MesaWater DISTRICT©

Pipeline Integrity Program

Data Driven Decisions for Pipeline Replacement

WACO

December 4, 2020

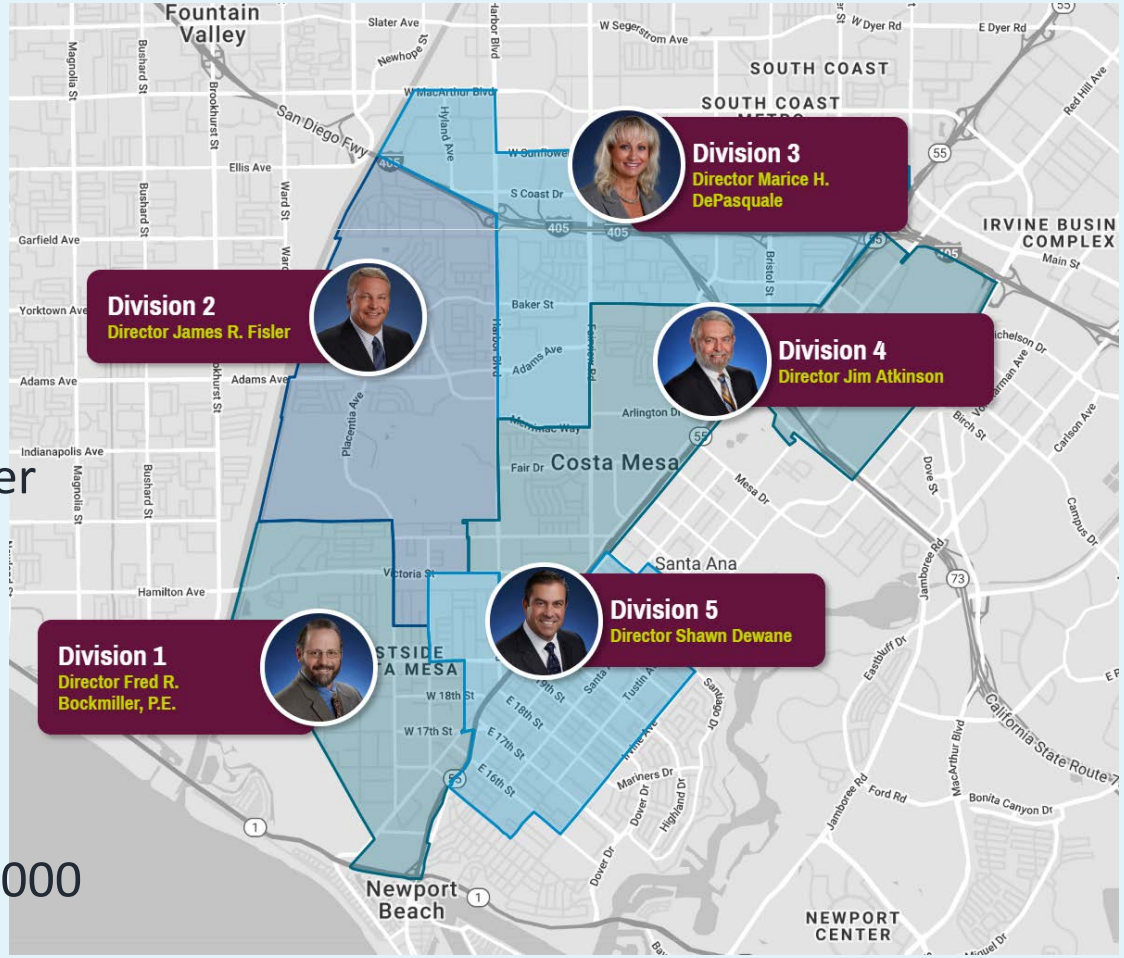
Presentation Outline

- Introduction to Mesa Water District
- Genesis of the Pipeline Integrity Program
- Program Implementation
- Program Benefits

MesaWater DISTRICT©

Introduction to Mesa Water District

- Special District
- Formed in 1960
- Governed by Five-member Elected Board of Directors
- Potable and Reclaimed Water
- 18 Square Mile Service Area
  - Most of Costa Mesa
  - Parts of Newport Beach
  - John Wayne Airport
- ~24,000 retail accounts
- Service Population of ~110,000

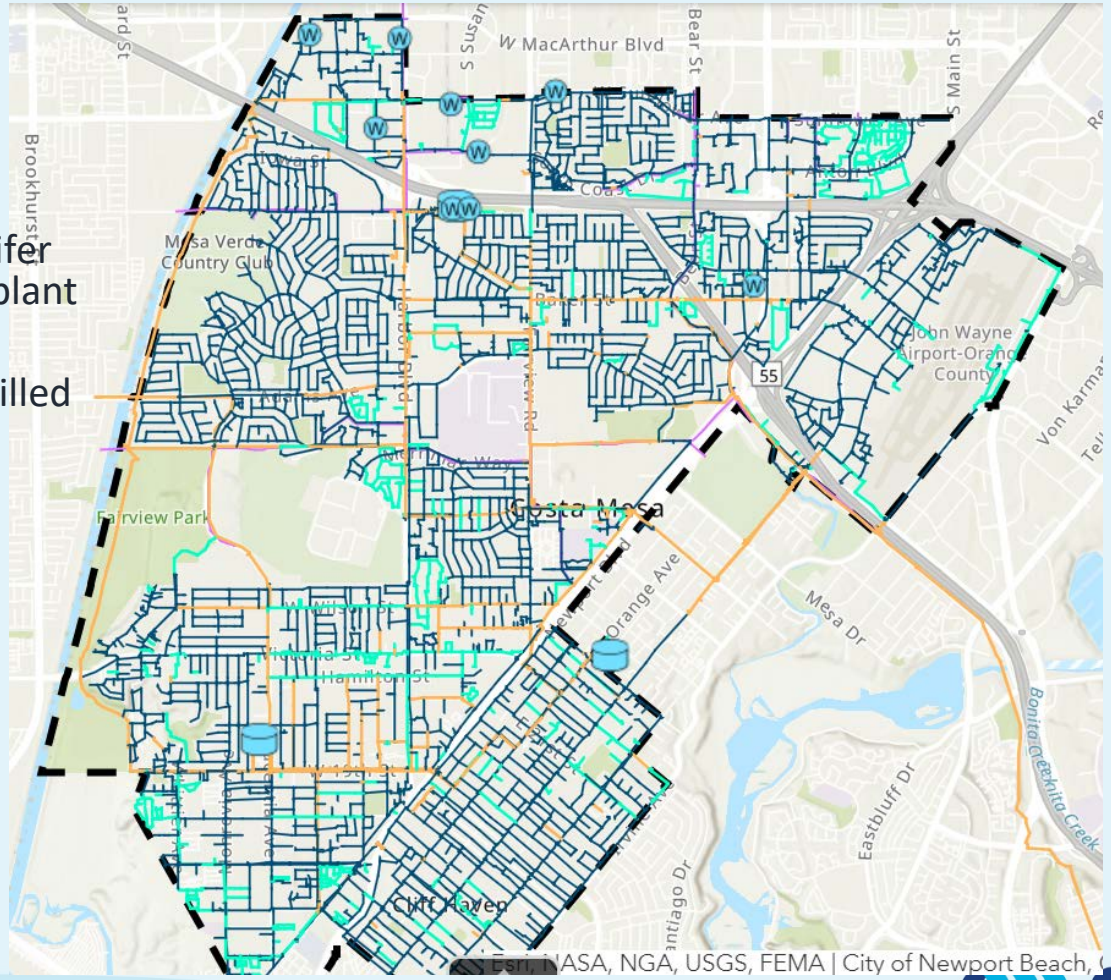


MesaWater DISTRICT®

Introduction to Mesa Water District

Key Assets

- 100% Local Supply
  - 2 Deep wells in the lower aquifer and nanofiltration treatment plant
  - 5 Principal Aquifer Wells
  - Two more clear wells being drilled
- Two Water Storage Tanks
  - 18M Gallons
  - 11M Gallons
  - 1 Pressure Zone
- 317 miles of pipeline
  - ~75% of total capital asset replacement costs



MesaWater DISTRICT®

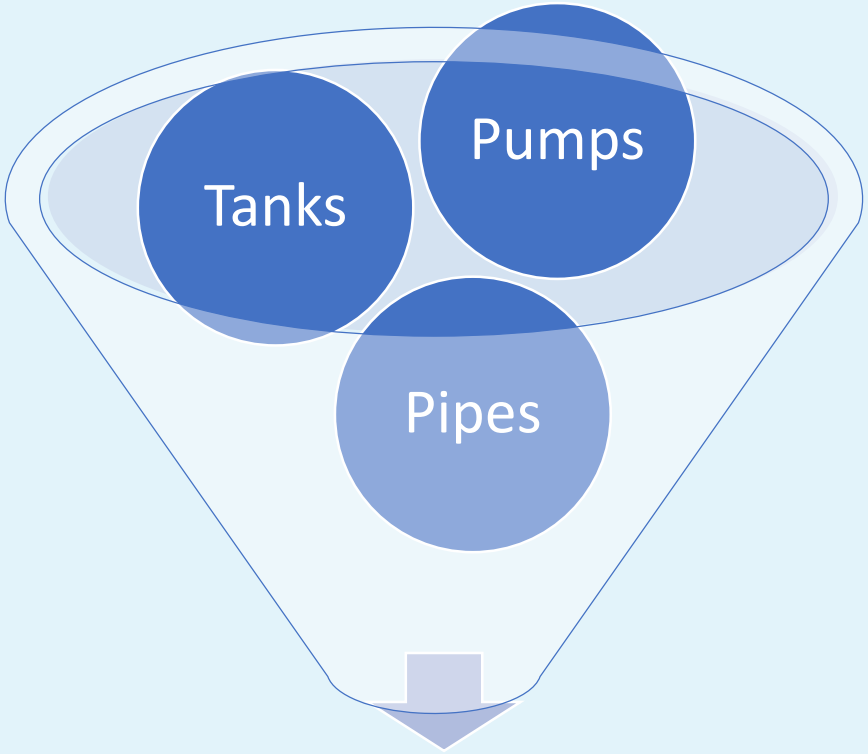
Water Infrastructure Challenges

Table 3. Top 10 issues facing the water industry as ranked by all participants, 2015–2019

Rank	2015	2016	2017	2018	2019
1	Renewal and replacement of aging water and wastewater infrastructure	Renewal and replacement of aging water and wastewater infrastructure	Renewal and replacement of aging water and wastewater infrastructure	Renewal and replacement of aging water and wastewater infrastructure	Renewal and replacement of aging water and wastewater infrastructure
2	Financing for capital improvements	Financing for capital improvements	Financing for capital improvements	Financing for capital improvements	Financing for capital improvements
3	Long-term water supply availability	Public understanding of the value of water systems and services	Long-term water supply availability	Public understanding of the value of water systems and services	Long-term water supply availability
4	Public understanding of the value of water systems and services	Long-term water supply availability	Public understanding of the value of water systems and services	Long-term water supply availability	Public understanding of the value of water systems and services
5	Public understanding of the value of water resources	Public understanding of the value of water resources	Public understanding of the value of water resources	Public understanding of the value of water resources	Watershed/source water protection
6	Watershed/source water protection	Watershed/source water protection	Watershed/source water protection	Watershed/source water protection	Public understanding of the value of water resources
7	Cost recovery (pricing water to accurately reflect its true cost)	Public acceptance of future water and wastewater rate increases	Emergency preparedness	Aging workforce / anticipated retirements	Groundwater management and overuse
8	Emergency preparedness	Water conservation/ efficiency	Cost recovery (pricing water to accurately reflect its true cost)	Public acceptance of future water and wastewater rate increases	Aging workforce/ anticipated retirements
9	Water conservation/ efficiency	Cost recovery (pricing water to accurately reflect its true cost)	Public acceptance of future water and wastewater rate increases	Emergency preparedness	Emergency preparedness
10	Compliance with future regulations	Groundwater management and overuse	Water conservation/ efficiency	Governing board acceptance of future water and wastewater rate increases	Cost recovery (pricing water to accurately reflect the cost of service)

MesaWater DISTRICT®

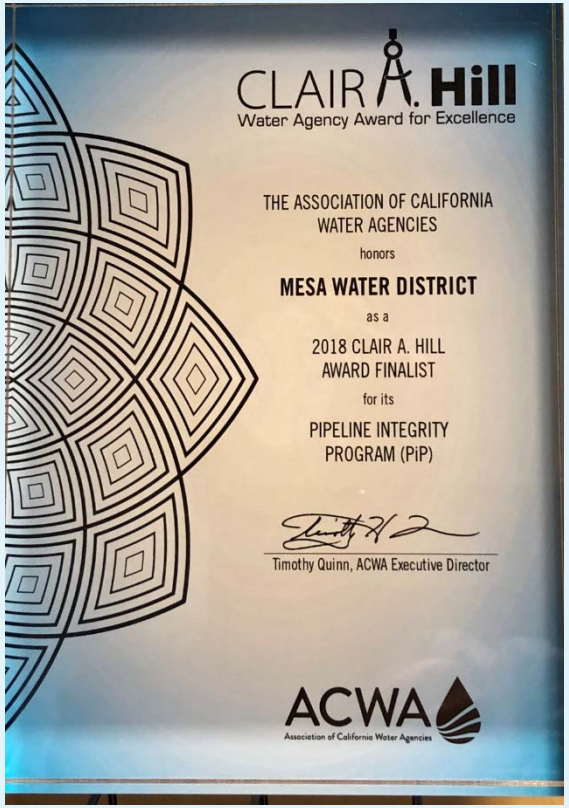
Water Infrastructure Challenges



Asset Renewal Program

Pipes ~75% of total system Renewal Cost

Genesis of the Pipeline Integrity Program

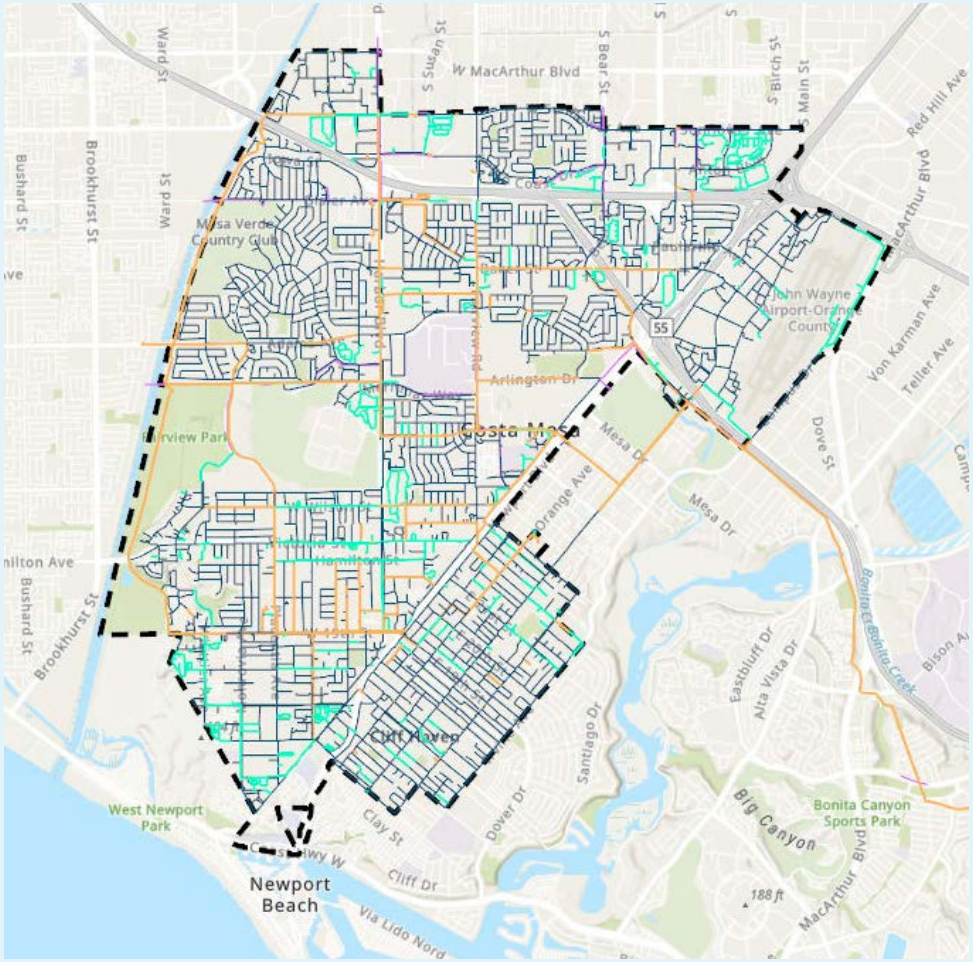


MesaWater DISTRICT©

Pipeline Renewal & Replacement

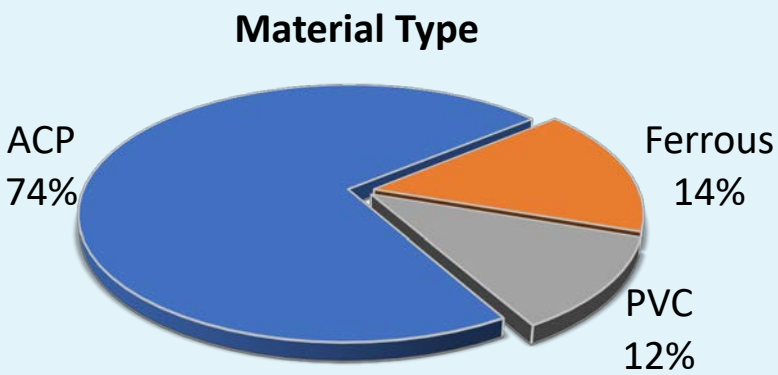
If we had to replace all of our pipelines in 100 years

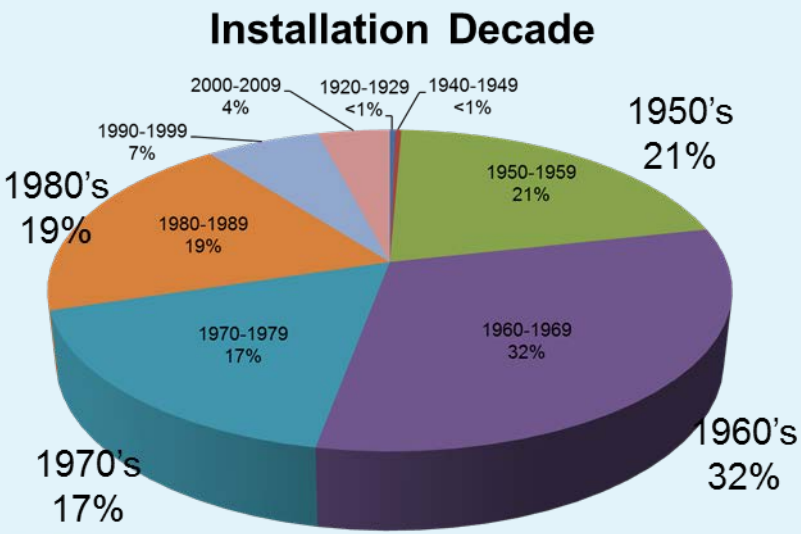
- How much would it cost?
- How would we do it?
- How would we fund it?

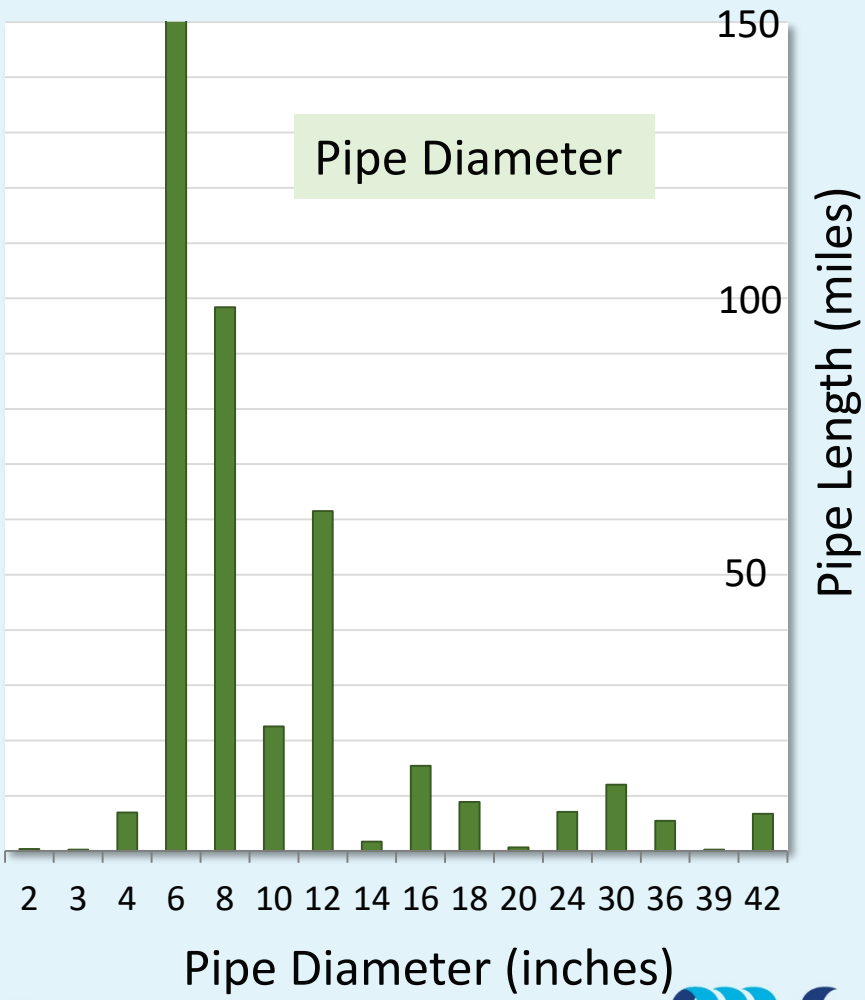


MesaWater DISTRICT®

System Overview- 317 Miles of Pipeline







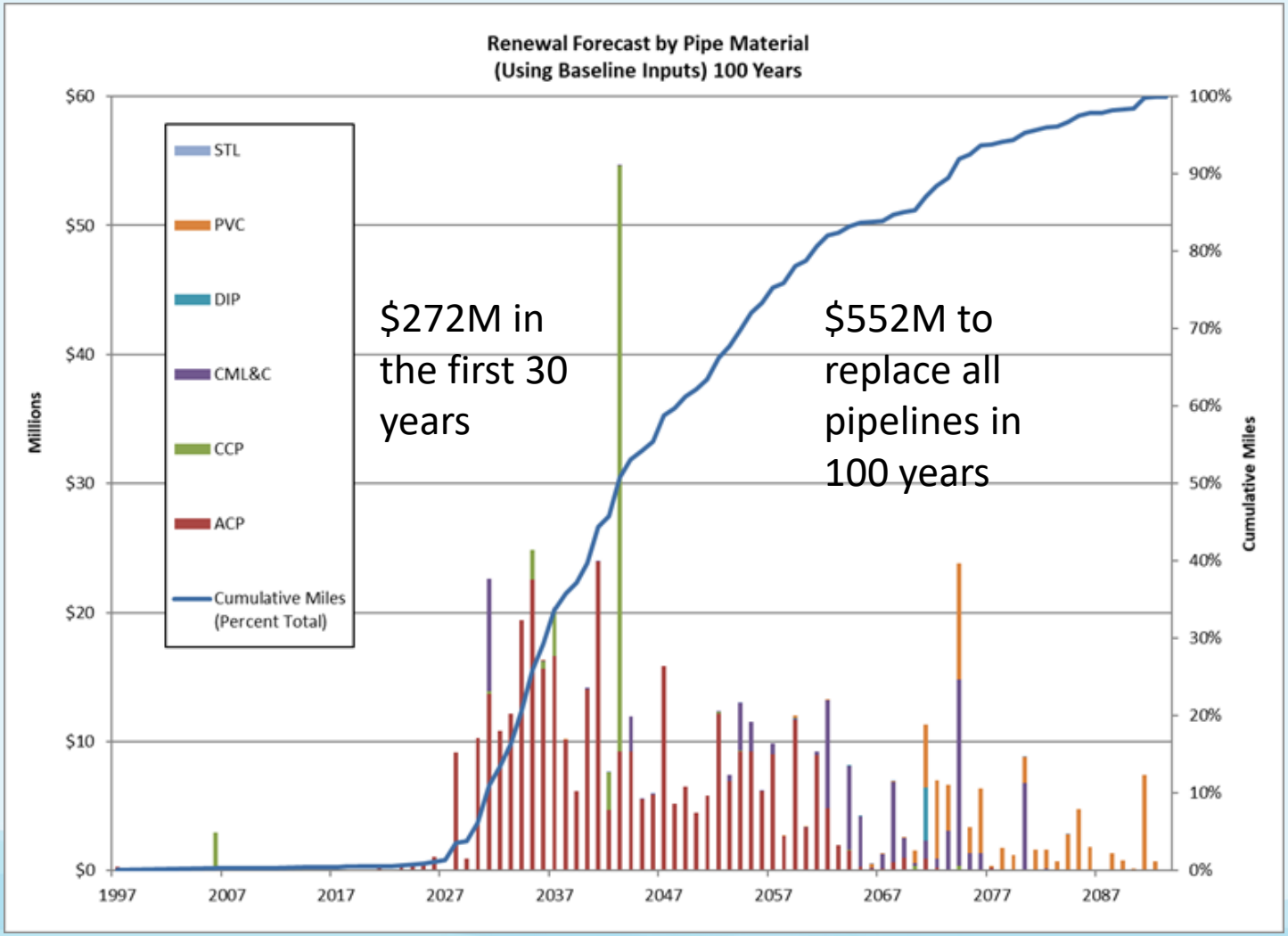
MesaWater DISTRICT®

Age- based Useful Life Assumptions

Material		Average Age-Based Useful Life
ACP		75
Metals	CIP	65
	CMLC	80
	CCP	80
	DIP	82.5
PVC		85

MesaWater DISTRICT©

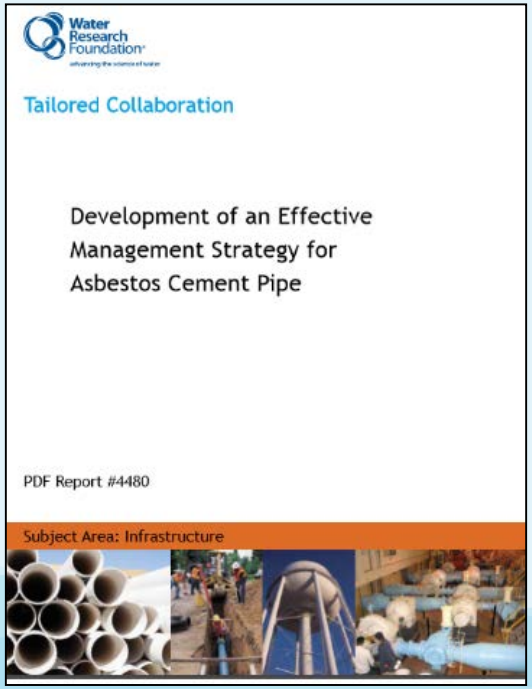
Age- Based Replacement Costs

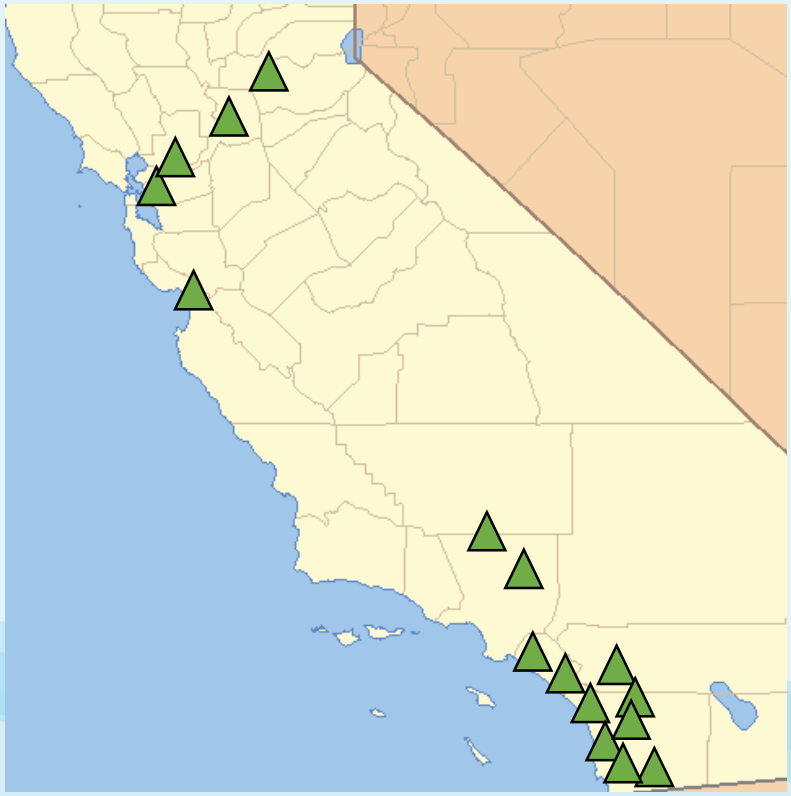


MesaWater DISTRICT©

Pipeline Integrity Program Goals

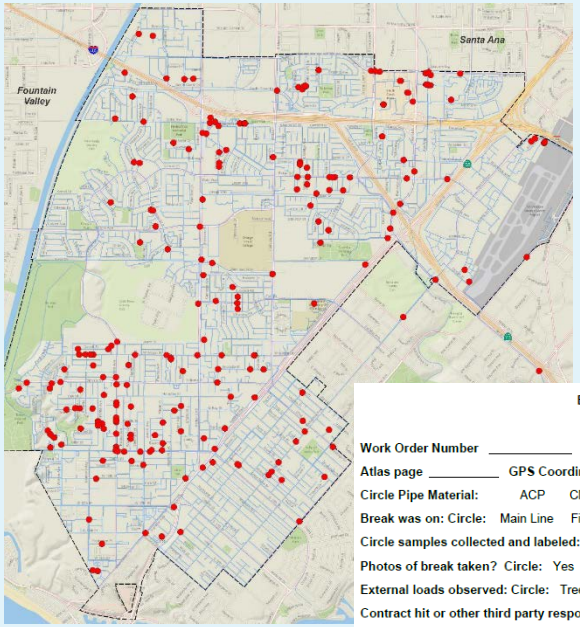
- Strategic pipeline replacement
  - Maximize investment
  - Replace at end of Useful Life
  - Transparent and Dependable Decision Making

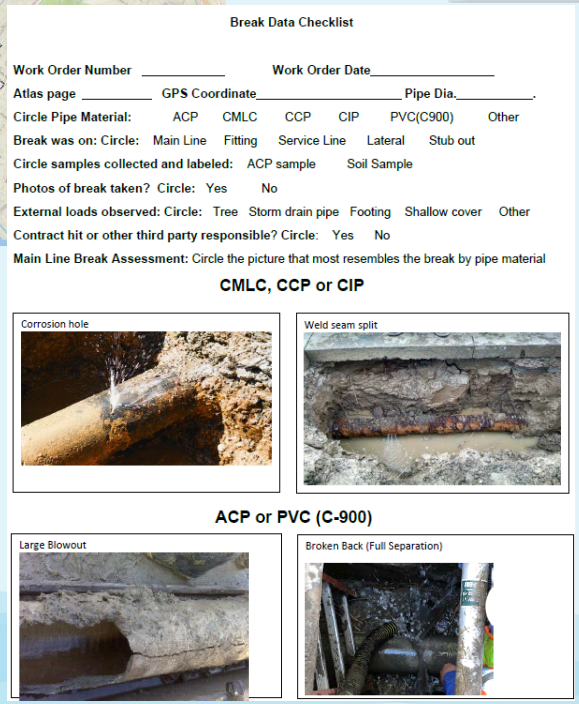




MesaWater DISTRICT®

Data Driven Decisions





Break Data Checklist

Work Order Number _____ **Work Order Date**_____

Atlas page _____ **GPS Coordinate**_____ **Pipe Dia.**_____.

Circle Pipe Material: ACP CMLC CCP CIP PVC(C900) Other

Break was on: Circle: Main Line Fitting Service Line Lateral Stub out

Circle samples collected and labeled: ACP sample Soil Sample

Photos of break taken? Circle: Yes No

External loads observed: Circle: Tree Storm drain pipe Footing Shallow cover Other

Contract hit or other third party responsible? Circle: Yes No

Main Line Break Assessment: Circle the picture that most resembles the break by pipe material

CMLC, CCP or CIP

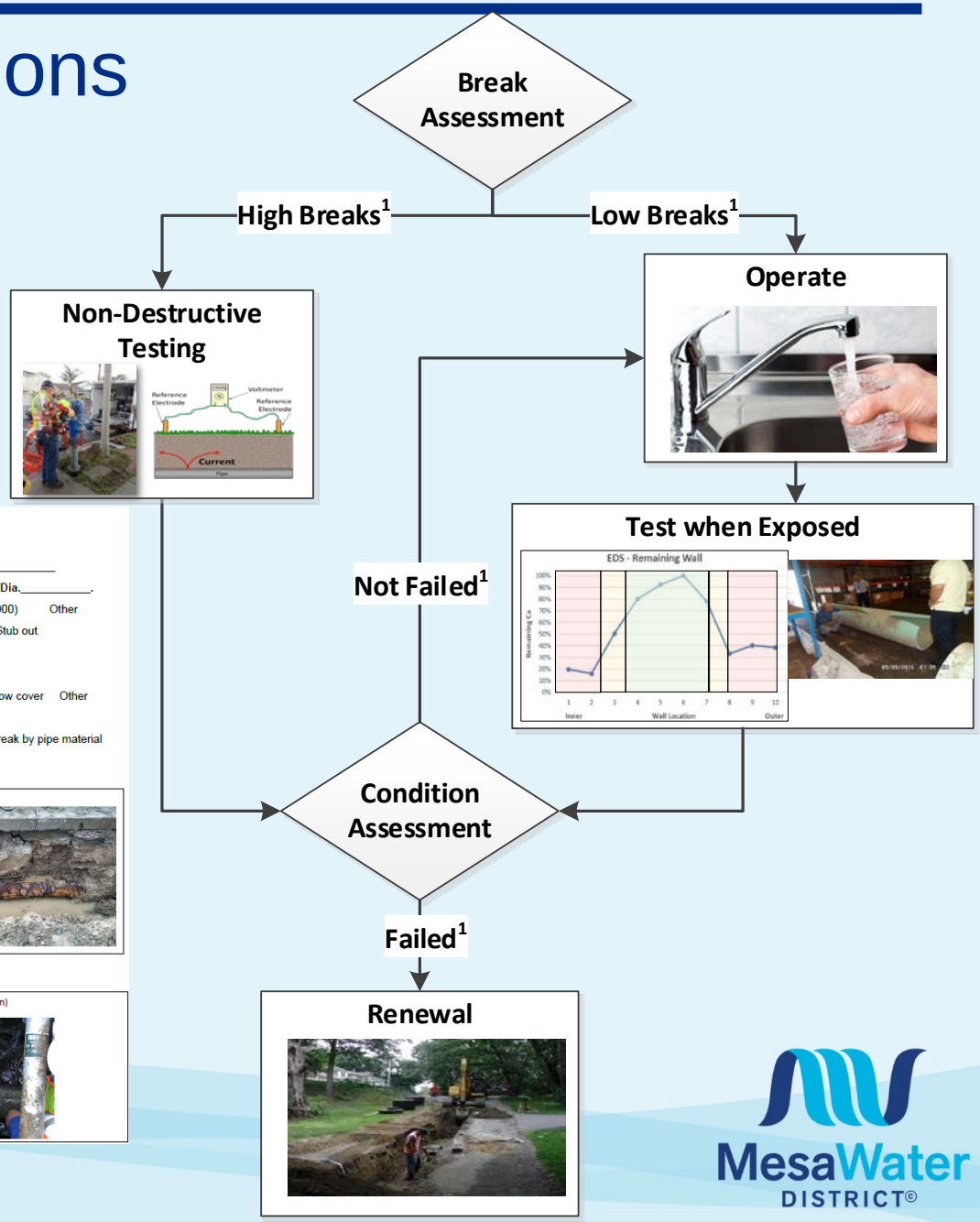
Corrosion hole

Weld seam split

ACP or PVC (C-900)

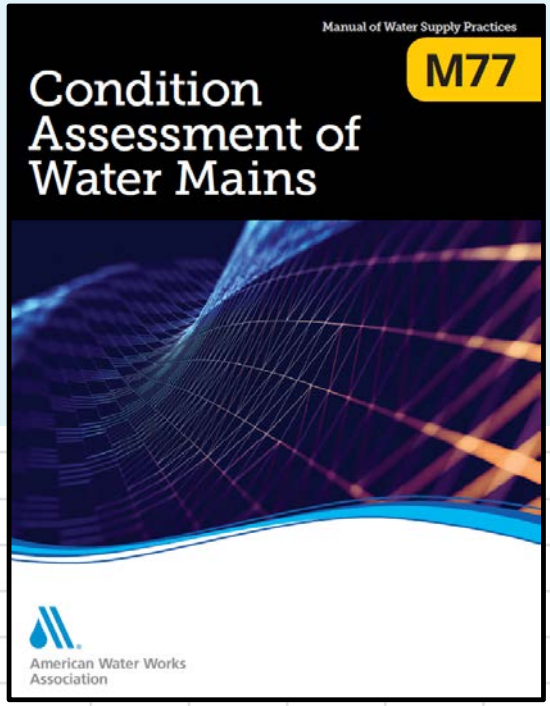
Large Blowout

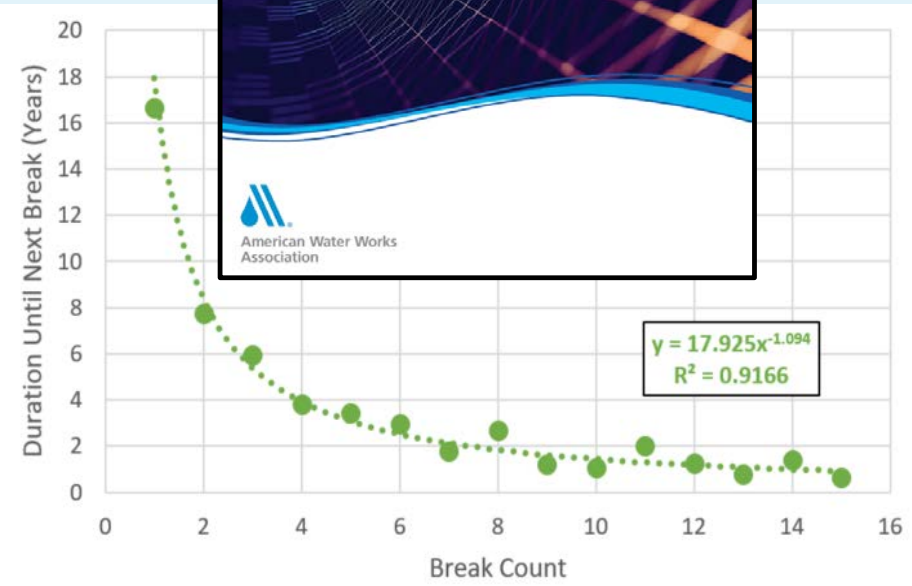
Broken Back (Full Separation)

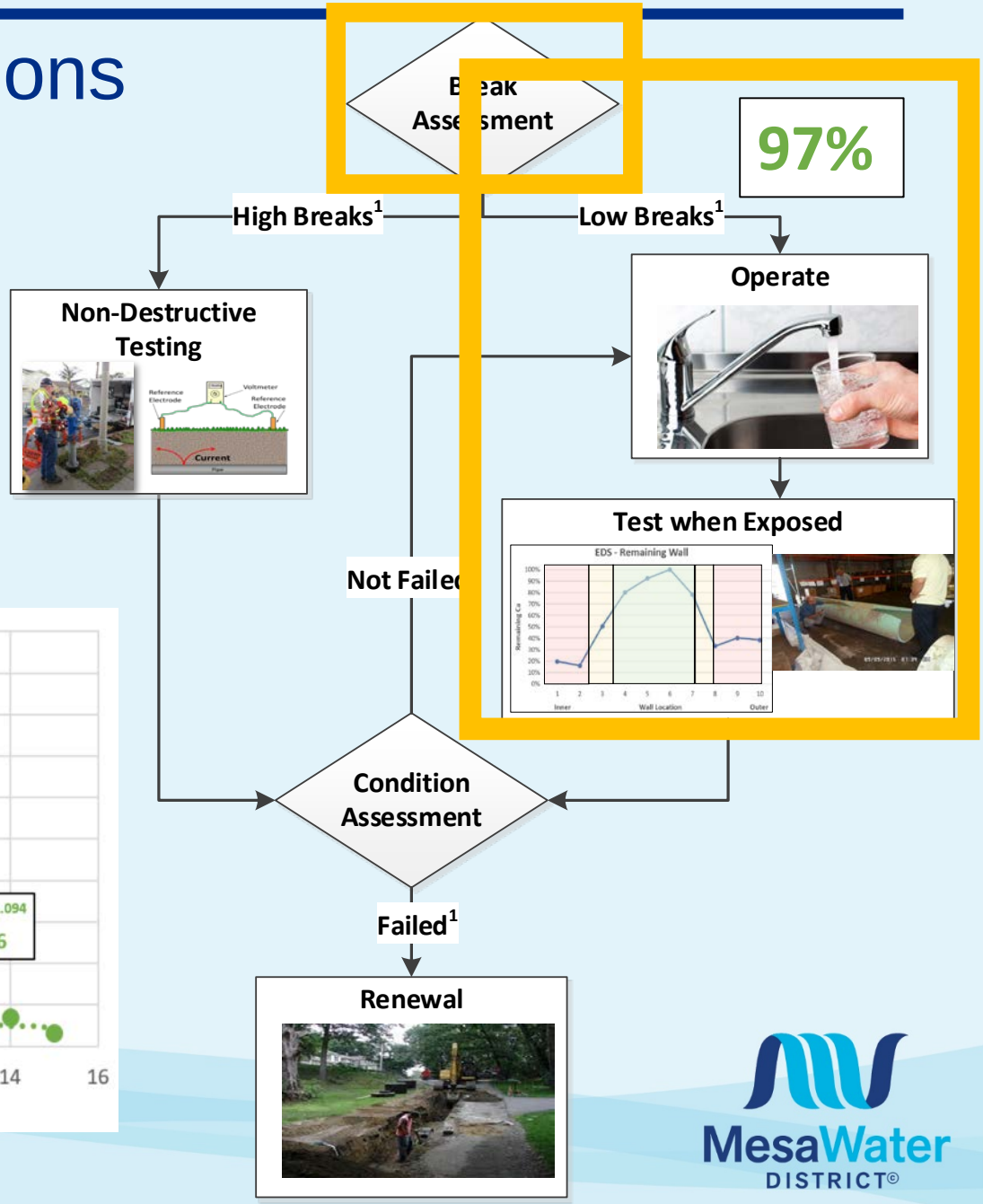


MesaWater DISTRICT®

Data Driven Decisions







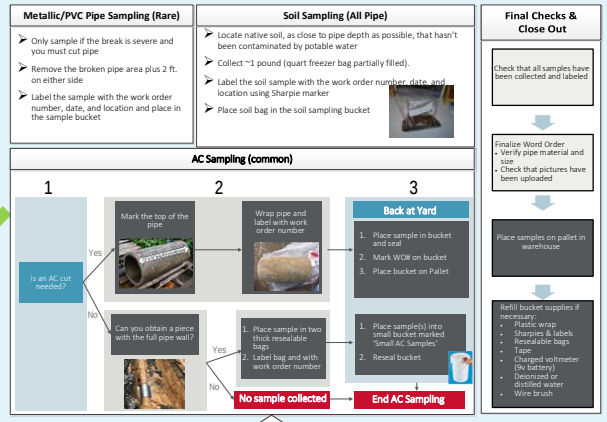
MesaWater DISTRICT®

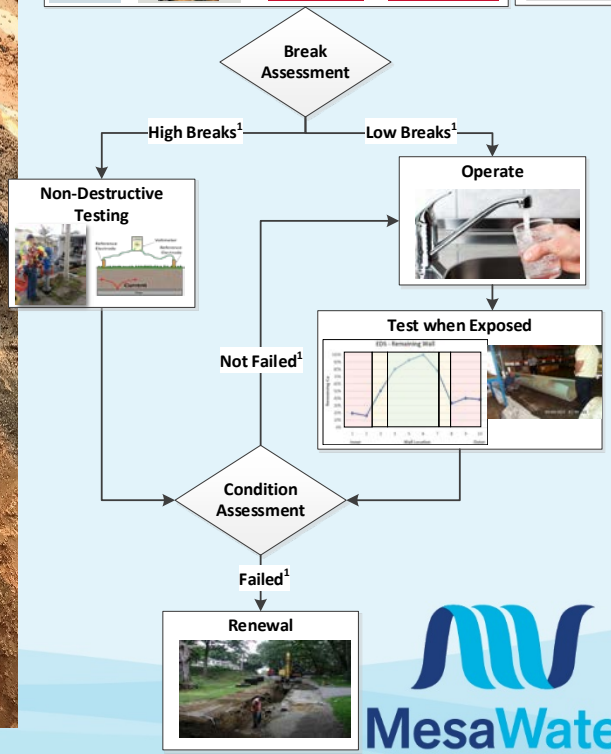
Test when Exposed

Transforming Challenges…

into Opportunities

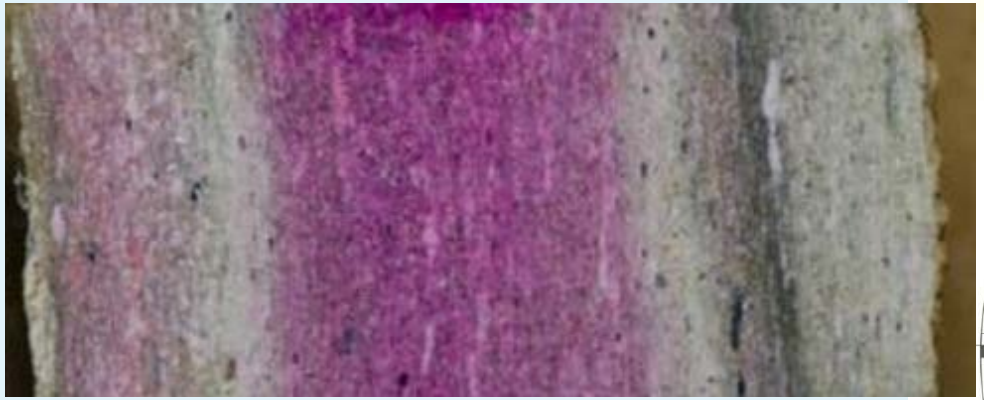
SOPs, Tools, & Training



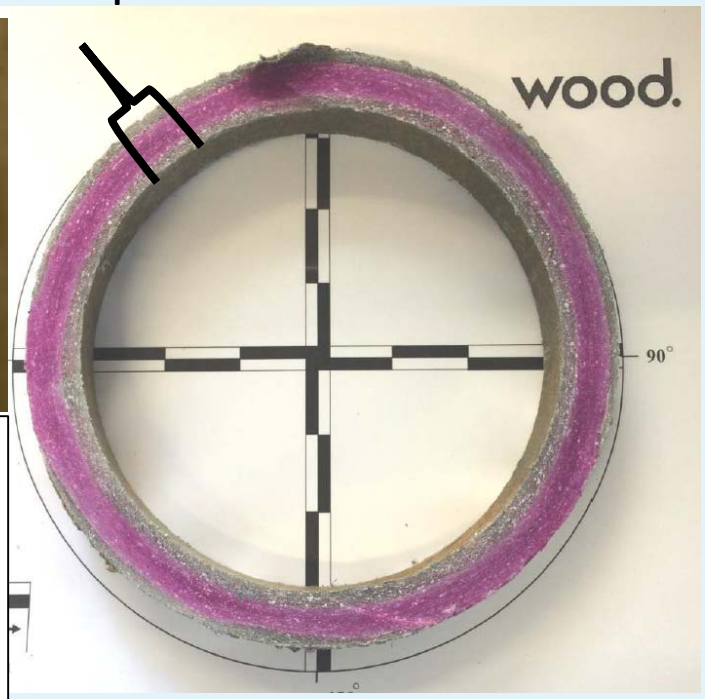


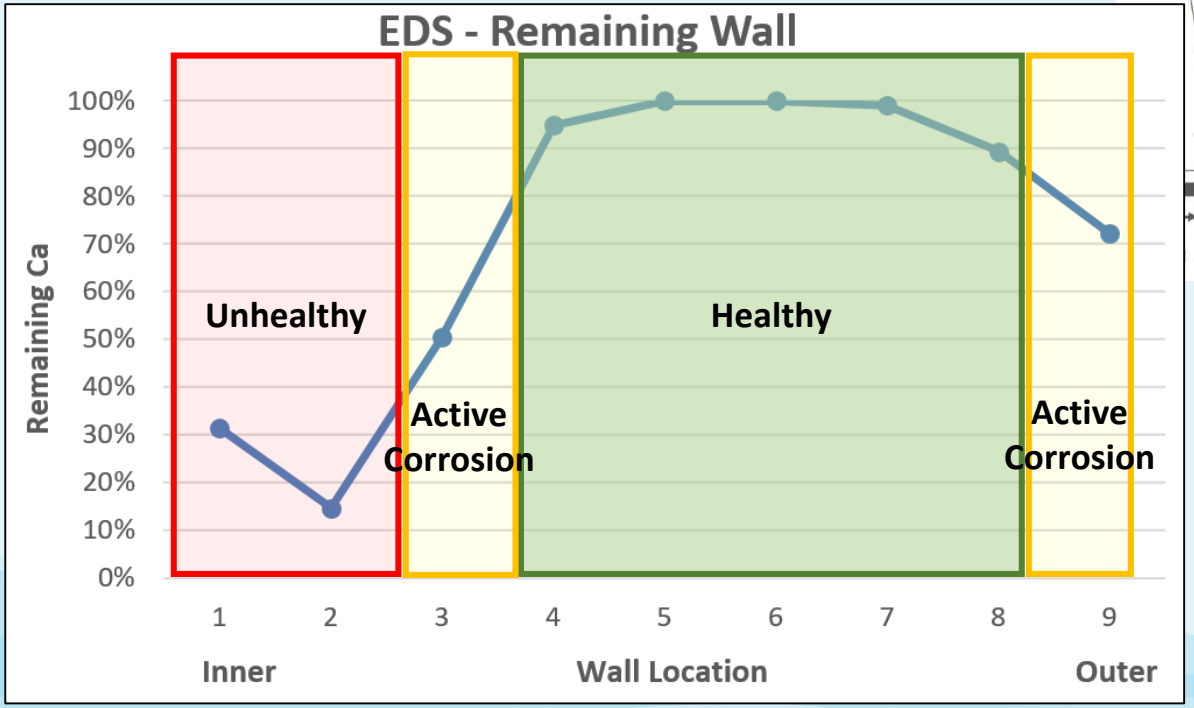
MesaWater DISTRICT®

Test when Exposed



Extract Sample at weakest point





MesaWater DISTRICT®

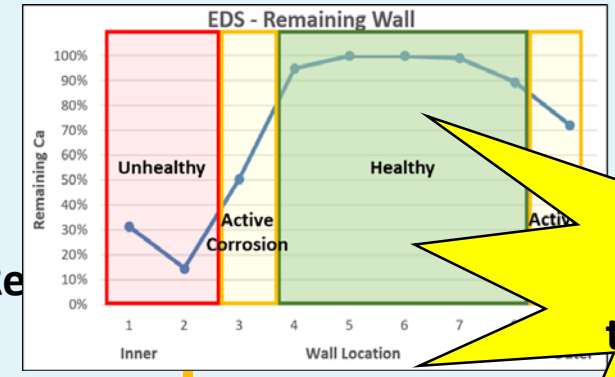
Test when Exposed

Results of 42 AC Samples

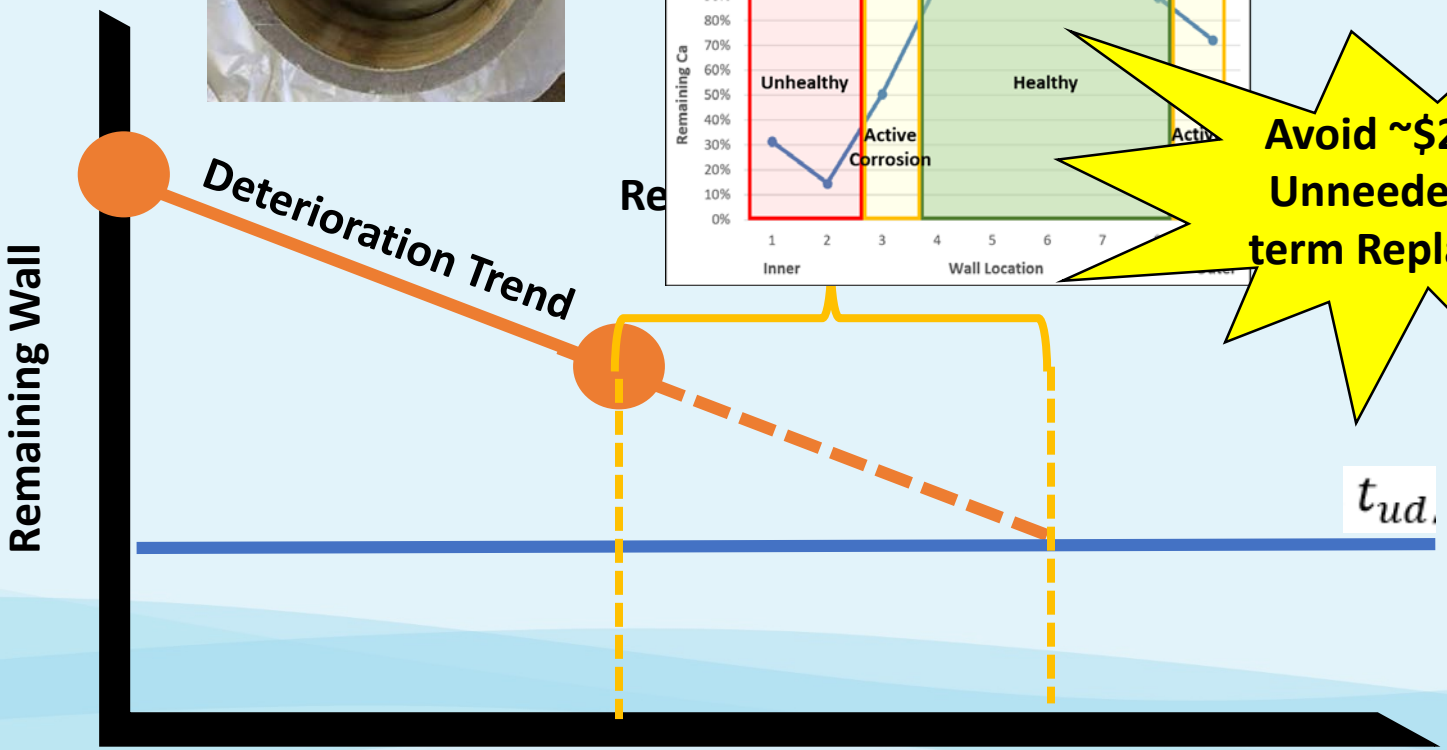
Age-Based Useful Life	Condition-Based Useful Life	Gain in Useful Life
75 years	**142 years**	**+67 years**

Age = 0
Assume no corrosion

Age when Sampled



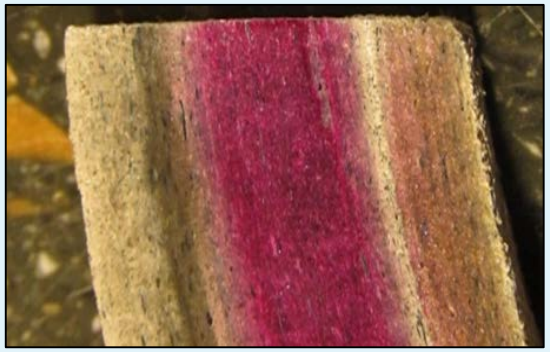
Avoid ~$260M In Unneeded Near-term Replacement



MesaWater DISTRICT®

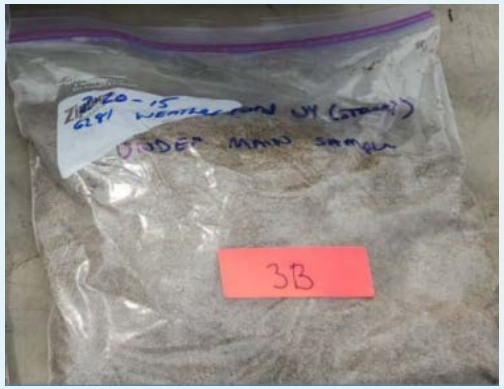
Test when Exposed

Pipe Sample



Photo

Soil



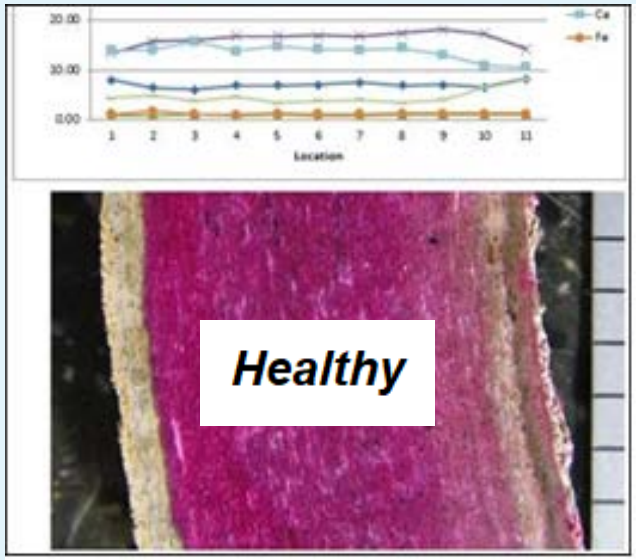
CP Test Station Installation

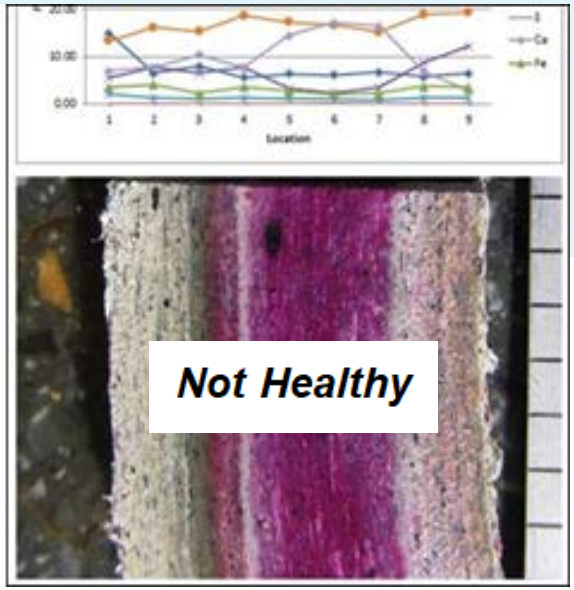
Anode

Potential Reading

MesaWater DISTRICT©

Cost Effective Decision Making



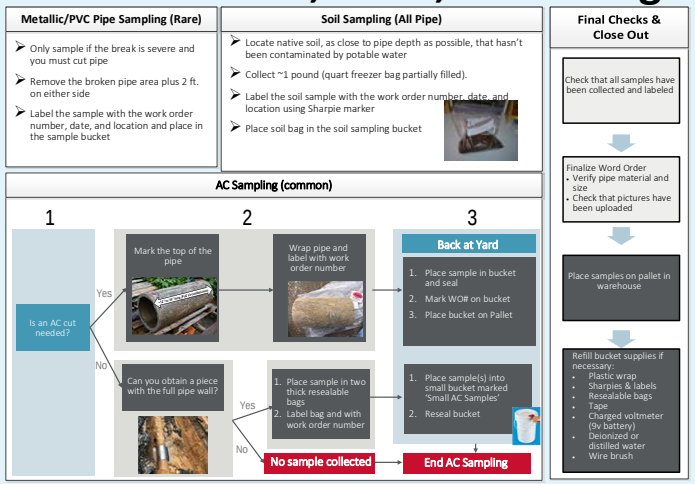


Fix the right pipe at the right time

MesaWater DISTRICT©

Staff Owned Opportunistic Program

Crew SOPs, Tools, & Training

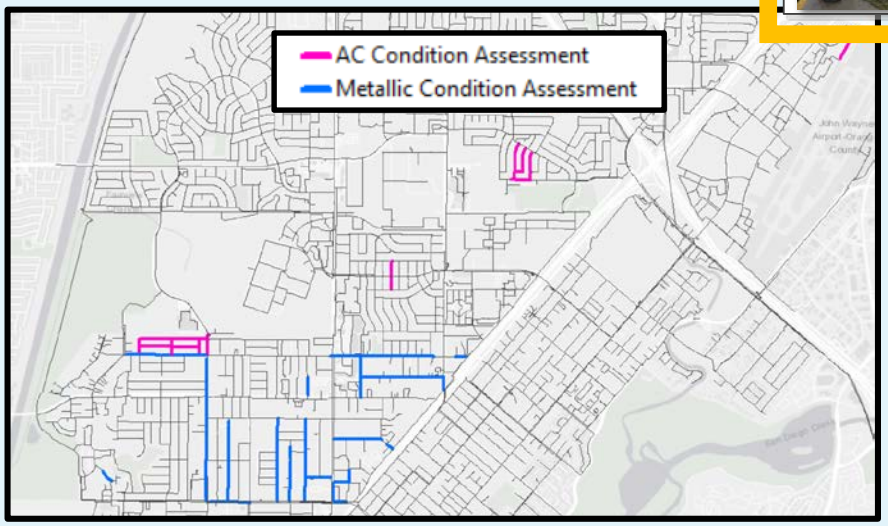


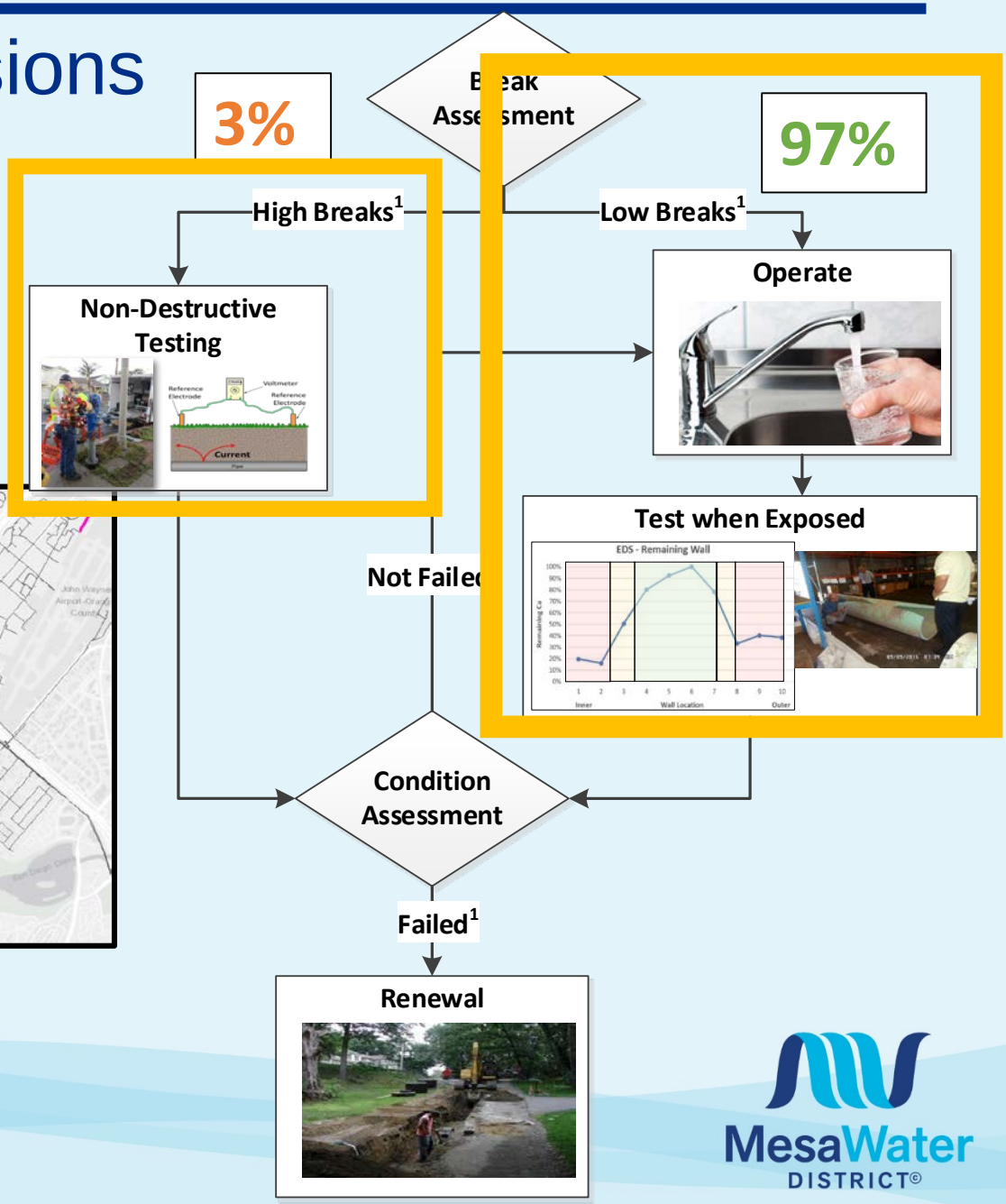
How data will be used to make decisions

MesaWater DISTRICT®

Data Driven Decisions

Non-Destructive Testing Trigger		
	Number of Breaks	Annual Break Rate
Distribution (14” Dia. and smaller)	3	0.2
Transmission (16” Dia. and greater)	2	0.2





MesaWater DISTRICT®

Non-Destructive Testing

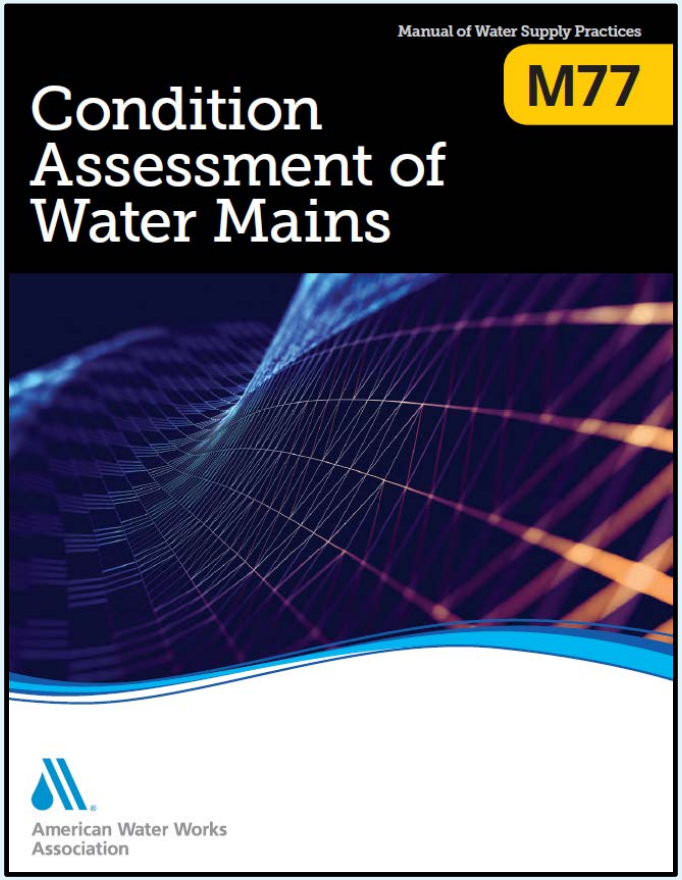


Table 3-1 Available inspection technologies for pressure pipe

Method	Soil Corrosivity Surveys	Acoustic	Remote Field Electromagnetic	Ultrasonic	Magnetic Flux Leakage	Broadband Electromagnetic	Other	Typical Recommended Approach
Description	Various electro-magnetic, electrical, and laboratory methods char the c of so meas activ effec of co prote cath	Acoustic velocity: pipe wall stiffness is calculated from the speed of sound	Changes in electromagnetic signals indicate broken wires, corrosion pits,	Reflection of sound waves is used to measure the thickness of various types of	Changes in magnetic fields are used to detect corrosion pits and other defects.	Changes in electromagnetic signals indicate corrosion pits and changes in	Sampling of pipes for various physical tests Manned entry for visual	GENERAL APPROACH (all pipe types): 1. Statistical analysis of

Table 3-1 Available inspection technologies for pressure pipe (continued)

Method	Soil Corrosivity Surveys	Acoustic	Remote Field Electromagnetic	Ultrasonic	Magnetic Flux Leakage	Broadband Electromagnetic	Other	Typical Recommended Approach
Asbestos Cement (AWWA C402)	Assess potential for AC (concrete) deterioration (pH and sulfates)	Acoustic velocity can detect gross deterioration	n/a	n/a	n/a	n/a	Testing of samples: • Phenolphthalein stain • SEM/EDS • petrography	1. Tests of opportunity samples from repairs and service taps 2. GIS mapping of soil data, breaks, and condition

Table 3-1 Available inspection technologies for pressure pipe (continued)

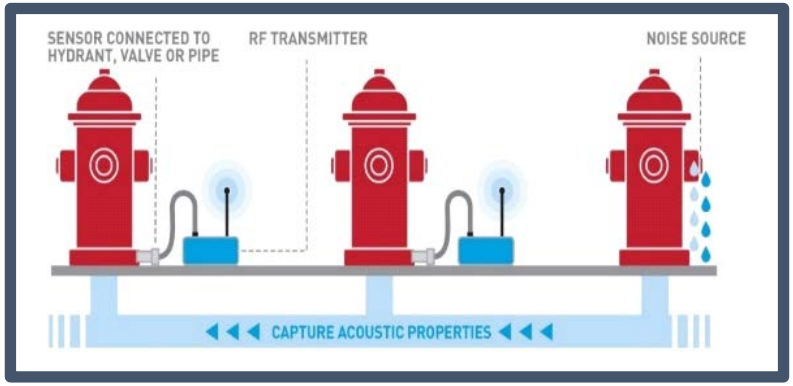
Method	Soil Corrosivity Surveys	Acoustic	Remote Field Electromagnetic	Ultrasonic	Magnetic Flux Leakage	Broadband Electromagnetic	Other	Typical Recommended Approach
Ductile Iron Cast Iron (AWWA C150 & C153)	Assess corrosivity to iron Monitor corrosion activity	Acoustic velocity can detect gross deterioration	Detailed internal scan of pipes and external spot assessment. Works with cement mortar and tuberculation	Used for external spot assessments	Internal scanning of non-CML lined pipes. External spot assessments.	External spot assessments. Emerging method for internal scanning	Petrographic analysis of mortar	1. Corrosivity survey 2. Remote field electromagnetic
Prestressed Concrete Cylinder Pressure Pip (AWWA C3 and C304)								
Steel (AWWA C200)	Assess potential for metal and concrete deterioration Monitor corrosion activity	Acoustic velocity can detect gross deterioration	Used for detailed internal scan of pipes. Works with cement mortar and tuberculation.	Used for external spot assessments	Internal and external scanning of both CML and non-CML pipes	External spot assessments. Emerging for internal scanning.	Petrographic analysis of mortar	1. Corrosivity survey 2. Pipe-to-soil potential; cathodic protection assessment 3. Remote field electromagnetic or magnetic flux leakage
Non-Prestre Concrete Pressure Pip (AWWA C3 C302, and C								
Copper	Assess potential for metal deterioration	n/a	Used for detailed internal scan of pipes	n/a	n/a	Potential for detailed scan of pipes	Forensic examinations of failed pipes Electrochemical noise monitoring	1. Evaluate construction methods and standards 2. Evaluate soil corrosivity 3. Forensic exams of failures
Plastic Pipes (HDPE – AWWA C906) (PVC – AWWA C900)	n/a	n/a	n/a	n/a	n/a	n/a	Forensic examinations of failed pipes, using laboratory and mechanical tests	1. Review of drawings, specs, and inspection records 2. Forensic examination if early or frequent failures have occurred

Source: HDR
AC: asbestos concrete, CCTV: closed-circuit television, CML: cement mortar lines, GIS: geographic information system, HDPE: high-density polyethylene, n/a: not applicable, PVC: polyvinyl chloride, SEM/EDS: scanning electron microscopy with energy-dispersive spectroscopy

MesaWater DISTRICT©

Non-Destructive Testing (AC)

Remaining Wall (e-Pulse)

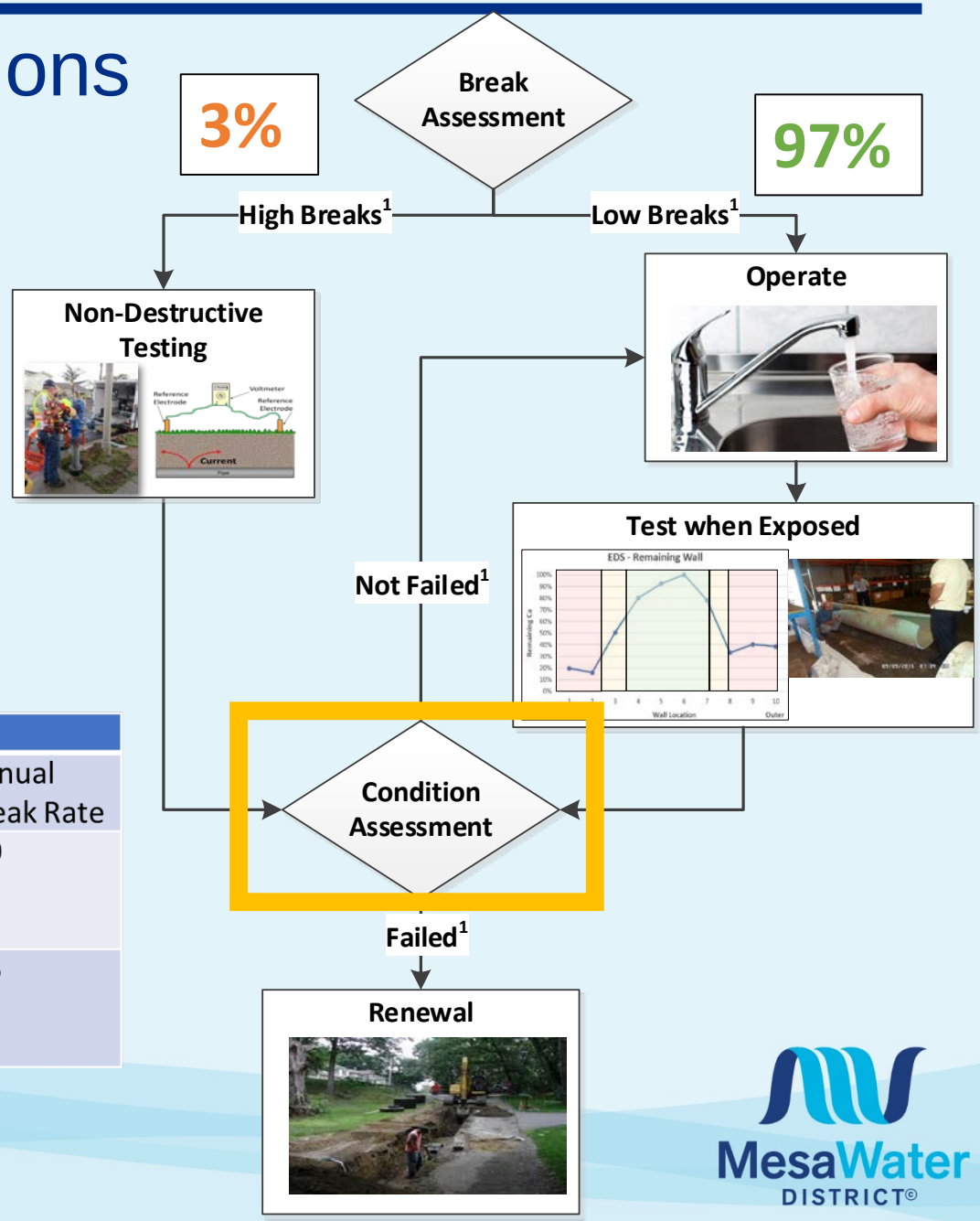


Advantages:

1. Fast / Low Cost
2. Low Risk & Community Impact

MesaWater DISTRICT®

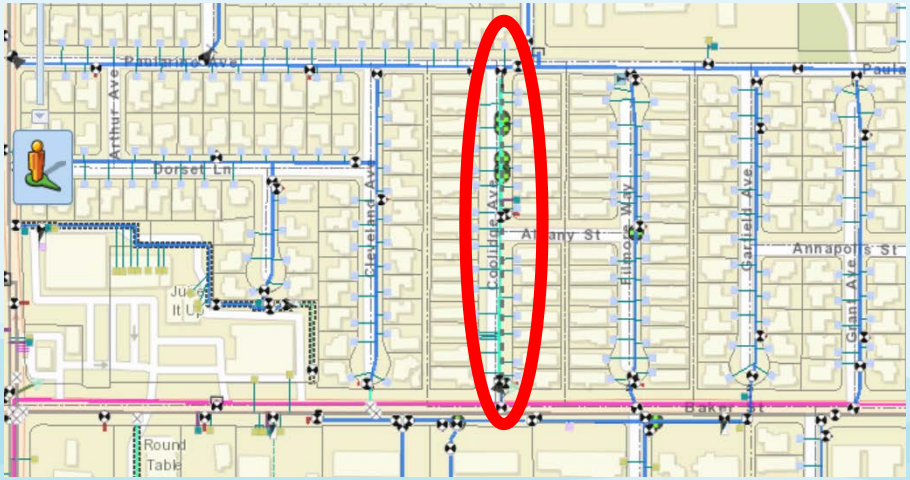
Data Driven Decisions

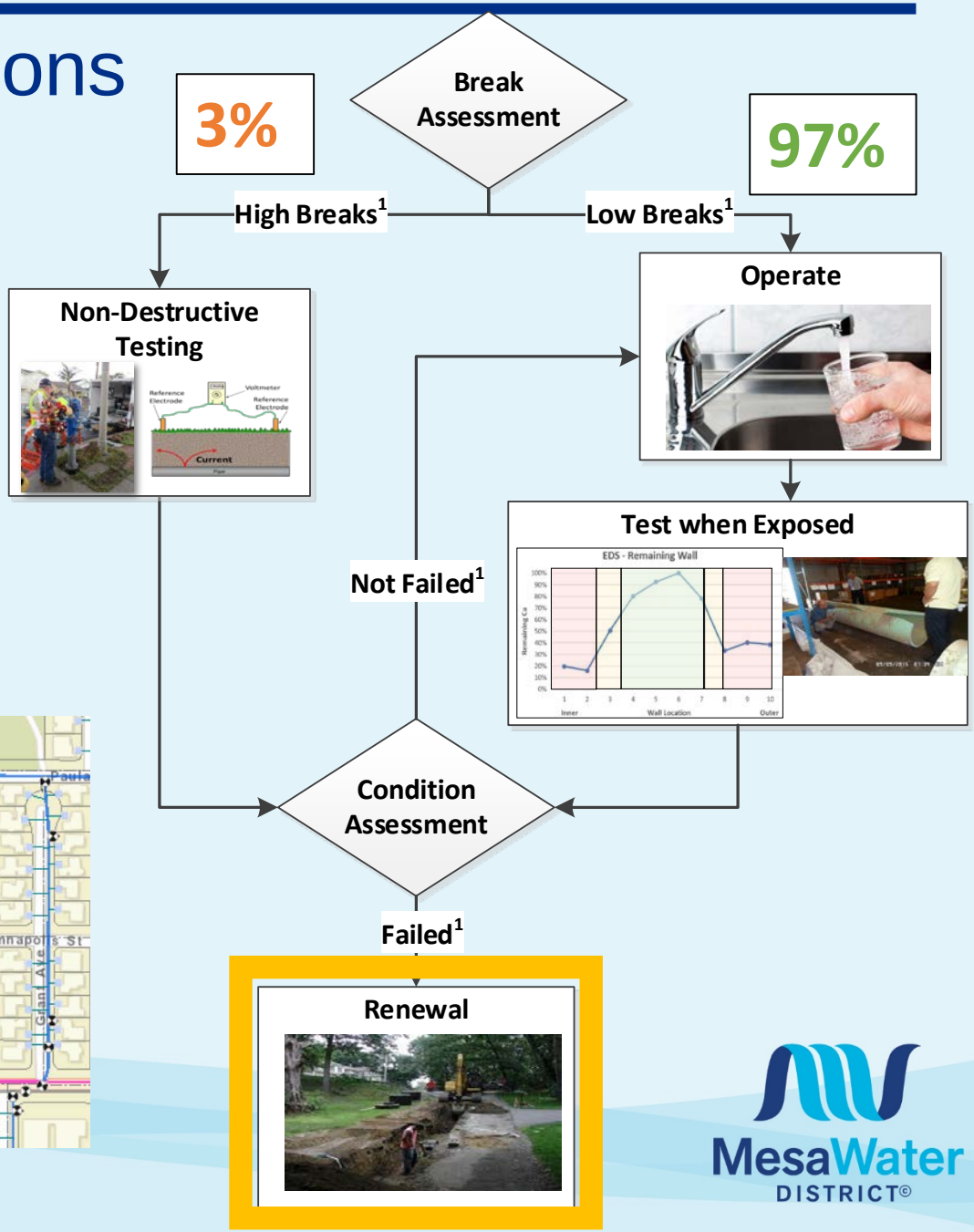


	Replacement		
	Remaining Useful Life	Number of Breaks	Annual Break Rate
Distribution (14" Dia. and smaller)	<10 years	5	1.0
Transmission (16" Dia. and greater)	<10 years	3	0.5

MesaWater DISTRICT©

Data Driven Decisions

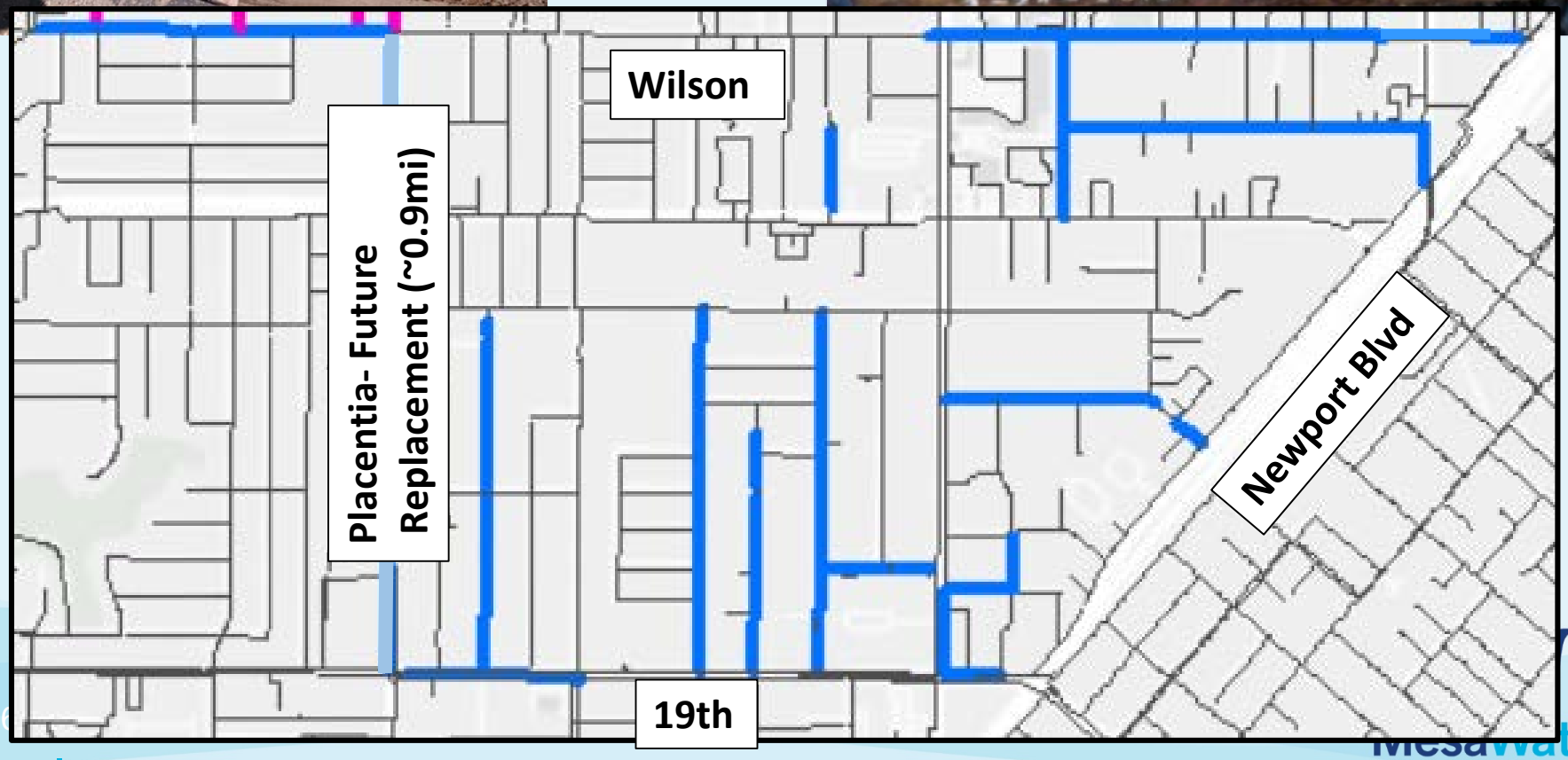




MesaWater DISTRICT®

Priority Metallic Pipe Replacement Project

Project 1951 CMLC (4.7 mi) 27 Breaks; Break Rate = 0.32

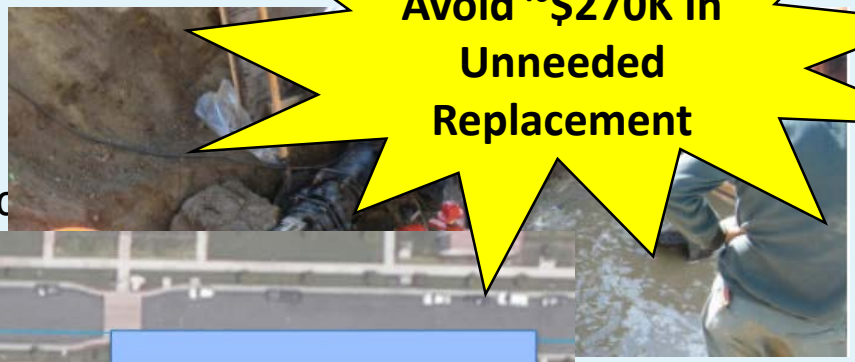


Mesa Water DISTRICT©

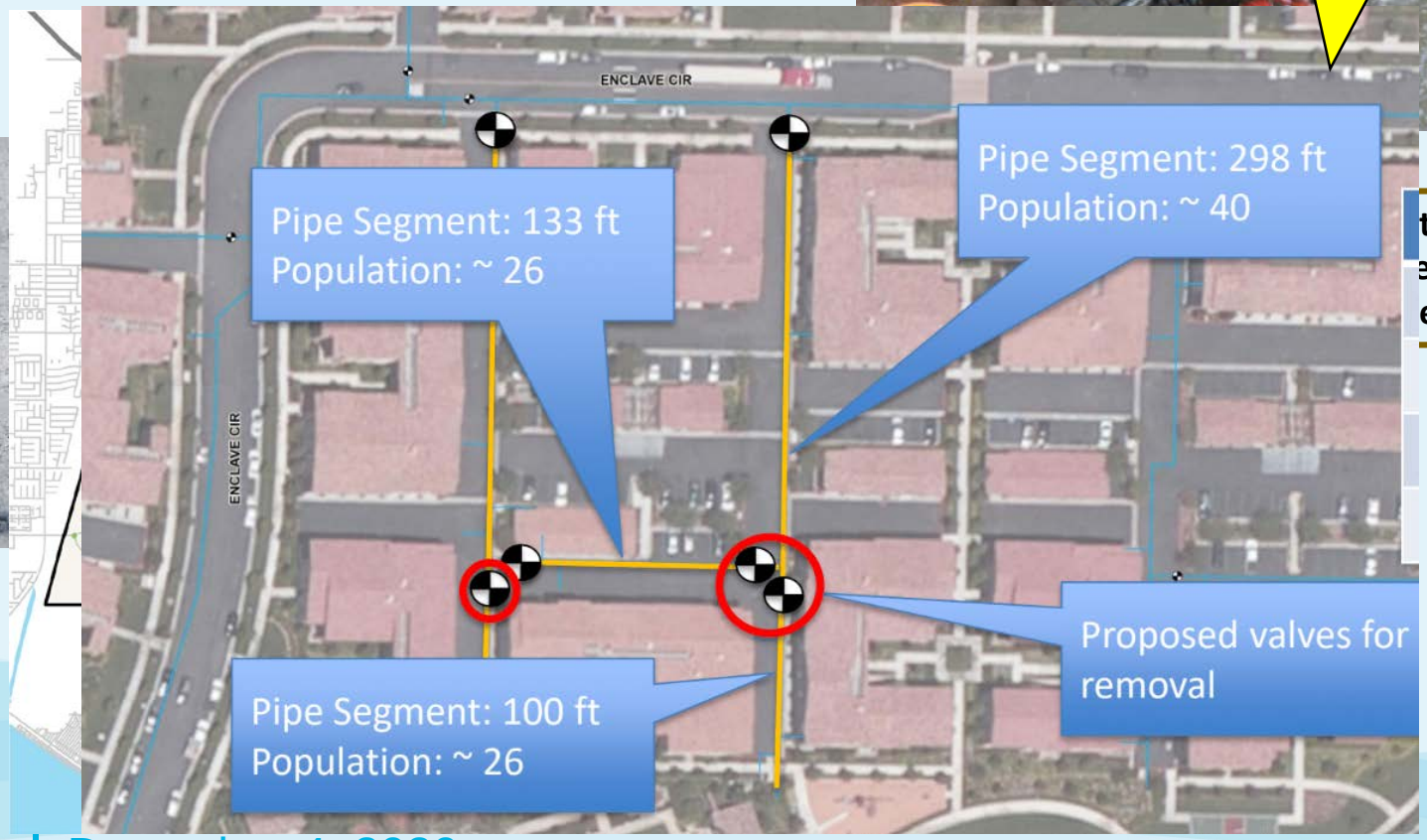
Alternatives to Replacement

Valves Spacing Policy

- Purpose: Control or Stop Flow
- District: 4,400 main valves
- Investment: 168 inoperable valves
- Over time, add 422 valves in optimal loc



Avoid ~$270K In Unneeded Replacement

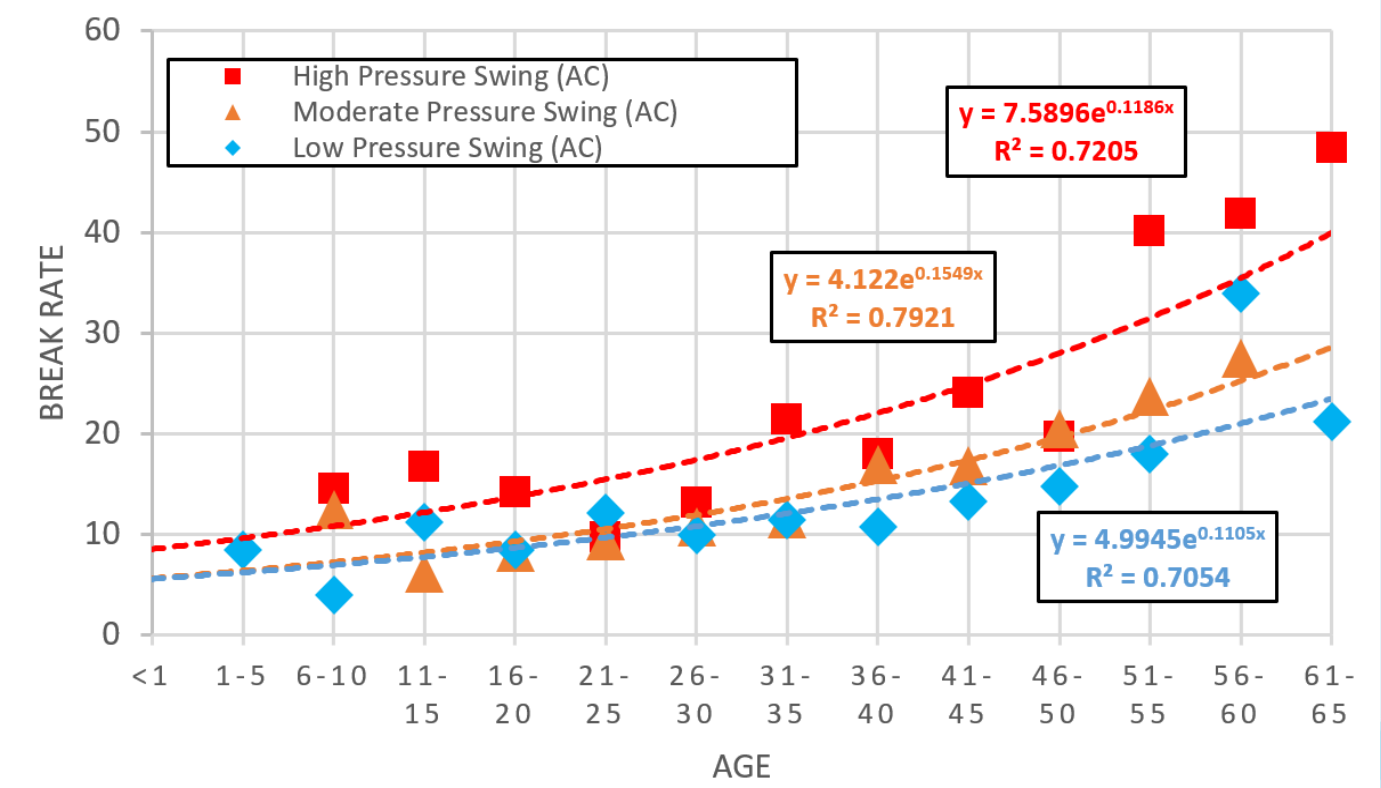


tallic
e
ent

MesaWater DISTRICT®

Managing Aging Infrastructure

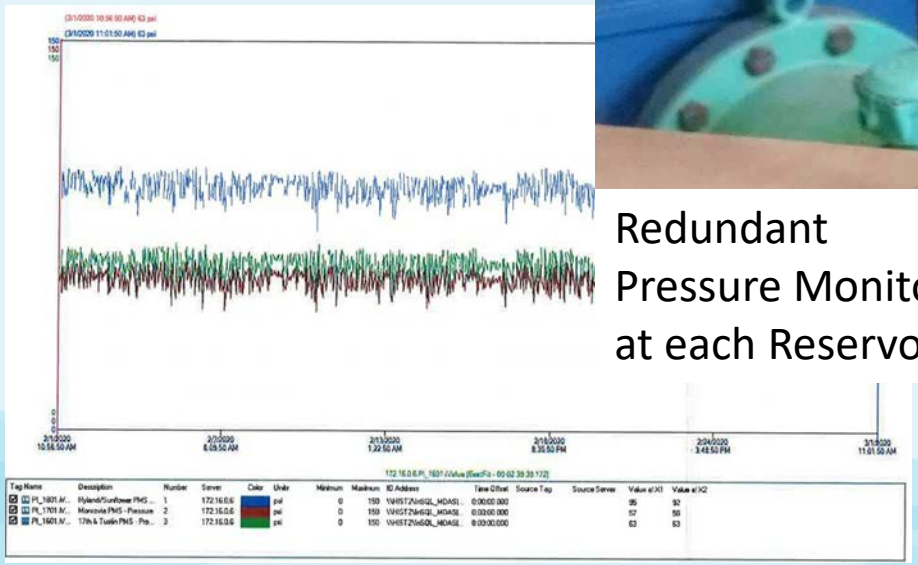
- ✓ Pipeline Integrity Program
  - ✓ Opportunistic Testing
  - ✓ Condition Based Renewal & Budgeting
- ✓ Optimizing Valve Spacing
- ❑ Pressure Management



MesaWater DISTRICT®

Pressure Management

1. **Training**
   - Slow opening and closing of valves to prevent surges
2. **Pressure Monitoring & Automated Control**
3. **Design**
   - SCADA alarms for high or
   - Electric motor-driving pu
   - Gas-driving pumps ramp
   - Pressure monitoring at al
   - Dedicated Pressure Moni

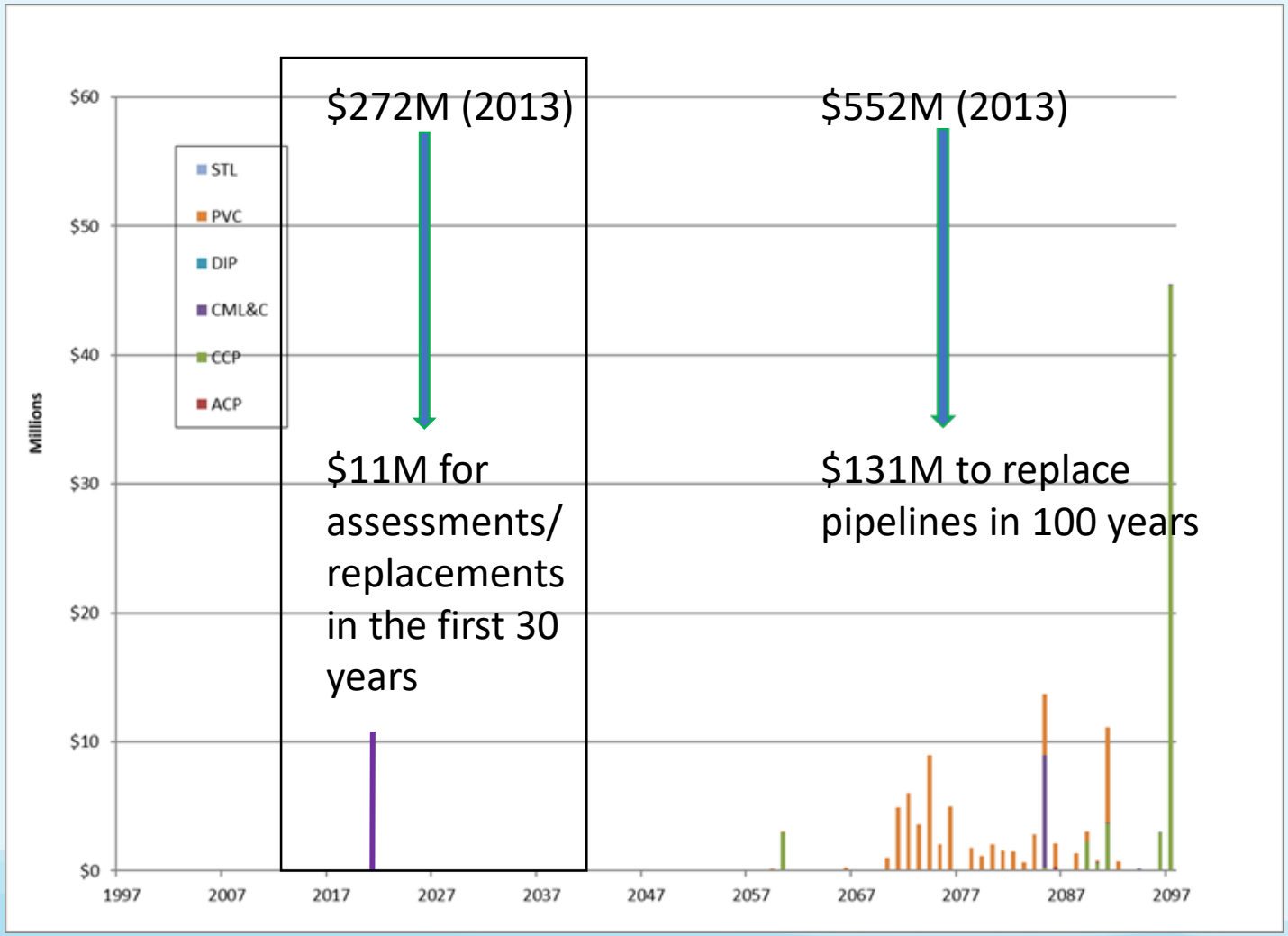


Redundant Pressure Monitors at each Reservoir

MesaWater DISTRICT©

Program Benefits

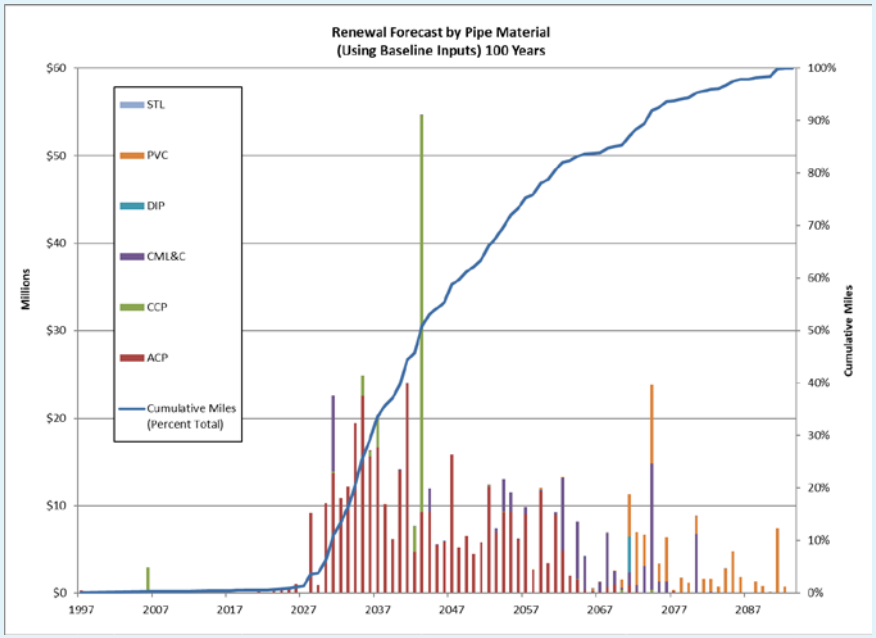
Updated Cost Curve



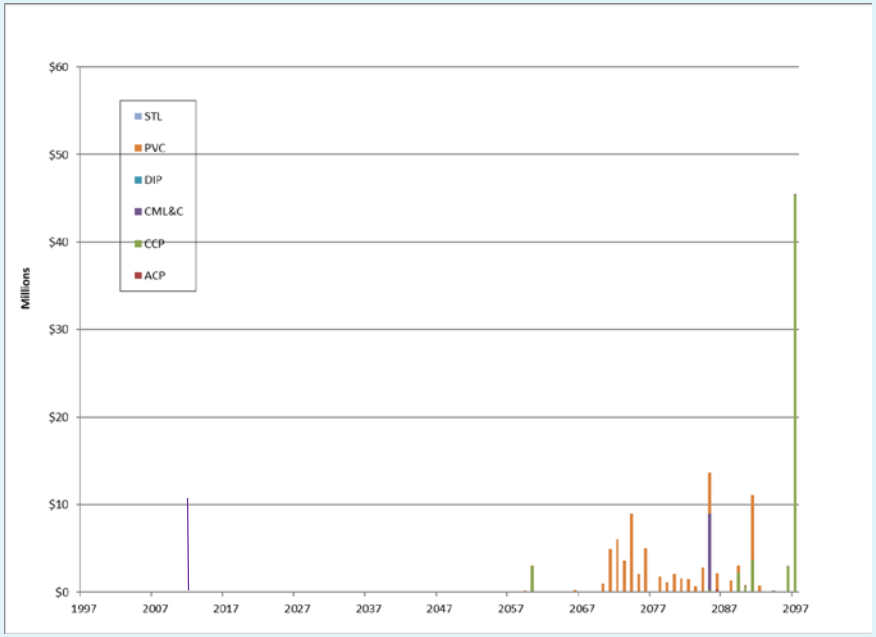
MesaWater DISTRICT®

100 Year Pipeline Replacement Evolution

2013:Industry Average Age- Based Replacement



2019: Breaks +Condition Replacement



Age-based Replacement:
All pipelines replaced in 100 years: $557M
First 30 years (2013-2043): $273M

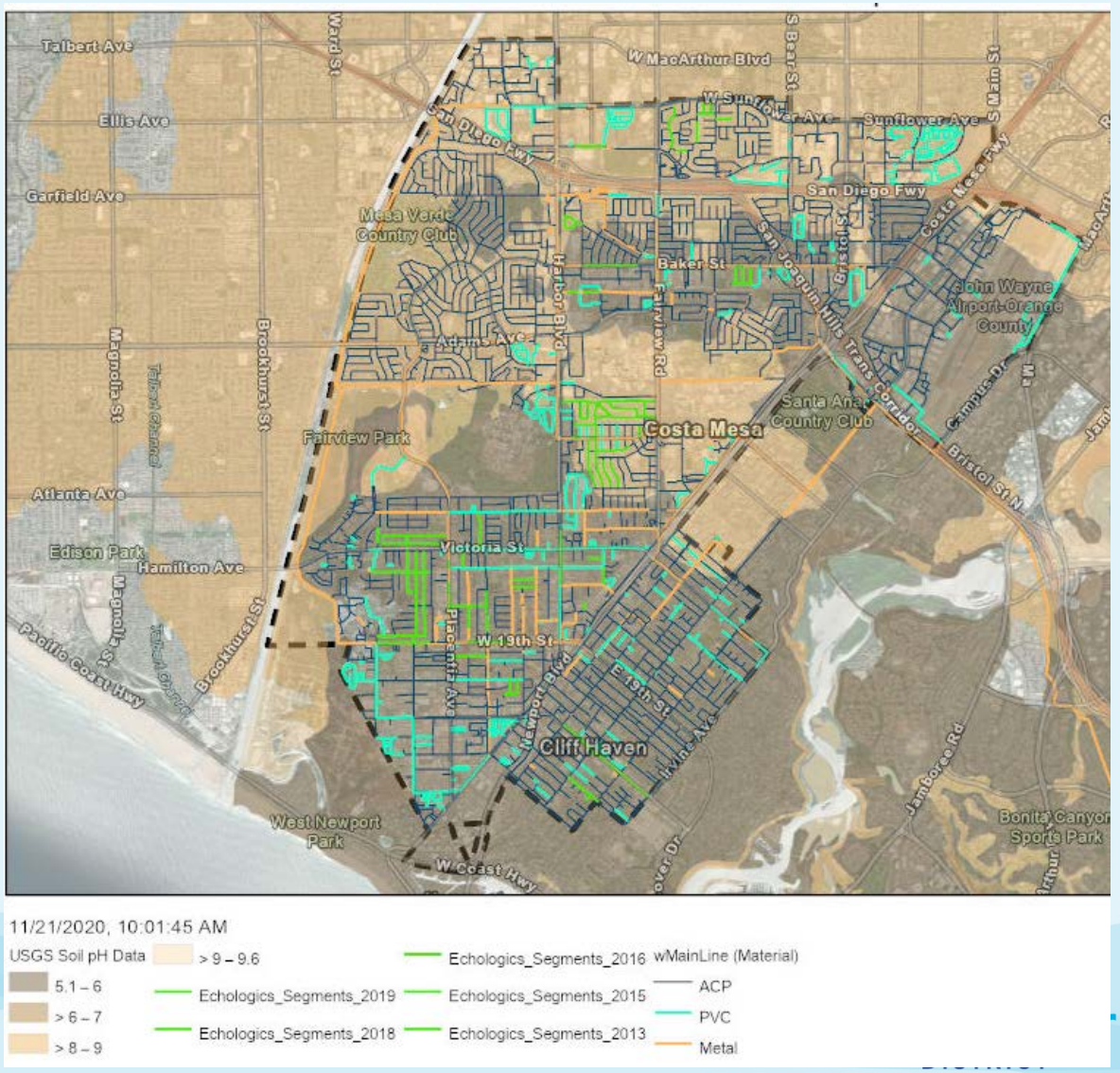
Breaks+ Condition Based Replacement:
Pipelines replaced in 100 years: $131M
First 30 years (2013-2043): $11M

MesaWater DISTRICT©

Continuous Improvement

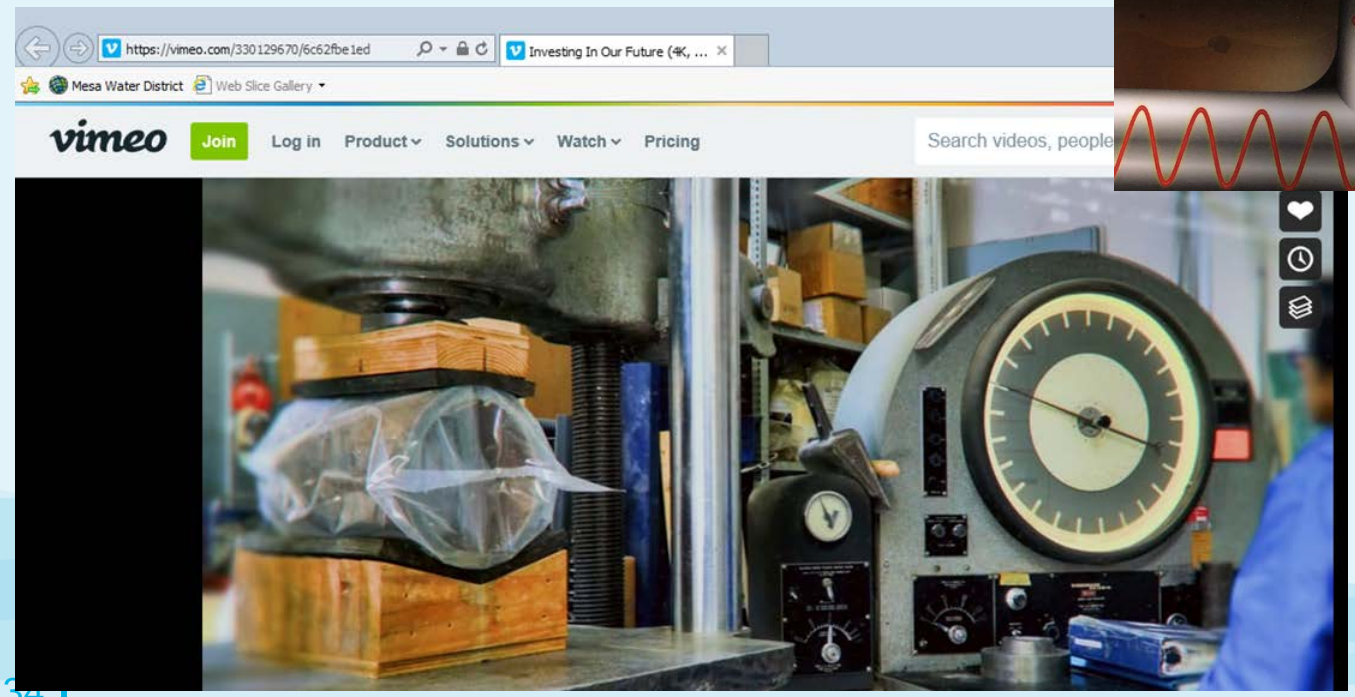
Data Driven Decisions

- Material
- Installation year
- Project Cohort
- Depth
- Break date and location
- Non-destructive testing
- Wall thickness
- Remaining Useful Life
- Soil properties
- Traffic loading



For More Information

- Journal AWWA, September 2019, ***Assessing the Useful Life of Pipeline Infrastructure,*** https://awwa.onlinelibrary.wiley.com/doi/abs/10.1002/awwa.1358
- ACWA Video, ***Investing In Our Future,*** https://vimeo.com/330129670/6c62fbe1ed



For More Information

David Spencer, PE, HDR

- Phone 858-245-0771
- David.R.Spencer@HDRinc.com

Karyn Igar, PE

- 949-207-5452
- karyni@mesawater.org

MesaWater DISTRICT®