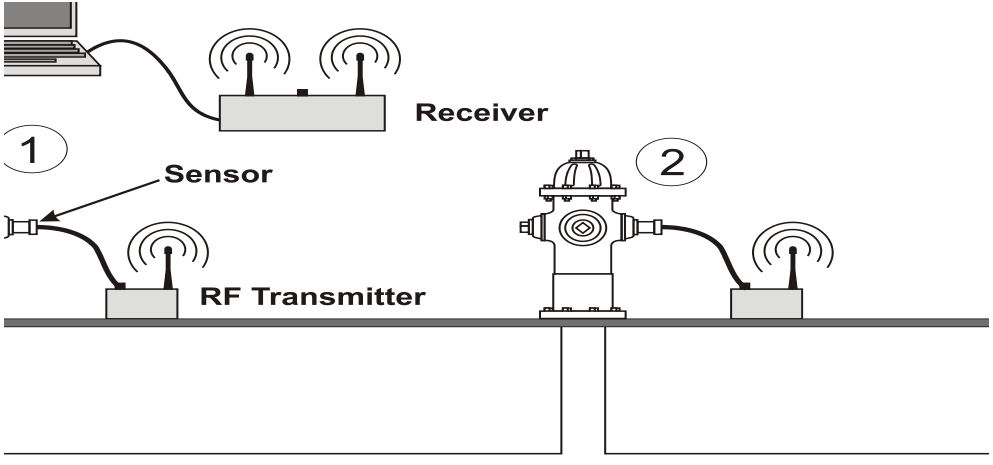
- Pressure >15 psi
- No air in pipe
- Contact points every 100m to 200m
- Diameter : Thickness ratio of 30:1 or less
- Pipe information (maps, as-builts, repair sections, etc.)

Deliverables For Each Test Segment

- Average structural wall thickness
- Percentage loss
- Qualitative condition
- Leak locations and estimated sizes
- Remaining service live also available for AC and iron mains

Alternatives: Acoustic

Non-Disruptive Condition Assessment:



Measures Average Wall Thickness Over Intervals

Scenario:	Non-Disruptive
Preparation Cost	$3.50 / ft
Inspection Cost	$1.50 / ft
Error Rate	10%
Replacement Cost	$200 / ft
Error Risk	$20 / ft
Total Cost	**$25 / ft**

Acoustic Condition Assessment provides savings by making sure the pipes in worst conditions are selected:

Field Verification / Condition Assessment

Acoustic Condition Assessment provides savings in a rehabilitation program, making sure the pipes in worst conditions are selected:

Scenario:	Desktop	Invasive	Acoustic
Preparation Cost	$0 / ft	$40 / ft	$3.50 / ft
Inspection Cost	$0.05 / ft	$10 / ft	$1.50 / ft
Error Rate	50%	5%	10%
Replacement Cost	$200 / ft	$200 / ft	$200 / ft
Error Risk	$100 / ft	$10 / ft	$20 / ft
Total Cost	**$100.05 / ft**	**$60 / ft**	**$25 / ft**

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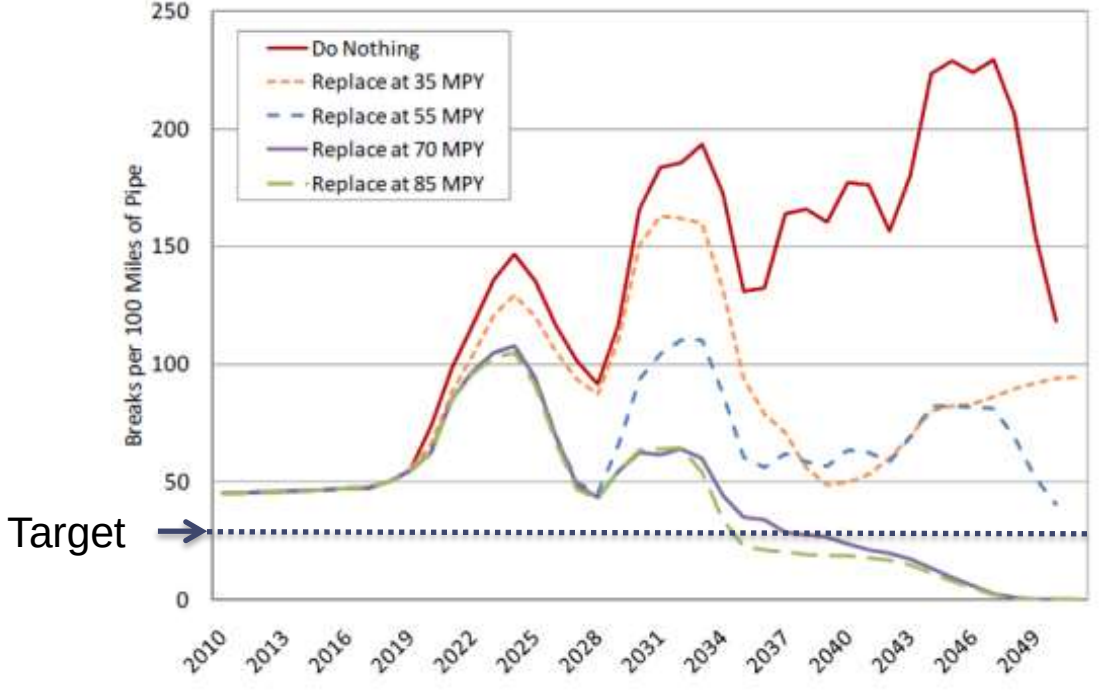
Case Study: Washington DC

Traditional Desktop Study:

- Pipes selected by a computer model considering age, material, soil, break history, and other factors

Decided on replacing 55 miles of pipe per year to reduce burst rate



Case Study: Washington DC

Traditional Desktop Study:

- After digging up pipes selected for replacement, found that more than 50% were still in good condition.
- Decided to run a pilot program using Acoustic to check the condition of the selected pipes before replacing them.

Project Details

- 43 miles of Acoustic testing
- < $1M invested in Condition Assessment
- 10 weeks of testing
- 0 excavations / 0 disruptions

Case Study: Washington DC

Condition Assessment results:

Project Details

- 43 miles of Acoustic testing
- < $1M invested in Condition Assessment
- 10 weeks of testing
- 0 excavations / 0 disruptions

Results:

- **20 miles of good pipe found**
- **$14M saved (46%)**
- $117k worth of leaks found
- Budget redirected from pipes actually in good shape

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Acoustic Condition Assessment: Benefits

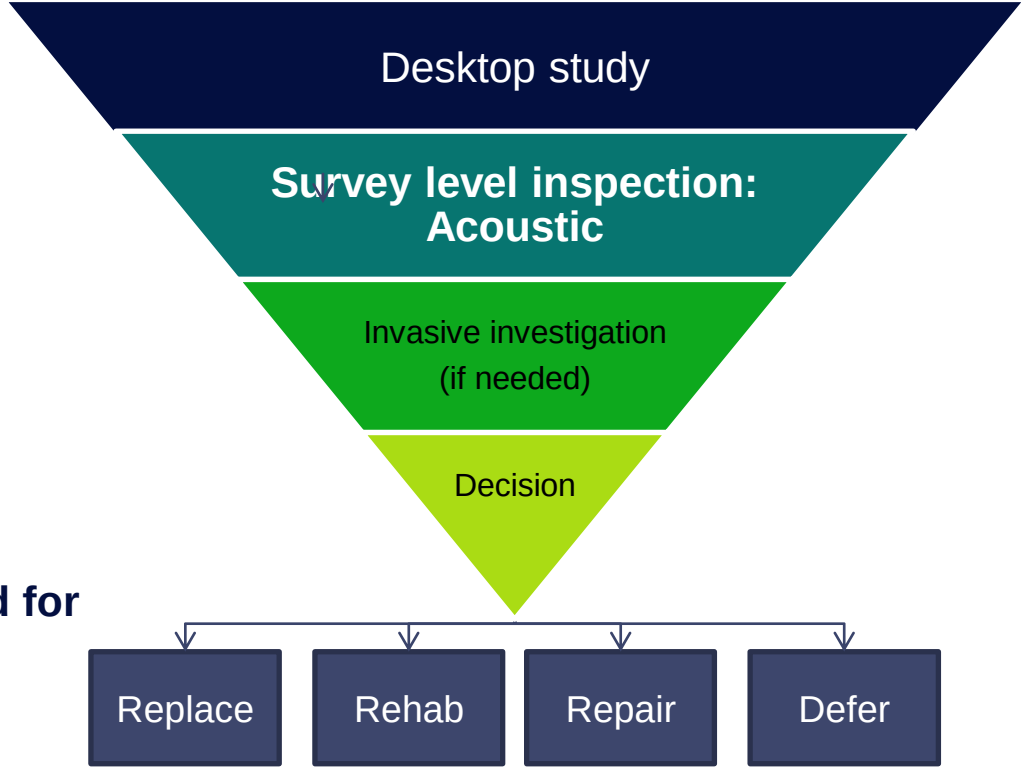
Acoustic Condition Assessment (Distribution water pipes) is an efficient solution

- **Part of a Systematic Asset Management approach that includes verification**
- **Cost Efficient**
  - Provides Up to 50% savings when included with traditional engineering study
- **Non-Invasive**
  - No service interruption
  - No Risk
- **Quick**
  - Minimum preparation required
  - Usually no site preparation / construction needed

The solution: Pyramid Model

The best practice approach:

1. **Use a desktop study to prioritize where to perform annual acoustic surveys**
2. **Use acoustic surveys to prioritize pipes for rehabilitation**
3. **Use invasive inspections if needed for spot investigations**



Condition Assessment: Is it right for you?

Key Questions:

- **Do you have an annual budget for replacing mains?**
  - Condition Assessments can let you be sure you are replacing the right ones
- **Have you ever replaced pipes and then discovered they were still in good shape?**
  - Condition Assessments can help you avoid wasting this money
- **Do any of your pipes keep you up at night?**
  - Condition Assessments can help you understand that pipe's condition
- **Are you happy with how your pipe replacement choices are being made?**
  - Condition Assessments lets you make decisions based on actual condition
- **Are you looking to institute a pipe replacement program?**
  - Condition Assessments can help target the right pipes from the beginning

Questions?

For Additional information:

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Acoustic Condition Assessment: Features and Benefits

Feature	Advantage	Benefit
Test from outside the main	No operational disruptions	Lower preparation costs. Water never contaminated. Sediment undisturbed.
Works with all appurtenances	No need to dig up the main or install new ports	Lower total project costs. Minimal traffic disruptions.
Field tests fast, non-disruptive	Test 1 km / team / day with minimal support	Scalable to large portions of a network
Report current wall thickness	Easily predict remaining useful life	Allows clear decisions about replacement or rehabilitation.
Verified and proven	Dozens of utilities have verified our results	Utilities can act with confidence in the information provided

The low cost and minimal support required for Acoustic Condition Assesment make it easy to scale to large portions of a network.