Optimizing Physical Condition Assessment Dollars using Statistical Results

INFRA 2014
CONGRÈS | 20ᴱ ÉDITION
Vers une nouvelle dynamique municipale pour une urbanité durable
1ᴱᴿ AU 3 DÉCEMBRE | PALAIS DES CONGRÈS DE MONTRÉAL

Introductions

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Presentation Outline

- Present Water Sector Practices
- Case Study: AWWU
  - AWWU system, approach and tools
  - Statistical Modeling & pipes selection
  - Use of Condition Assessment techniques to confirm statistical modeling
  - Results
  - Costs & Benefits from approach
- Conclusions

Renewals Planning across the Water Sector today:

- Emerging awareness of Risk assessment approaches (LOF and COF), but….
- Reliance on semi-quantitative scoring criteria to answer question: what projects should I do?

AND

- Limited use of statistical techniques and Utility specific data sets, instead…..
- Renewal planning based on 'typical' service lives (EUL's) because condition data are not used, or is lacking.

Water Sector has reluctantly embraced condition assessment

Asset Management and Condition Assessment

- Overall CA seems little used, given its potential
  - Typically, used by those that have suffered spectacular failures - it is a threshold of pain thing
  - Apprehension as to "unwelcome news" - it is a risk and liability thing
  - Problems also, if no problems identified - it is an accounting thing

(Water Research Foundation, 2013)

But it could help the sector:

Asset Management and Condition Assessment

- Condition Assessment (CA) could be an important tool to help close the IFG
  - Help find pipe likely to fail, from pipe that is merely old
  - Better understand true condition of your system
  - Old pipe might be fine - so long as meets performance requirements

(Water Research Foundation, 2013)

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Understanding your system is key:

Prime Factor - Knowing Your System

- Most high-level replacement estimates based on age or age surrogates
- Using age may result in much good pipe un-necessarily replaced
- Using CA often find small % of suspect pipe needing renewal

(Water Research Foundation, 2013)

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So what's a Utility to do? A Case Study: AWWU

- **Use both statistical methods and condition assessment!**

  -- Revised cohorts definition ➔ conducted in-depth statistical failure analysis

  -- Accessed flexible suite of powerful analytical tools

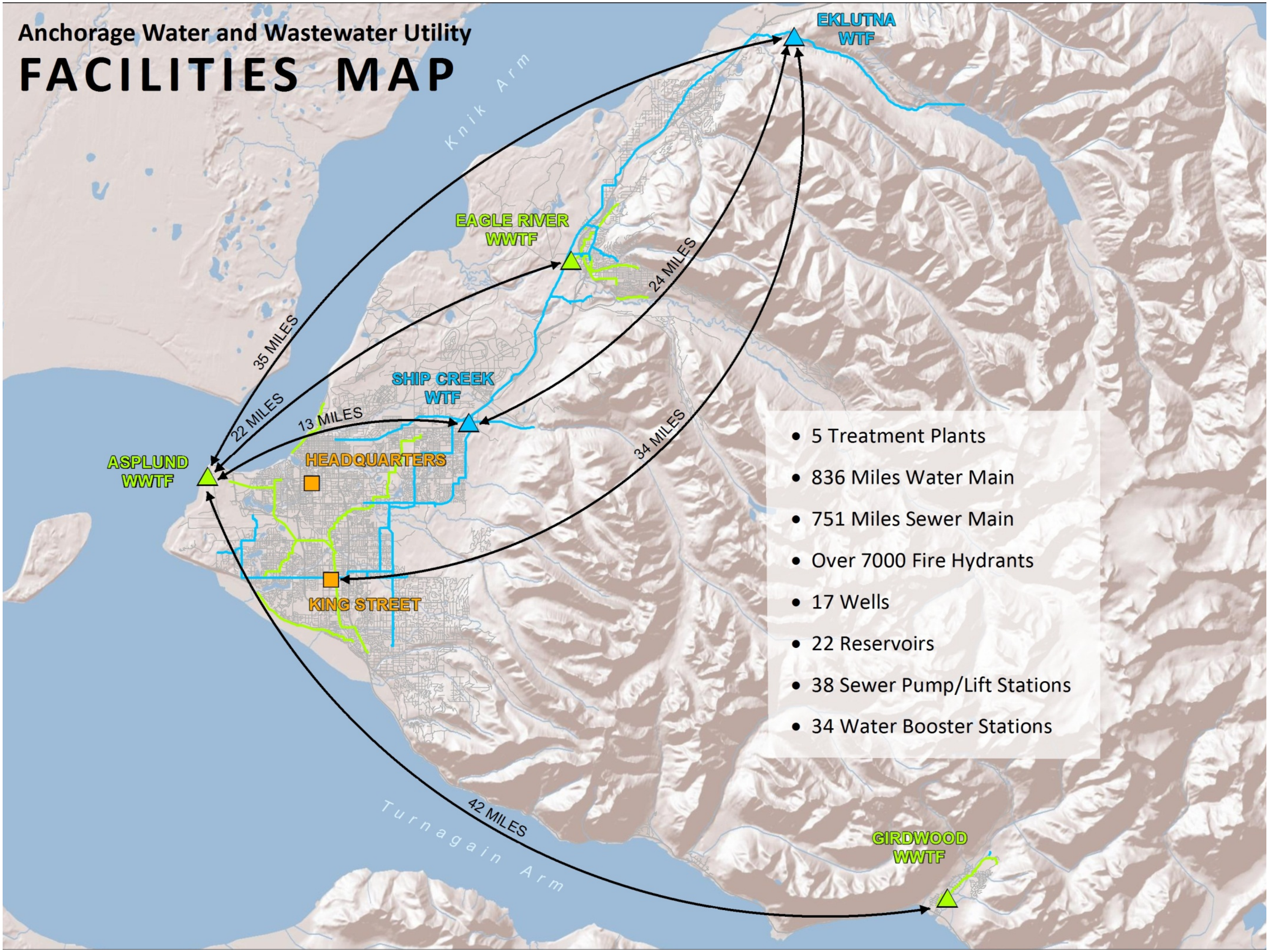
- **Built internal analytical capacity**:

  -- Secured tools and training to run all planning studies update results, and address additional planning questions.

  -- Used infraPLAN:

  - Developed and implemented models acquired by AWWU
  - Offered training

- **Ran initial studies – then validated statistical results with field inspection !!!**


Anchorage Water and Wastewater Utility
FACILITIES MAP
Knik Arm
EKLUTNA WTF
EAGLE RIVER WWTF
SHIP CREEK WTF
ASPLUND WWTF
HEADQUARTERS
KING STREET
GIRDWOOD WWTF
Turnagain Arm
35 MILES
22 MILES
13 MILES
24 MILES
34 MILES
42 MILES
• 5 Treatment Plants
• 836 Miles Water Main
• 751 Miles Sewer Main
• Over 7000 Fire Hydrants
• 17 Wells
• 22 Reservoirs
• 38 Sewer Pump/Lift Stations
• 34 Water Booster Stations

Approach and Tools

- **Historical Failure *Analysis* – Descriptive Statistics (system level)**
- **Failure *Prediction* – Casses (pipe level)**
- **Projects Selection – Annual Replacement Plan (pipe)**
- **Schedule Optimization – Economic Replacement Pipe Model (pipe)**

Define Cohorts
Historical Break Analysis

- **Calculate break rate based on:**
  - Risk Factors:
    - Pipe (Year of Installation, Material, Diameter, Length)
    - Environmental Risk Factors (Traffic, Soil, etc)
  - Year of the break
  - Age at time of break
- **Average Age now**

AWWU Cohorts

- Asbestos Cement
- Cast Iron - Post_65 - Bad Soil
- Cast Iron - Post_65 - Good Soil
- Cast Iron - Pre_65 - Bad Soil
- Cast Iron - Pre_65 - Good Soil
- Ductile Iron - Bad Soil
- Ductile Iron - Good Soil

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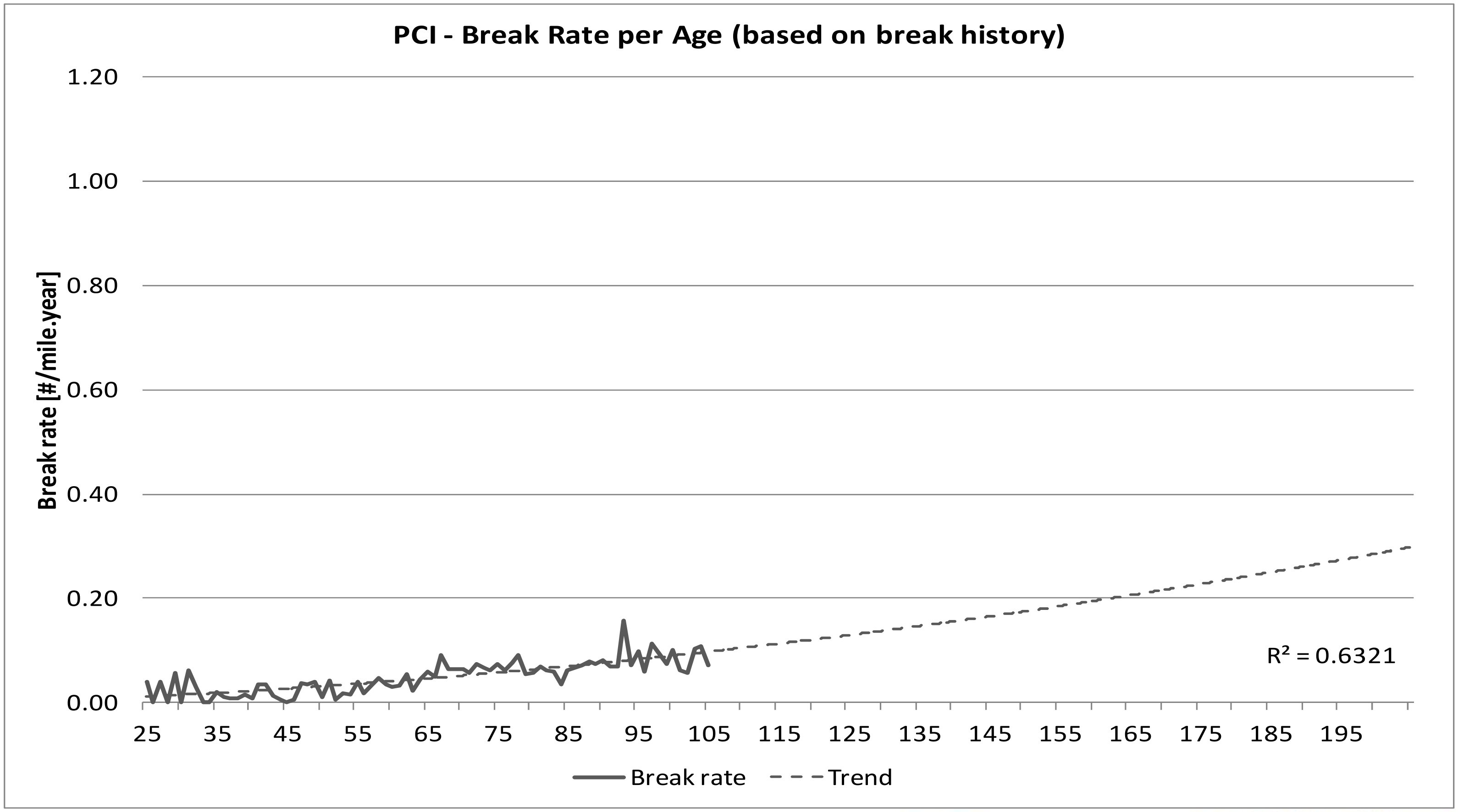
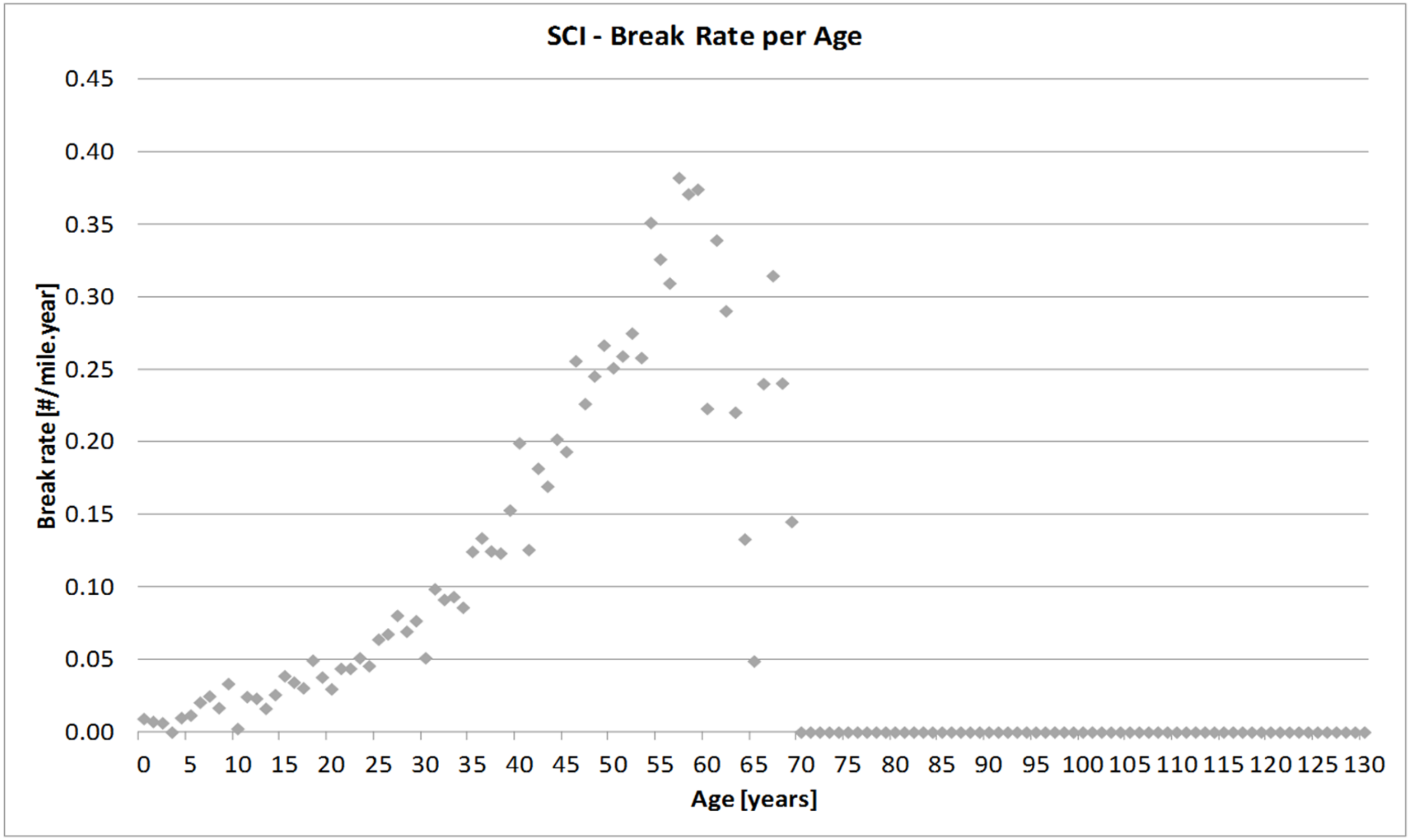
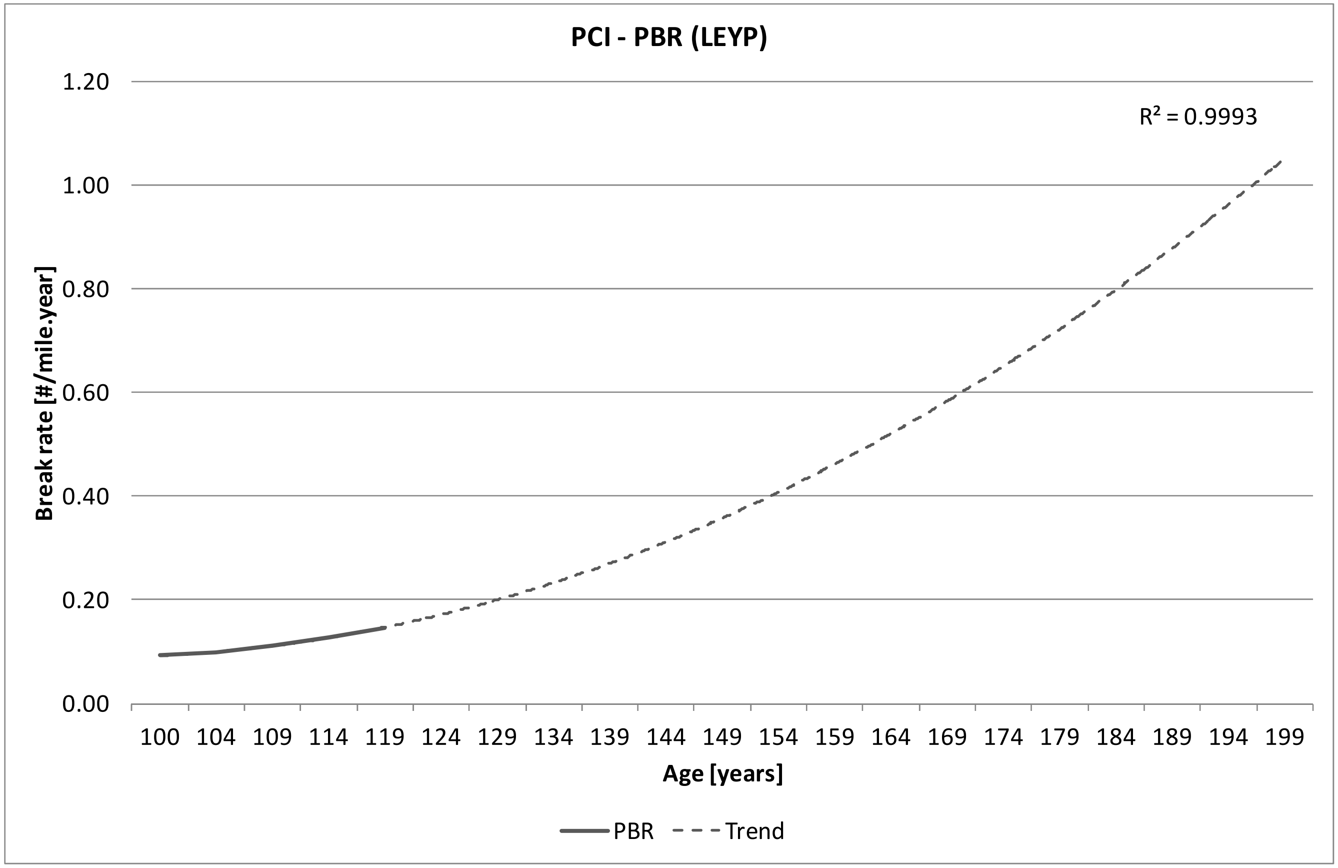
Ageing Curve
Extrapolation from Past History



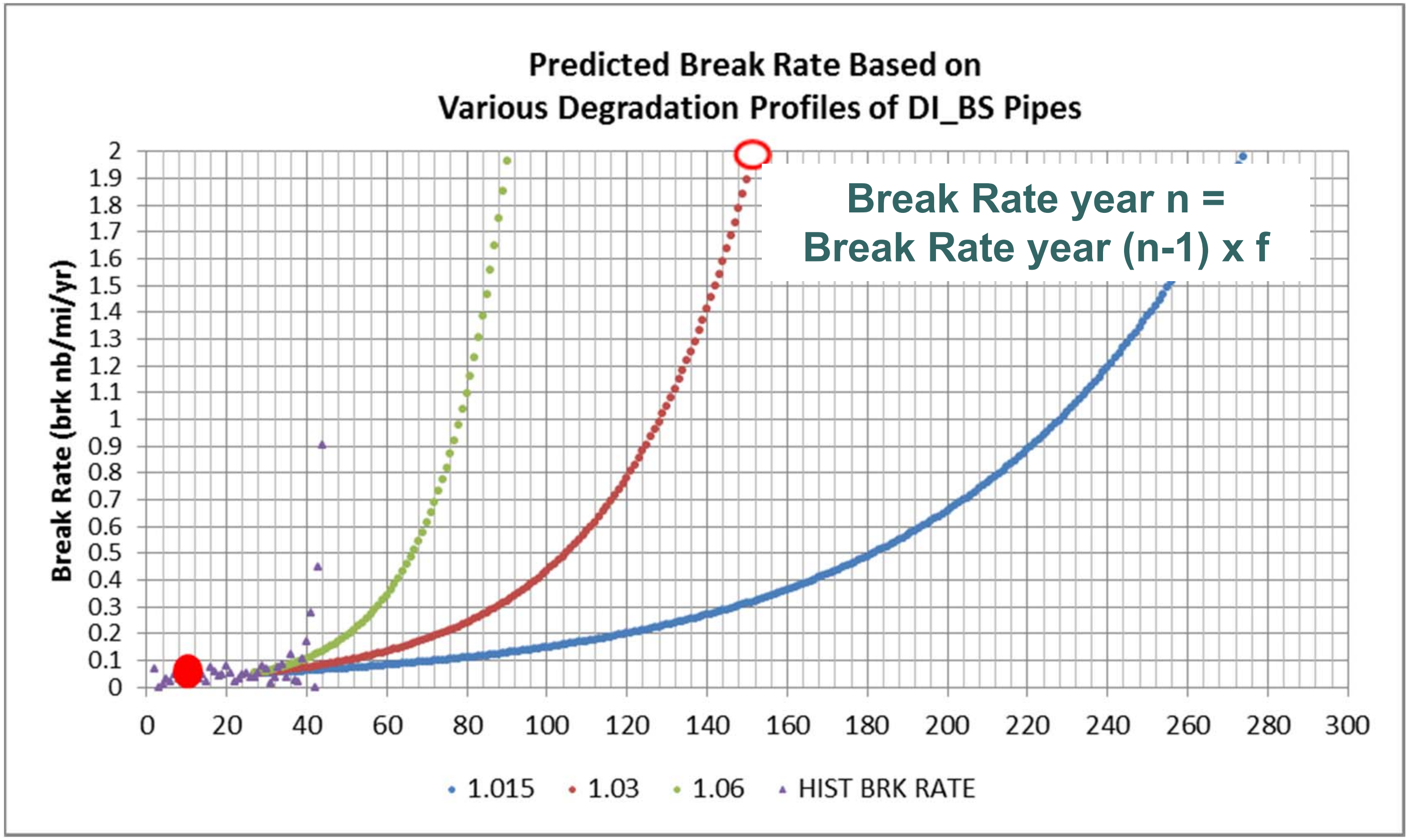
Not always possible…



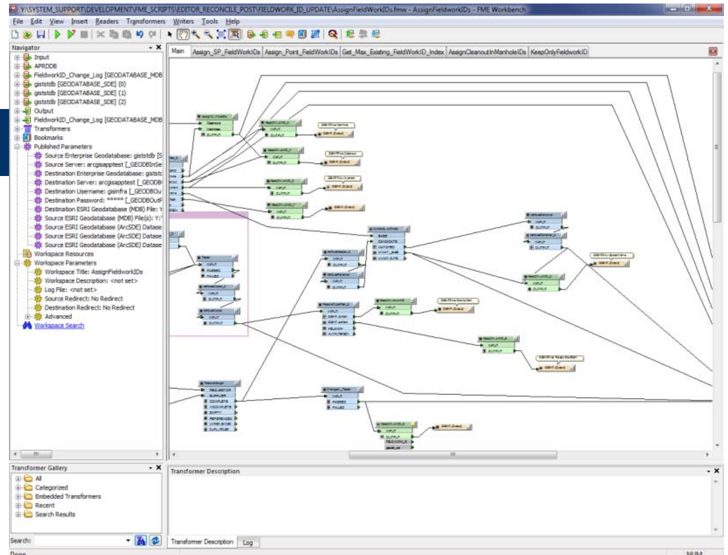
Predictive Statistical Model



Sensitivity Analysis



Optimal Replacement Timing

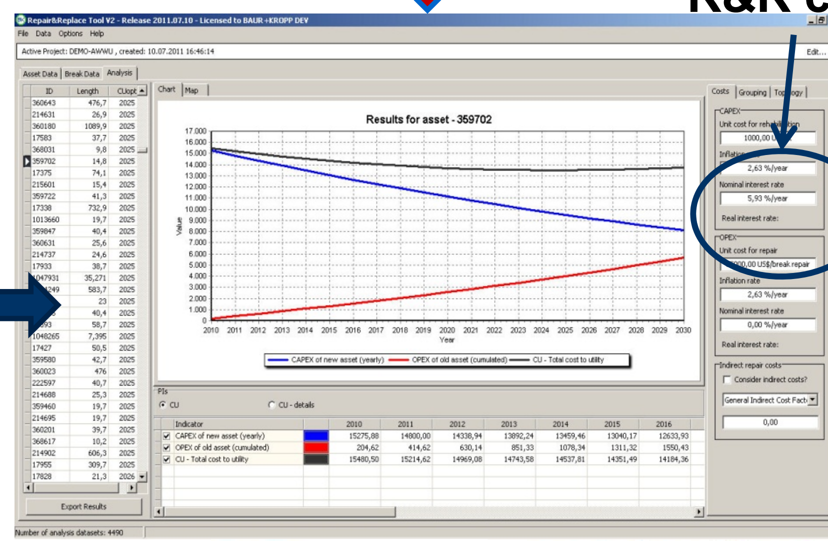


- Scripting Process Does Heavy Lifting

Triple Bottom Line Consequence of Failure

Scripting tools also generate R&R costs

Likelihood of Failure Developed through Statistical Failure Model



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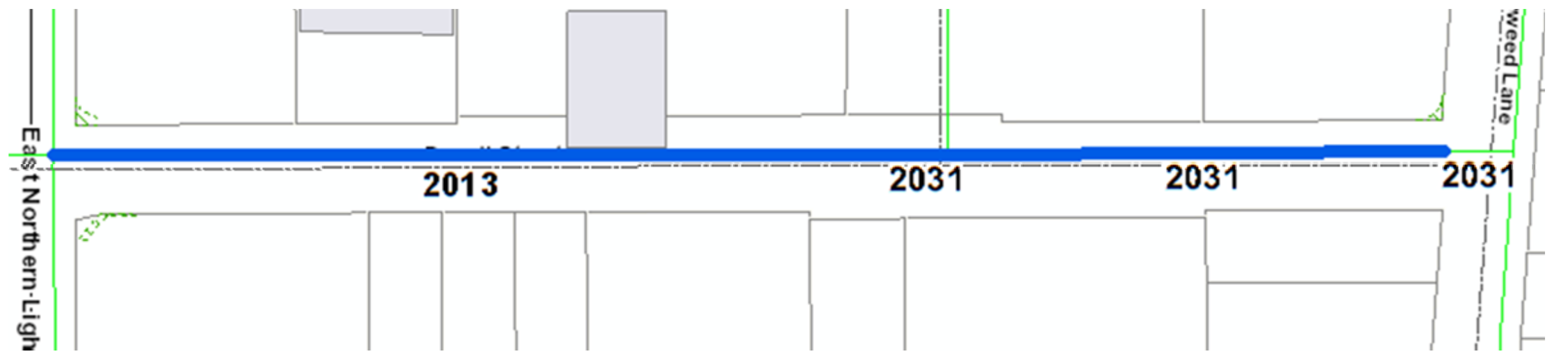
Optimal Replacement Timing

Optimal Replacement Year By Individual Pipe Segment

Final Sieve is Engineering Judgment on Final Project Scope



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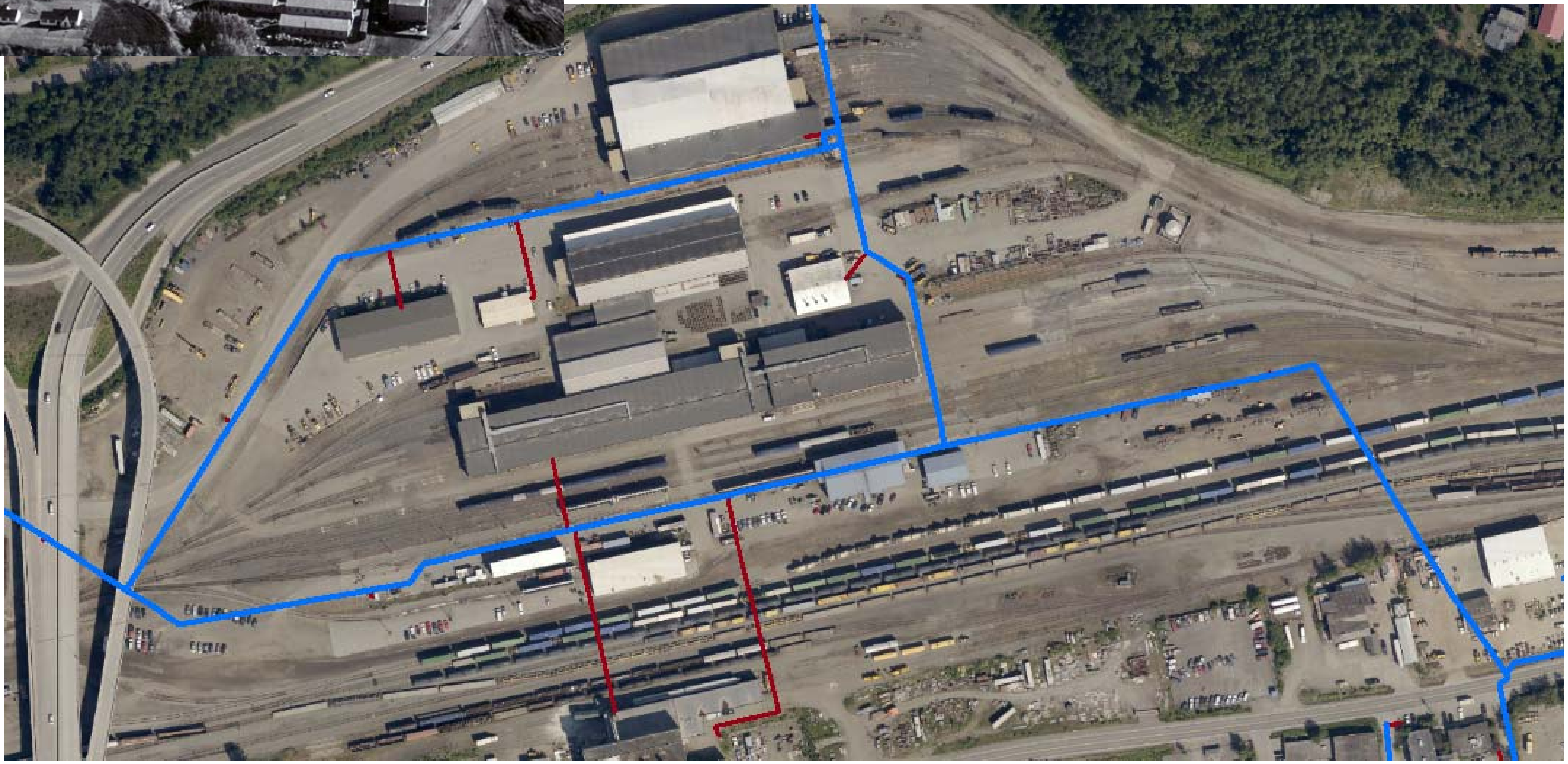
Application of the model:

Inspection Area



Capital Planning Project / Process

First section of pipe recommended for replacement using Economic Pipe Replacement Model, which uses TBL failure costing in conjunction with statistical failure forecasting.

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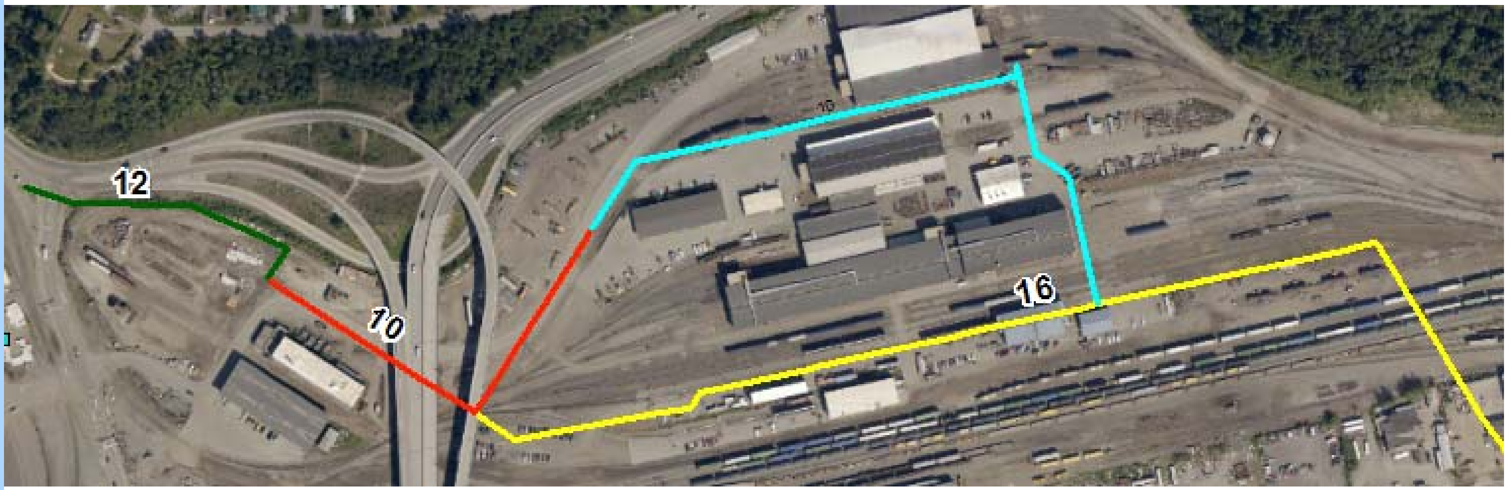
Capital Planning Project / Process



Nearby portions recommended by the Water Mains Asset Management Plan after engineering review due to proximity and similarity (same vintage, material and installation) to EPRM recommended pipe.

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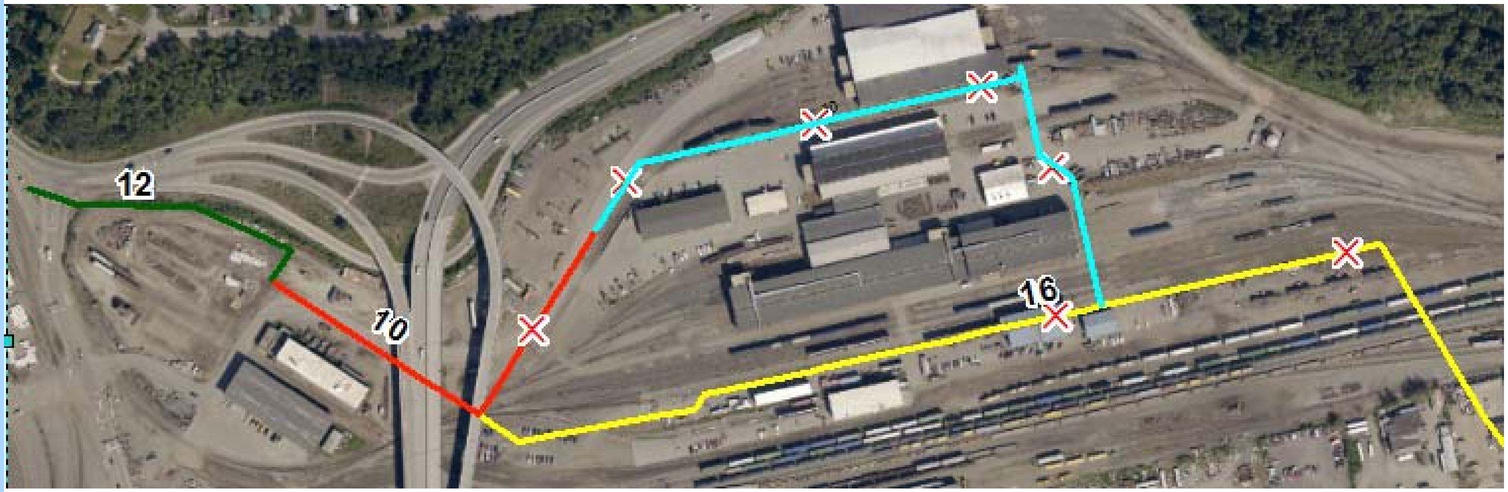
Capital Planning Project / Process



Condition Assessment was recommended to confirm replacement need prior to replacing due to minimal failure history

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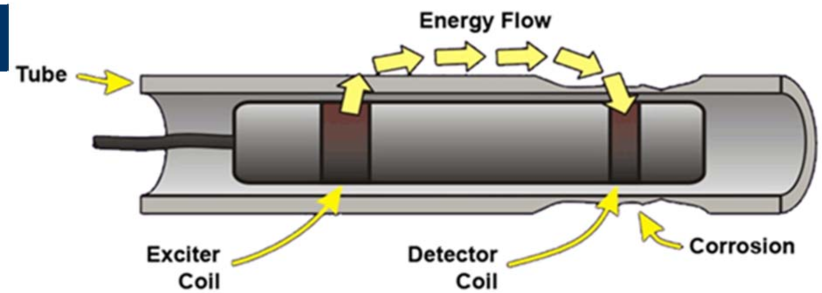
Technology Selection & Planning

- **PICA See Snake Tool**
  - **Remote field technology measure wall thickness**

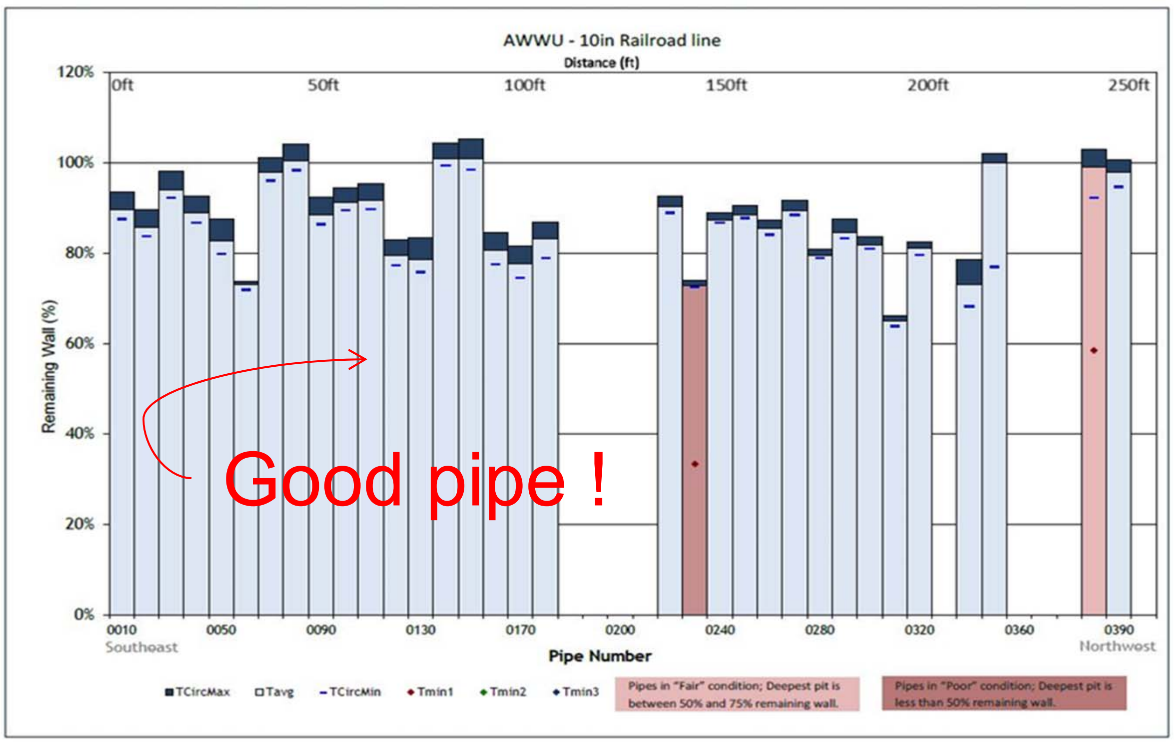


- **Equipment Shipment**
- **Coordination with Railroad**
  - 10 Day Work Period
  - Limited Inspection Windows 3PM - 11PM
  - Early Excavation Prep for Launch Pits

PICA
Pipeline Inspection and Condition Analysis Corporation

Inspection Results – 10 Inch Main

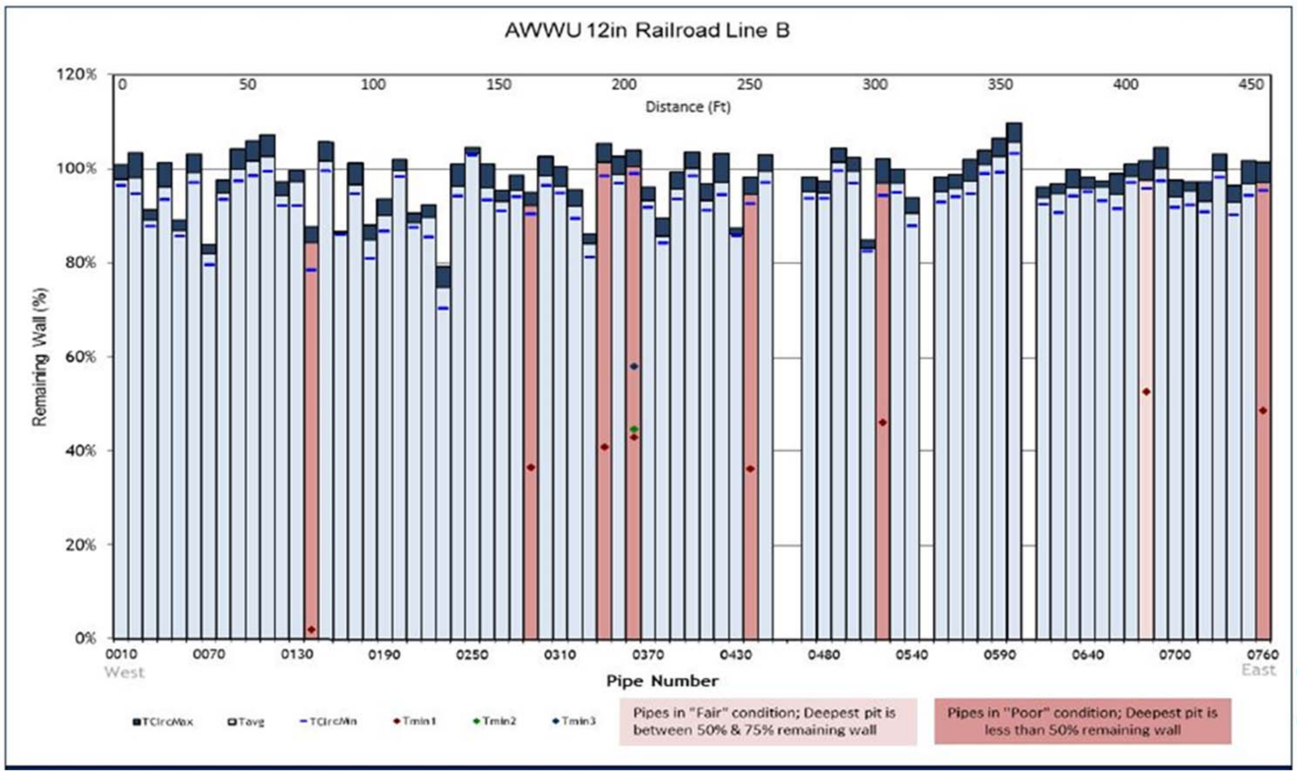
- **10 Inch – Inspected 233ft out of 1020ft planned**
  - Average wall thickness 86%
  - Two localized defects with wall thickness losses of up to 67%



PICA
Pipeline Inspection and Condition Analysis Corporation

Inspection Results – 12 Inch Main

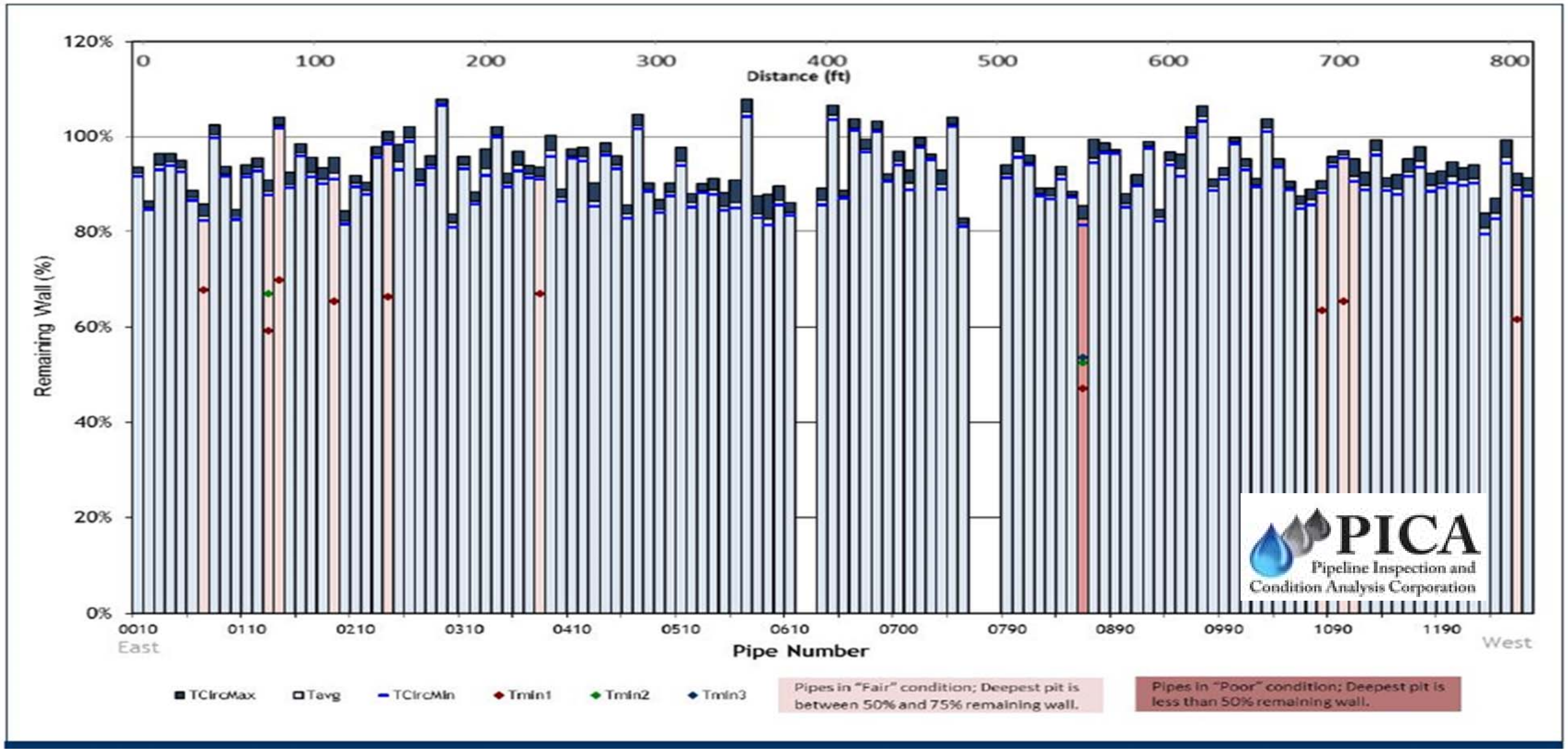
- **12 Inch – Inspected 1285ft out of 1570ft planned**
  - Average wall thickness 96% and 94%
  - 12 localized defects with wall thickness losses of up to 75%



PICA
Pipeline Inspection and Condition Analysis Corporation

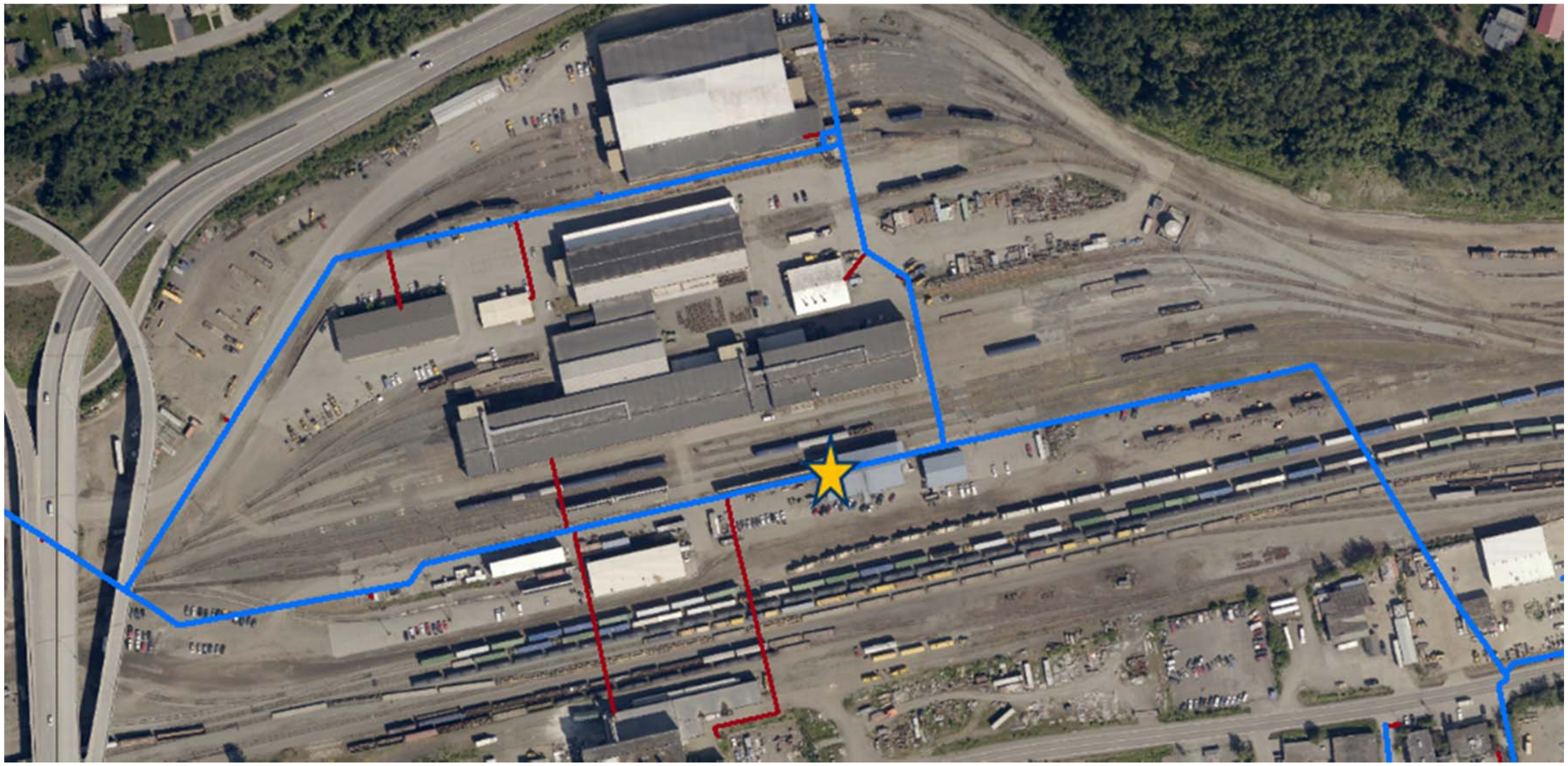
Inspection Results – 16 Inch Main

- **16 Inch - Inspected 742ft out of 1400ft planned**
  - Average wall thickness 92%
  - Two localized defects with wall thickness losses of up to 53%



Inspection reveals critical pipe wall loss locations

A bullseye – Murphy's Law wins again! ★ marks the spot



Inspection Results – Lab Samples

- **6 Samples tested for:**
  - Wall Thickness

Pipe Sample	Wall Thickness Range (in)	Average Wall Thickness (in)
1	0.370-0.570	0.477
2 Pipe only With liner	 0.370-0.377 0.461-0.475	 0.374 0.467
3	0.365-0.463	0.404
4	0.376-0.427	0.401
6	0.490-0.707	0.590

  - Corrosion Pitting

Pipe Sample	Measurement Location	Average Depth (in)	Maximum Depth (in)
1	OD ID	0.122 0.091	0.146 0.130
2	OD ID	No visible pitting on either surface	No visible pitting on either surface
3	OD ID	0.052 0.148	0.070 0.262
4	OD ID	0.057 0.169	0.096 0.193
6	OD ID	0.056 0.143	0.070 0.184

Cost of Inspection

- **Contract Costs**
  - PICA
  - Local Excavation Support (BC Excavating)
- **Internal Costs**
  - Engineering
  - Project Management
  - Distribution Operations Staff

	PICA	BC Ex	Labor	Over	Total
Planned	$ 135,000	$ 377,500	$ 22,000	$ 5,000	$ 539,500
Actual	$ 139,421	$ 365,527	$ 45,843	$ 11,465	$ 562,256

Cost of Inspection

	Planned	Actual
Contract Cost	$ 512,500	$ 504,948
Inspection feet	3,990	2,260
	$ 516,490	$ 507,208
Contract $/Ft	$ 128/LF	$ 223/LF
In-House Costs	27,000	$ 57,308
Total Costs	$ 543,490	$ 564,516
Total $/Ft	**$ 136/LF**	**$ 250/LF**

- **Big difference was in LF inspected**
- **Improve with lessons learned**

Factors Impacting Inspection Cost

- **Alaska Relative cost differentials !**
- **Fixed Costs - Transportation and Mobilization**
- **Accurate Pipe Data**
  - Size
  - Historic repairs
- **Planning**
  - Plan for extra time due to fixed costs
- **Indirect Costs**
  - Railroad Customer Impact

Value of Condition Assessment

- **Direct Benefits**

  -- Reduction in project scope vs. what we would have done if CA was not available

Without Condition Assessment			
	LF to Replace	$/Ft	Replacement Cost
10inch	1020	$ 808	$ 824,242
12inch	1570	$ 911	$ 1,430,349
16inch	1400	$ 1,103	$ 1,544,088
Total	3990		**$ 3,798,678**

With Condition Assessment			
	LF to Replace	$/Ft	Replacement Cost
10inch	0	$ 770	$ -
12inch	856	$ 910	$ 778,960
16inch	742	$ 1,050	$ 779,397
	# of Repairs	$/Repair	Repair Cost
10inch	1	$ 40,000	$ 40,000
12inch	2	$ 45,000	$ 90,000
16inch	0	$ 50,000	$ -
Total R&R Cost			**$ 1,688,357**

Value of Condition Assessment

- **Direct Benefits**

  -- Reduction in project scope vs. what we would have done if CA was not available

Capital Reduction	$	2,110,321
Depreciation Rate		1.8%
Annual Depreciation Savings	$	37,986
Cost of Capital		6.1%
Annual Cost of Capital Savings	$	128,519
Total Annual Savings	$	166,505
Condition Assessment Cost	$	564,516
Payback Period		3.4 Years

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Value of Condition Assessment

- **Direct Benefits**

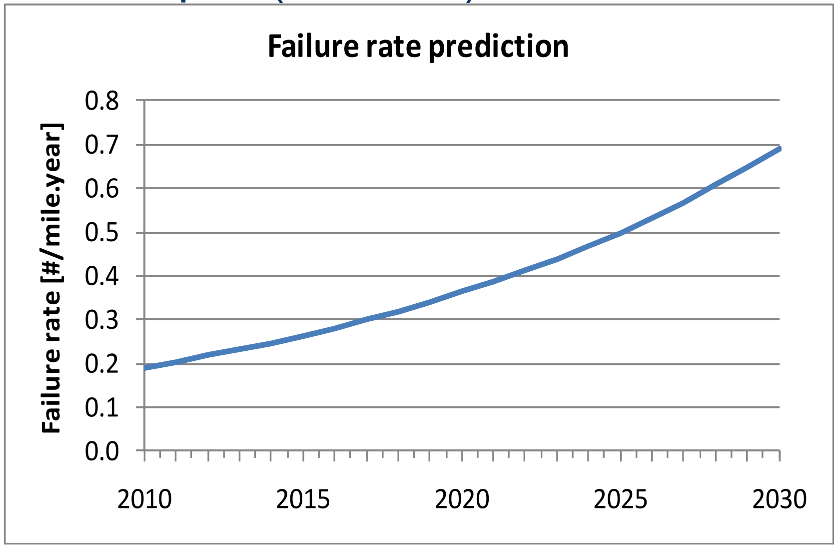
-- Reduction in Project scope vs. what we would have done if CA was not available

-- Reduction in Risk Cost

- Pipe specific failure rate predictions based on known pipe deficiencies, and pipe cohort escalation rate
- TBL Costs - Emergency Repair, Social Impact(Railroad), Fines, Environmental Impact

Net Present Value of 20 Yr Failure Risk	Risk Mitigation + Condition Assessment
$3.7M	$2.2M

Total Risk Reduction = $1.5M



Conclusions

- Statistical methods combined with condition assessment can provide an effective set of tools to improve renewal planning efforts
- Condition Assessment can be cost effective and worthwhile, but be certain to plan well and know when and where to use it effectively (see above!)

Questions ?

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