Optimizing Condition Assessment Planning – A Risk Based Approach

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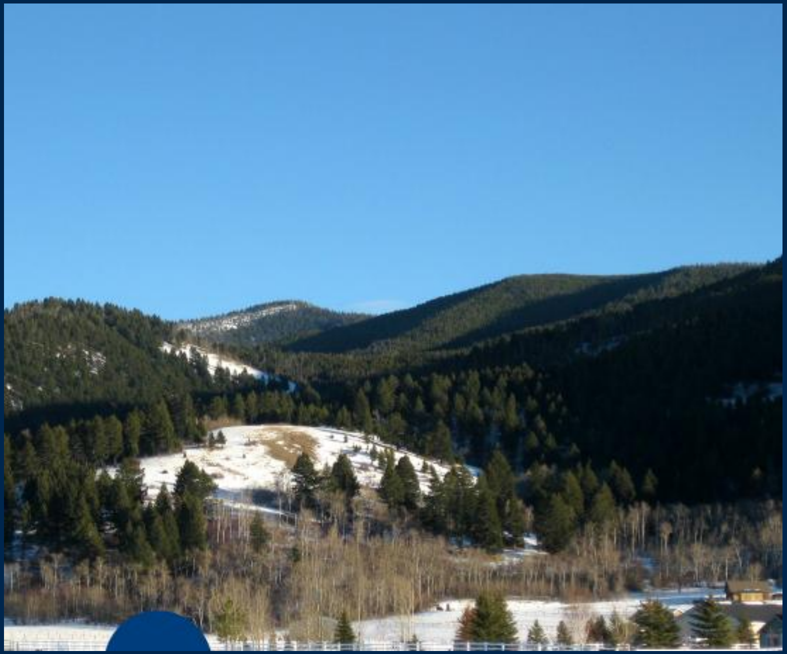
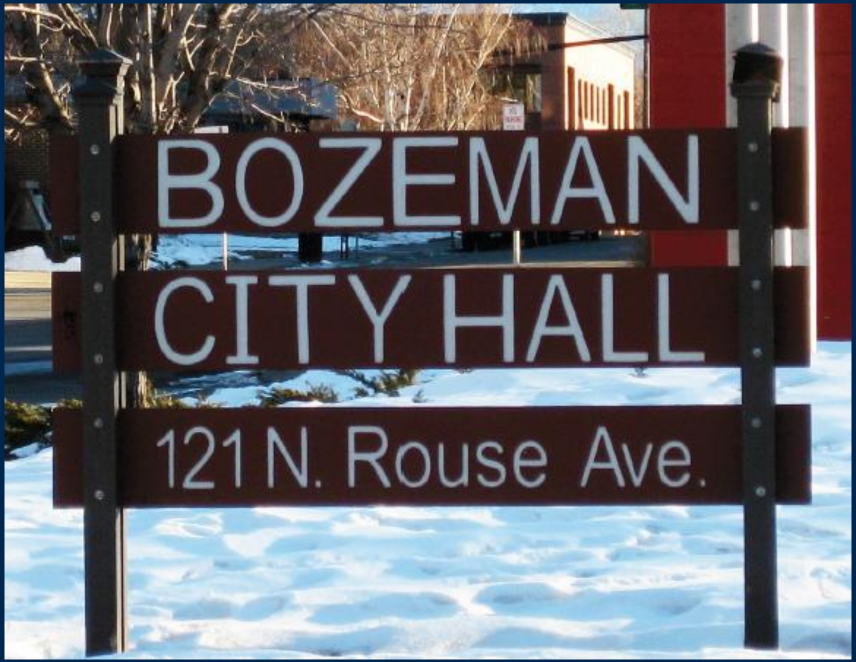
First A Few Definitions

- Condition Assessment
- Risk

Case Study location: Bozeman, MT, USA





The Issues

Standard Utility Issues

- ✓ Aging Infrastructure
- ✓ Limited Budget
- ✓ Limited Data

Additional Utility Concerns

- ➢ Several high profile / high consequence breaks in recent past
- ➢ Aging high consequence transmission mains

The Questions

- Condition assessment is expensive, so how do we decide which mains to assess?
- How do we determine when condition assessment is cost effective?
- How do we build a sustainable process for condition assessment?

The Plan

- Desktop Risk Model
- Condition Assessment Decision Tree
- Field Condition Assessment
- Revised Risk Analysis
- Business Case Evaluation
  - Operating Program
  - Capital Program

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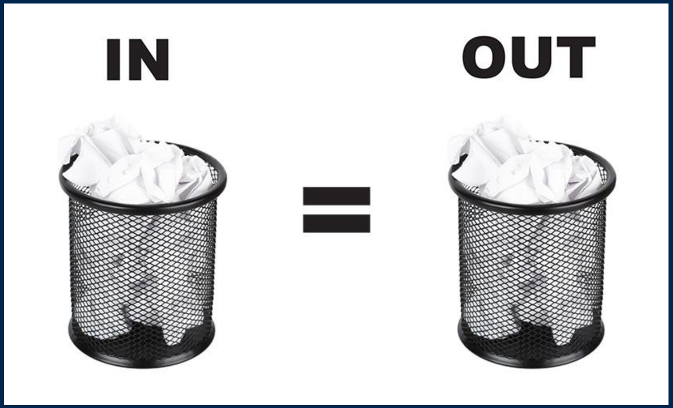
Desktop Risk Model

The Plan

A risk assessment is only as good as the data



And a risk model is only as stable as the data management practice

Setting up the Risk Model:

- Know What you Have (Asset Inventory)
  - Challenges -
    - Granular or Coarse
    - Where to Store Information
    - Who is Responsible

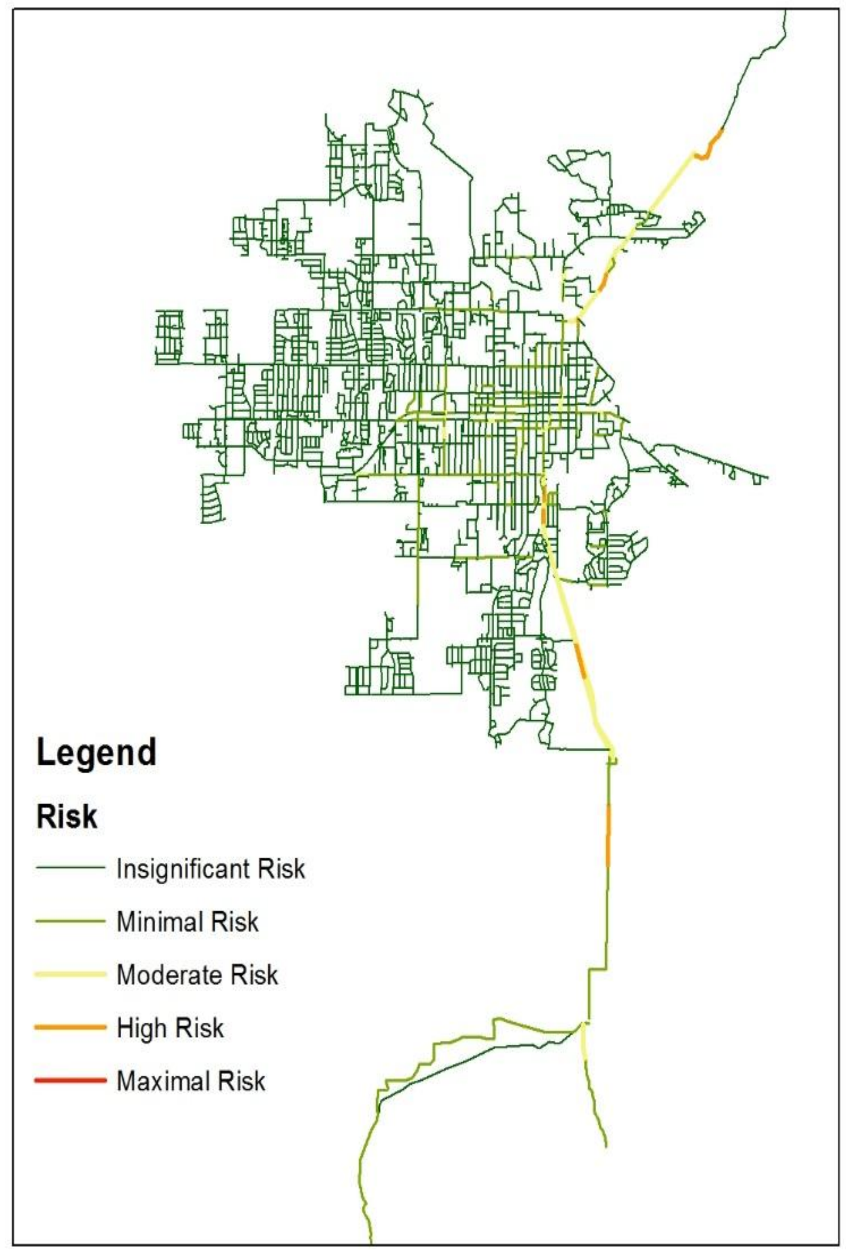
- Know / Estimate What Shape it is In
  - (Condition, Failure Prediction, Reliability Engineering)
  - Challenges -
    - Granular or Coarse
    - Where to Store Information
    - Who is Responsible

To Develop the Risk Model: Use the City's Data:

- Local Data sources and aggregation
- Remote Data validation
- Remote Data mining
- Local Data Maintenance

With better data comes better answers to the core questions we wanted to address

Based on these factors the model Identifies areas of highest risk and degree of relative risk across the system



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The Results of the Risk Model:

Risk Matrix – All Water Pipe

Likelihood					
5	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	0%
3	5%	2%	0%	1%	0%
2	11%	11%	3%	3%	0%
1	12%	39%	9%	4%	0%
	1	2	3	4	5

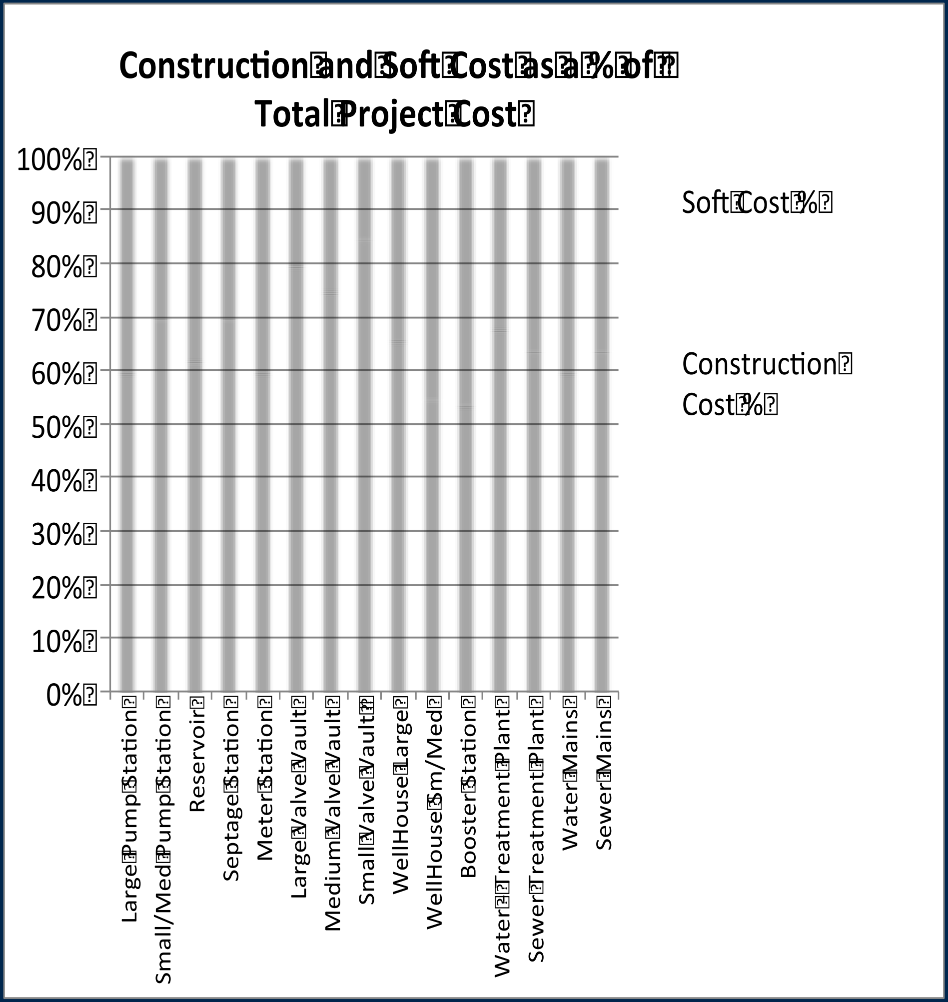
Consequence

Summary Statistics

Maximum	0.00%	-
High	0.69%	1.83 mi
Moderate	2.75%	7.26 mi
Minimal	9.01%	23.81 mi
Insignificant	87.54%	231.27 mi

Limitations: Data Availability

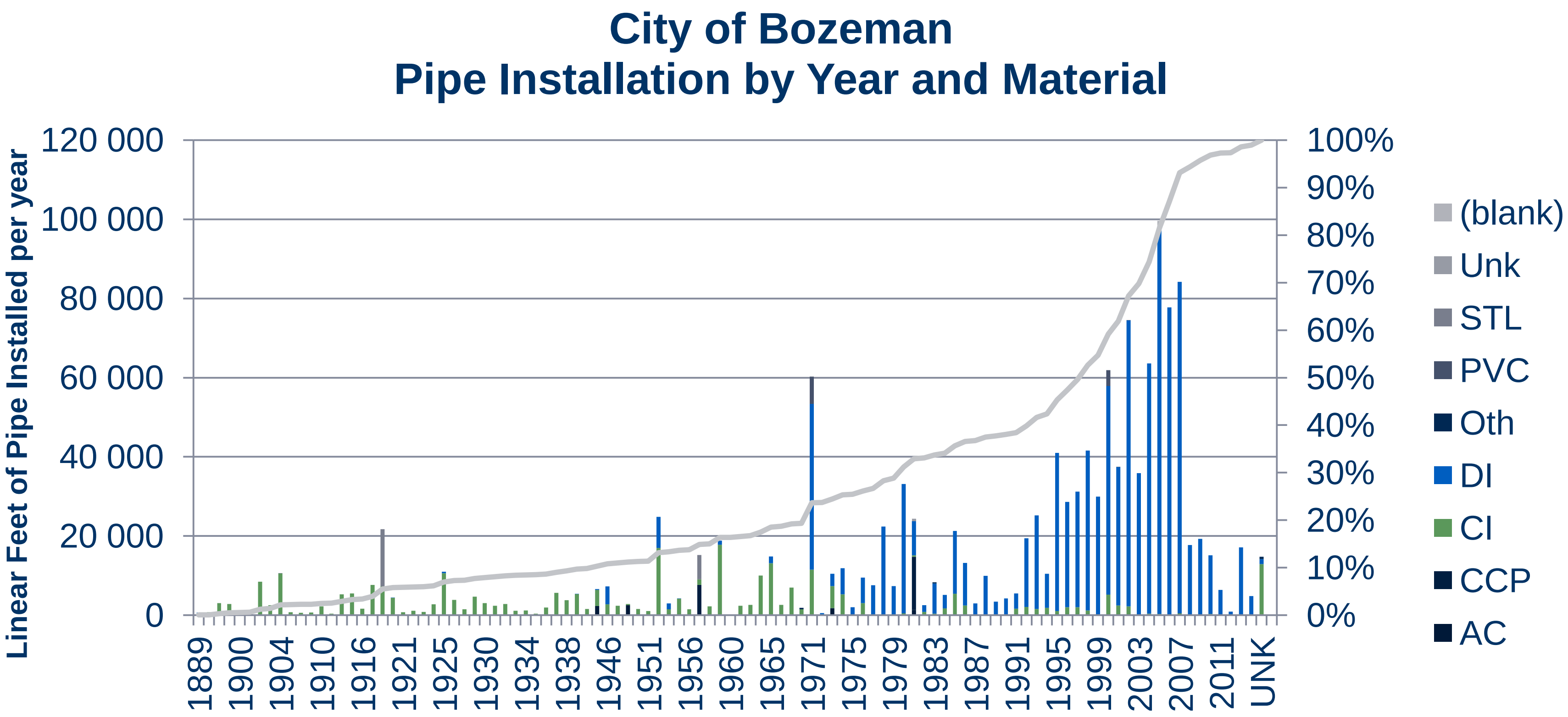
- Cost Information
  - Breaks: Loaded Costs, and indirect impacts
  - Replacements: Loaded costs
- Hydraulic Criticality



Limitations: Data Volume

Volume of Break Data

Young System in Good Condition = Few Breaks



Data Improvements

- Continue Maintaining Break Data
- Continue Cleaning Main Data
- Retired Assets
- Hydraulic Assessment
- Costing Information
  - Full Analysis for fully loaded costs
  - Case Study for Loaded Costs
  - Surrogate Information

And By Improving Its Data:

- Creates a living process the city can maintain and use, Which
- The city can use to build stronger, defensible, repeatable results on which to base program needs, and
- Identifies data gaps which can be addressed through new data development or through field condition assessment data

The Plan

Desktop Risk Model

Condition Assessment Decision Tree

Field Condition Assessment

Revised Risk Analysis

Business Case Evaluation

Operating Program

Capital Program

The Plan

Condition Assessment Decision Tree

Decision Tree for Condition Assessment

- Drivers for CA
  - High Consequence
  - High Replacement Costs
- Review of R&R costs
  - Comparing CA vs R&R Costs
- Use BCE to evaluate cost effectiveness
  - Direct Cost Avoidance
  - Indirect Cost Avoidance
- Decision tree for CA determination

Business Case Concept

- Establish and Define Business Need/Problem
- Evaluate Options to Meet Need or Solve Problem
- Make Recommendation

Drivers for Condition Assessment

- High Consequence – means you can't afford to have it fail

Drivers for Condition Assessment

- 14 Inch Failure in 2007

Drivers for Condition Assessment

- 14 Inch Failure in 2007
- 24 Inch Failure in 2010

Drivers for Condition Assessment

- High Consequence – means you can't afford to have it fail
- High Replacement Costs – means you can't afford to replace the pipe too early either

Drivers for Condition Assessment – R&R Costs

City Core	$ per Foot
8-inch	$306.90
10-inch	$338.83
12-inch	$363.29
14-inch	$413.94
16-inch	$447.30
18-inch	$509.52
20-inch	$583.44
24-inch	$687.51
30-inch	$883.26

Drivers for Condition Assessment

- High Consequence – means you can't afford to have it fail
- High Replacement Costs – means you can't afford to replace the pipe too early either

Business Need = Reduce uncertainty to insure optimal decision making

Effective Condition Assessment Can Save $$$ - Ex.-Northern Utility

Without Condition Assessment			
	LF of Replacement	$ / Foot	Replacement Cost
10"	1020	$ 808	$824,160
12"	1570	$ 911	$1,430,270
16"	1400	$ 1,103	$1,544,200
Total	3990 LF		**$3,798,630**

With Condition Assessment			
	LF to Replace	$ / Ft	Replacement Cost
10 Inch	0	$770.00	$-
12 Inch	856	$910.00	$778,960.00
16 Inch	742	$1,050.00	$779,100.00
	# of Repairs	$ / Repair	Repair Cost
10 Inch	1	$40,000.00	$40,000.00
12 Inch	2	$45,000.00	$90,000.00
16 Inch	0	$50,000.00	$-
		Total Cost	**$1,688,060.00**

How to Determine Cost Effectiveness

- Look to Compare Replacement, Consequence and Condition Assessment Costs
  - Replacement Costs Assessed by AE2S
  - Consequence Assessed through Risk Assessment
  - Condition Assessment Costs presented by Pure

- How do we combine all of those?

Condition Assessment BCE

- Next Step was to complete BCE
  - Develop break even points for cost effective CA based on available data
  - Use those break even points to develop CA decision tree

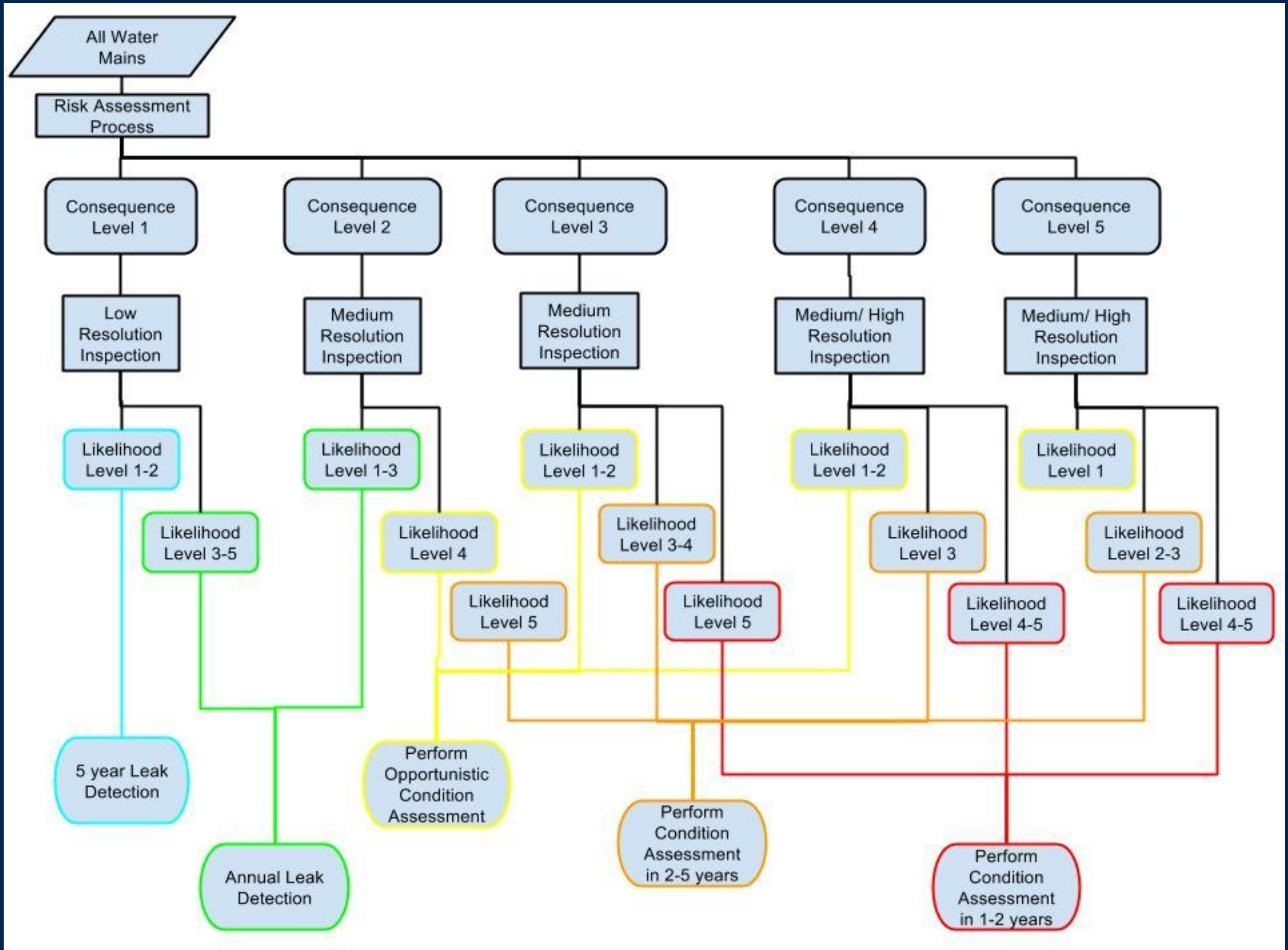
Condition Assessment BCE

- BCE determined set points for comparison to CA economies of scale curve
- Set points were used to develop CA decision tree

Condition Assessment BCE

Example 1 - 7/23/2014 Break - Small diameter, distribution pipe in medium density neighborhood				
Depreciation Rate	1.25%	Inflation Rate	2.35%	
Pipe Info				
Install Date	1903			
Length of Pipe	301			
Material	CI			
Size	6			
	$/LF	Total		
Estimated R&R Cost	$237.15	$71,266		
Estimated CA Costs	$2.54	$764	Low Resolution	
	$9.41	$2,828	Medium Resolution	
	$17.85	$5,363	High Resolution	
Estimated cost of Failure		$3,906		
Estimated Cost of Leak Repair		$2,400	Avg Cost of Leak repair 10" and under	
Comparison of Alternatives				
Option 1 - Do Nothing		3 failures in 20 years		
	Failure in Year 5	$3,478		
	Failure in Year 15	$2,757		
	Failure in Year 20	$2,455		
	20 Year NPV	**$8,690**		
Option 2 - Replace Now		$71,266		
	Annual Cost of Replacement	$891		
	20 Year NPV	**$14,086**		
Option 3 - CA & Repair		Low Resolution	Medium Resolution	High Resolution
	CA now	$764	$2,828	$5,363
	Repair	$2,400	$2,400	$2,400
	CA in 10 yrs	$746	$2,242	$4,251
	Break	$3,097	$1,902	$1,902
	Repair	$1,902	$1,902	$1,902
	20 Year NPV	**$8,908**	**$11,273**	**$15,818**

Condition Assessment Decision Tree



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Recommendations for 5 year Condition Assessment Plan

FACILITYID	MATERIAL	NOMINAL DIAMETER	NAME	INSTALL DATE	LENGTH	Source	Overall Likelihood	Overall Consequence	Risk
4163	CI	18	Lyman Creek	1925	9.521		2	5	2-5
4162	CI	18	Lyman Creek	1925	122.418		2	5	2-5
2699	CI	18	Lyman Creek	1925	22.62		2	5	2-5
4093	CI	18	Lyman Creek	1925	73.598		2	5	2-5
4950	DI	14	Water System Improvements Phase 1	1952	318.961		3	3	3-3
4494	CI	8	Hardboards	1904	310.615	Hardboards	3	3	3-3
2991	STL	18	Hardboards	1918	1711.739		3	4	3-4
2992	AC	18	Lyman Creek	1941	2304.941		3	4	3-4
2384	CCP	24		1957	751.252		3	4	3-4
6142	STL	18		1918	754.52		3	4	3-4
4057	CI	18	Lyman Creek	1925	1015.681		3	4	3-4
2988	CCP	30	Sourdough Transmission Main	1981	2884.61		3	4	3-4
1229	CI	6	Hardboards	1899	260.758	Hardboards	4	2	4-2
10064	CI	6	Hardboards	1929	88.218	Hardboards	4	2	4-2
2136	CI	4	Hardboards	1950	1331.229		4	2	4-2

Key Points

- Make a plan beyond the current need
- Base plan on supporting service levels and minimizing risk
- Develop data to support long term plan
- Use the long term plan to program both operational and capital planning needs

- Questions?