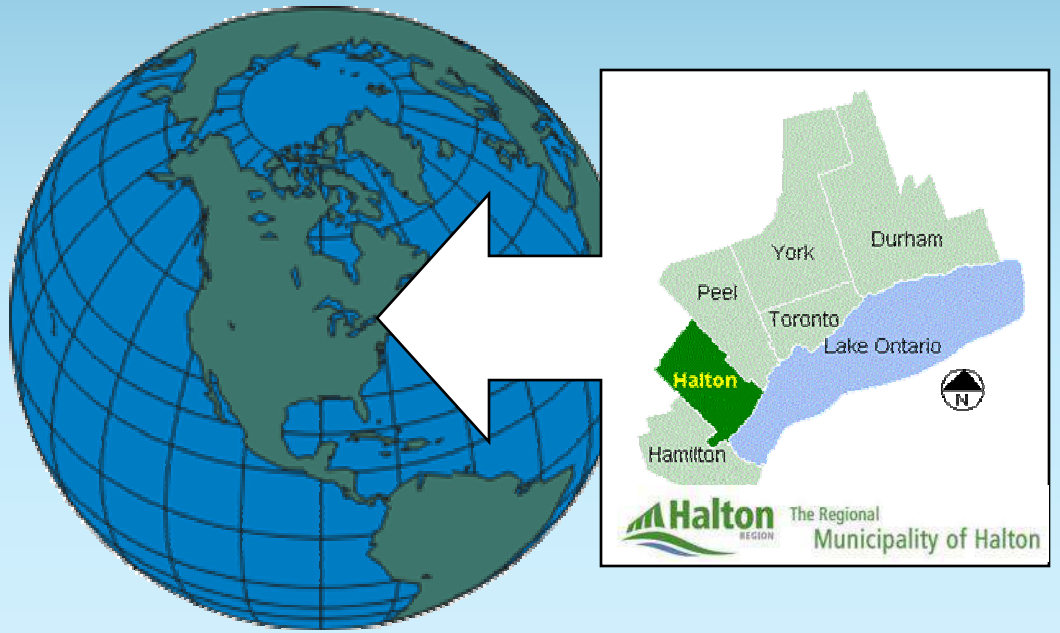
MANAGING RISK EXPOSURE AND MUNICIPAL CRITICAL INFRASTRUCTURE

CERIU Infra2011
Session D1 - Management
November 15, 2011

Presentation Overview

- Introductions
  - Tara Gudgeon, Region of Halton
  - Geoff Linschoten, AECOM
- Introduction to Risk, Criticality and Probability
- Criticality Model Development
  - Consequence of Failure
  - Probability of Failure
- Region of Halton Model
- Condition Assessment
- Discussion

About Halton Region….



Comprised of Four Area Municipalities

- The City of Burlington
- Town of Halton Hills (Georgetown & Acton)
- Town of Oakville
- Town of Milton

2001 – Population of 400,000

2011 – Projected to 450,000

2031 – Projected to be 780,000

www.halton.ca


There are the global risks you probably cannot do too much about
8105

And there are the risks that we deal with in our daily work that could be dealt with through a proper understanding of the factors contributing to the risk

Risk Definitions

Risk is a measure of the degree of exposure to the consequences that might result from event that might happen – Water Research Foundation, 2008

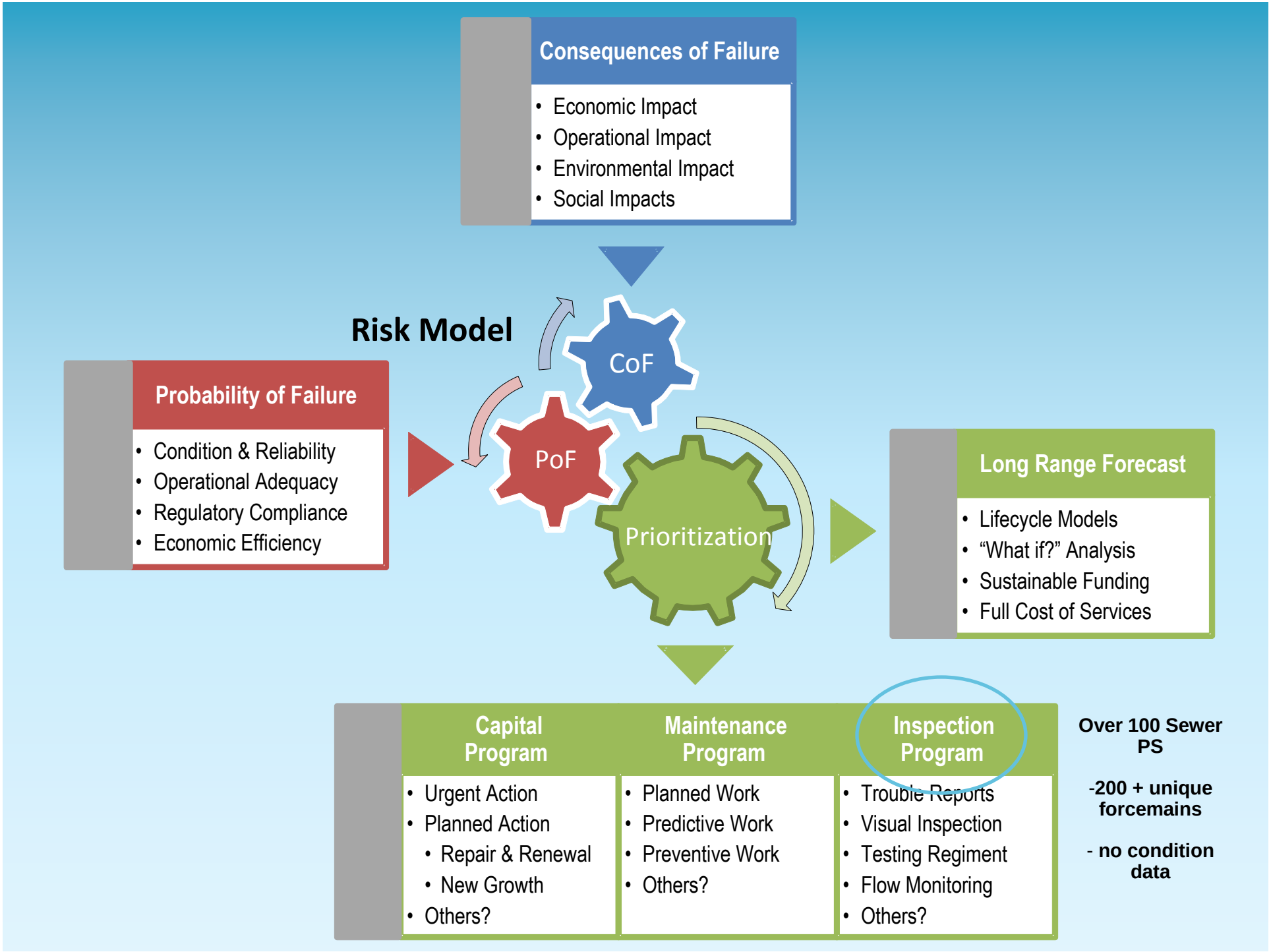
Risk = Probability of Failure (PoF) X Consequence of Failure (CoF)

Probability

How likely is it for the asset to fail?

Consequence

How severe are the long and short term consequences of asset failure?


Consequences of Failure
• Economic Impact
• Operational Impact
• Environmental Impact
• Social Impacts
Risk Model
CoF
PoF
Prioritization
Probability of Failure
• Condition & Reliability
• Operational Adequacy
• Regulatory Compliance
• Economic Efficiency
Long Range Forecast
• Lifecycle Models
• "What if?" Analysis
• Sustainable Funding
• Full Cost of Services
Capital Program
• Urgent Action
• Planned Action
• Repair & Renewal
• New Growth
• Others?
Maintenance Program
• Planned Work
• Predictive Work
• Preventive Work
• Others?
Inspection Program
• Trouble Reports
• Visual Inspection
• Testing Regiment
• Flow Monitoring
• Others?
Over 100 Sewer PS
-200 + unique forcemains
- no condition data

Sample Strategies for Reducing Risk

Sample Risk Reduction Option	Reduces Probability	Reduces Consequences
CAPITAL INVESTMENTS		
Rehabilitation	✓	
Replacement	✓	
New redundant asset	✓	✓
O&M ACTIVITIES		
Development of operating SOPs	✓	
Improved planned maintenance procedures	✓	
Enhanced monitoring through SCADA	✓	
LEVELS OF SERVICE CHANGES		
Demand management		✓
Improved response and recovery		✓
Reduce LoS with stakeholder involvement		✓

sample

Risk Model Development

Model is based on international best practice

WATER RESEARCH FOUNDATION
ADVANCING THE SCIENCE OF WATER

Global Water Research Coalition

UKWIR

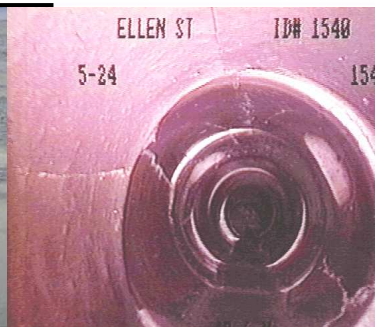
WERF

WATER SERVICES ASSOCIATION OF AUSTRALIA

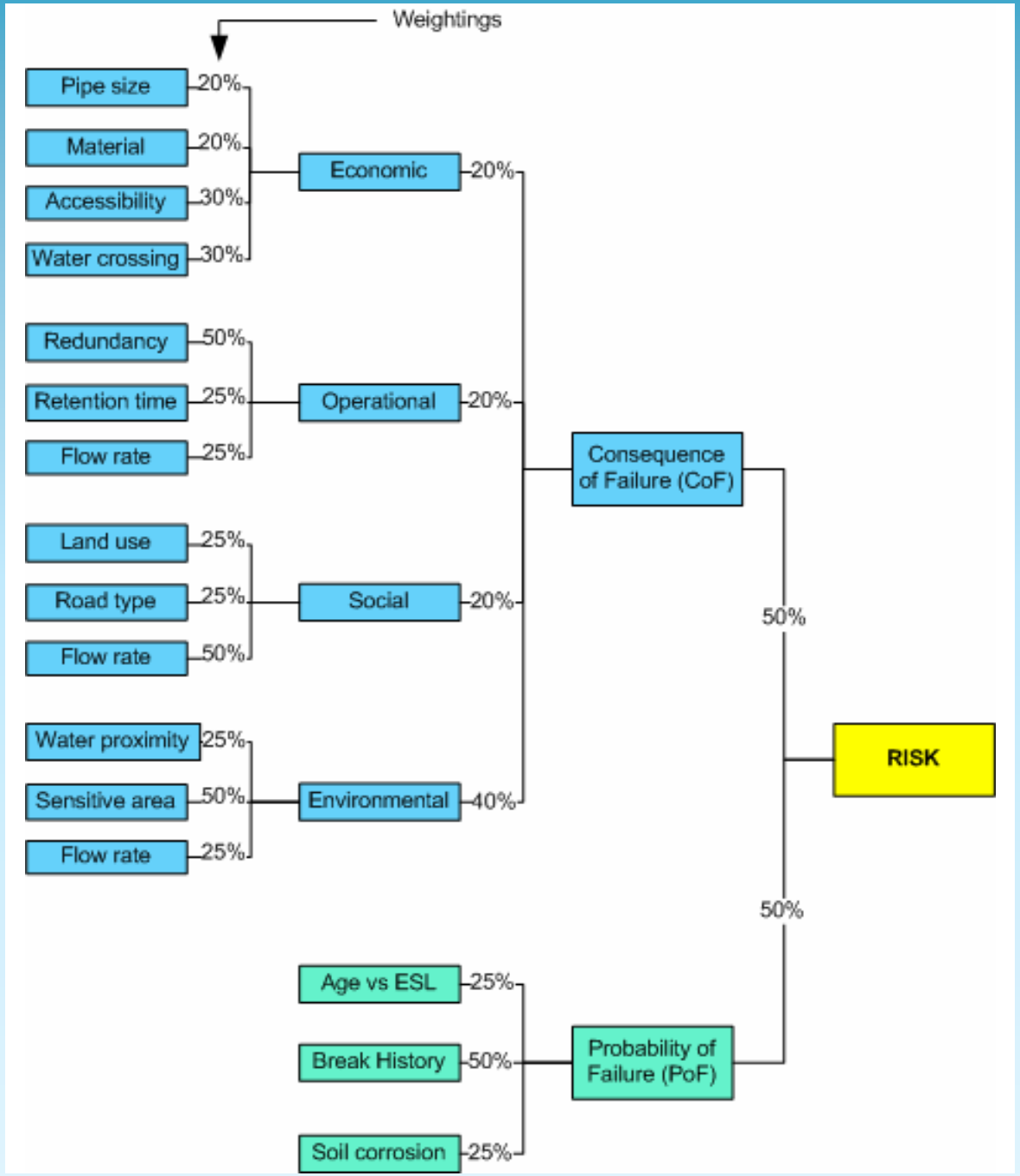
Risk Analysis and Management for Critical Asset Protection (RAMCAP®) Standard for

Risk and Resilience Management of Water and Wastewater Systems

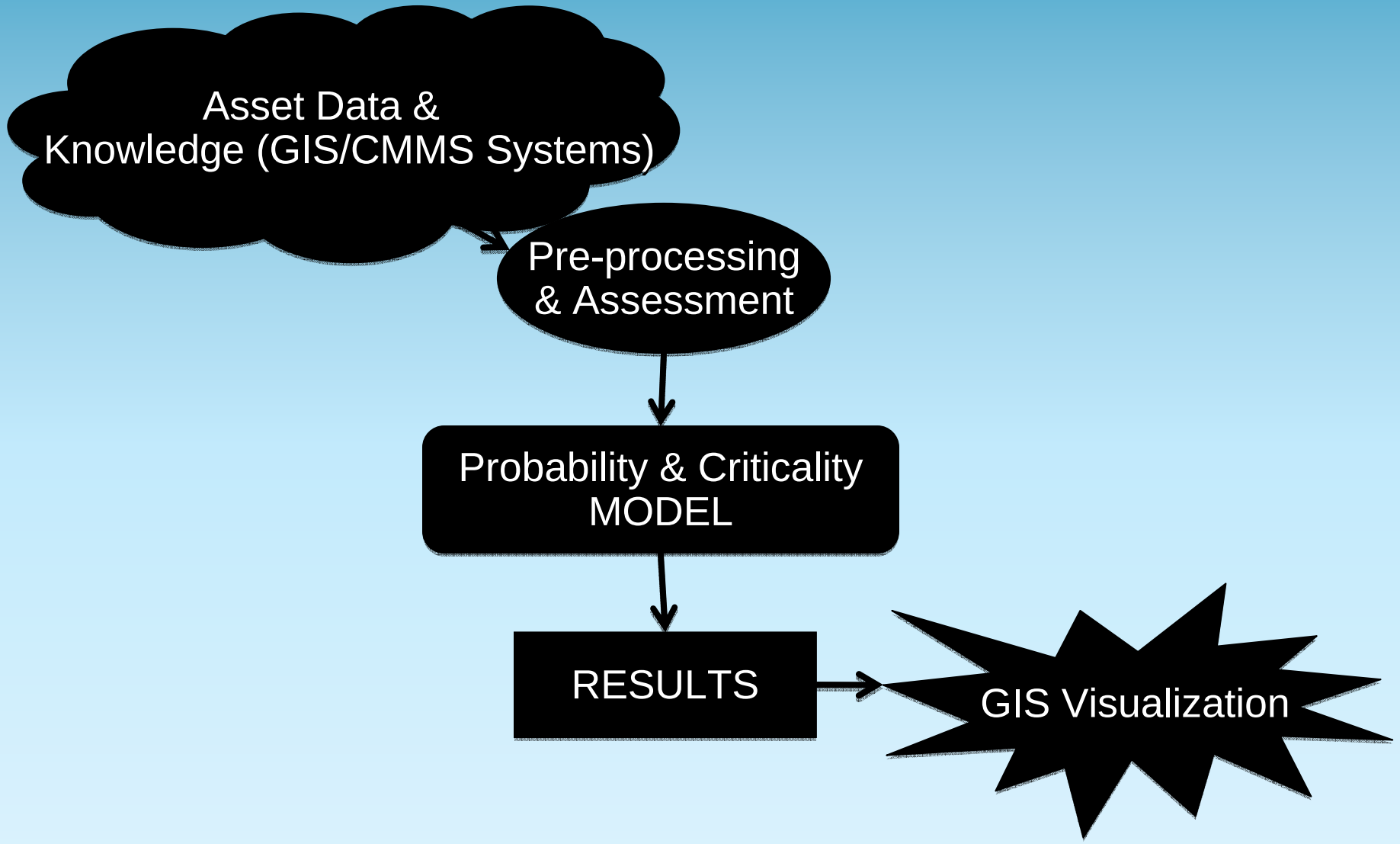
Tool for Risk Management of Water Utility Assets



Sample risk framework



Risk & Criticality Model Conceptual Process



MS Excel Model Development

Criticality Model

Consequences of Failure

Index	Index Weight	Variable	GIS Column	Variable Weight
Economic	0.2	Pipe Size	6	**0.2**
		Material	7	**0.2**
		Accessibility	14	**0.3**
		Water Crossing	14	**0.3**
Operational	0.2	Redundancy	11	**0.5**
		Retetention Time	25	**0.25**
		Flow Rate	26	**0.25**
Social	0.2	Land Use	16	**0.25**
		Road Type	18	**0.25**
		Flow Rate	26	**0.5**
Environmental	0.4	Water Proximity	37	**0.25**
		Sensitive Area	15	**0.5**
		Flow Rate	26	**0.25**

USER DEFINED 1

USER DEFINED

Probability

Probability of Failure

Index	Index Weight	Variable	GIS Column	Variable Weight
Condition	1	Age vs ESL	8	**0.25**
		Break History	38	**0.5**
		Soil Corrosion	17	**0.25**

USER DEFINED 1

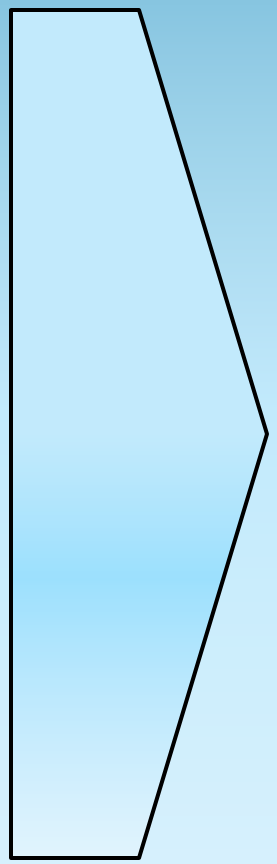
USER DEFINED

Typical Model Outputs

A Critical assets

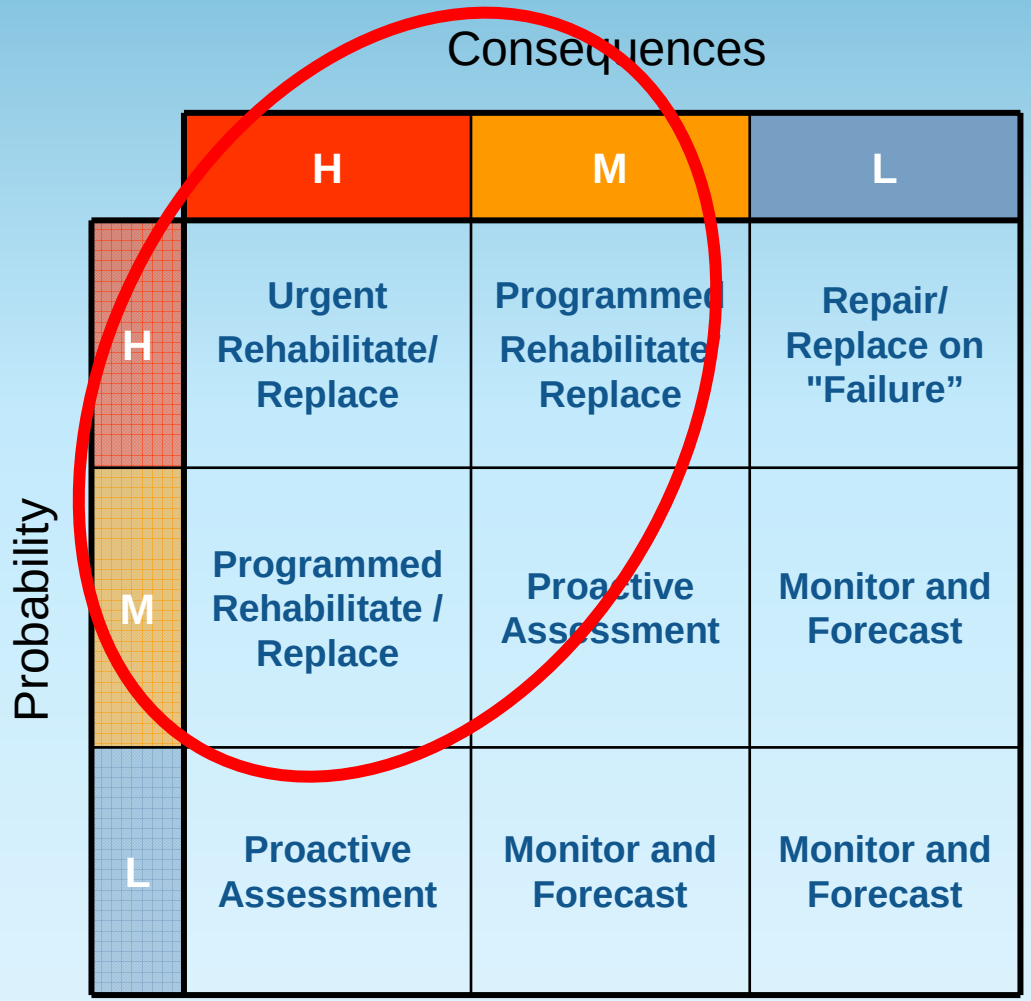
B Medium critical assets

C Least critical assets



Informs O&M and Capital Planning decision-making

O&M and Capital Planning Decision-Making




Consequence of failure

Consequence of Failure – Factors that Influence Consequence in Pressure Pipes

ECONOMIC	OPERATIONAL	SOCIAL	ENVIRONMENTAL
Pipe size	Pipe redundancy / alternative routes	Adjacent land use	Proximity to a fish bearing water course
Pipe material	Pipe retention time	Proximity to a critical customer	Proximity to a sensitive area
Pipe accessibility	Pipe flow rate	Volume of overflows	Impact of Repairs
Adjacent land use	Ease of Repair	Loss of Reputation	Volume of Overflows
Cost to Repair etc etc	Impact on the System	Public Disruption	Compliance and Regulatory Issues

What is the relative importance (weighting) of each factor?

Consequence of Failure - Economic

Index	Economic							
Weight	20							
Category	Repair Cost							
Weight	1							
Variable	PipeSize		Material		Accessibility		Water Crossing	
Weight	0.2		0.2		0.3		0.3	
Table	Main.shp		Main.shp		Halton List		geo spatial	
Attribute	Diameter		Material		Need to build table		analysis	
Valid Entries	Value	Score	Value	Score	Value	Score	Value	Score
	0 - 300	1	UNKN	0	Yes	1	No	1
	300 - 600	50	VC	5	No	100	Yes	100
	> 600	100	DI	10				
			HDPE					
			PE					
			PVC					
			STL					
			AC					
			CI					
			CONC	100				
			CONC PRE					
			CPP					

Consequence of Failure – Operational, Environmental Impact

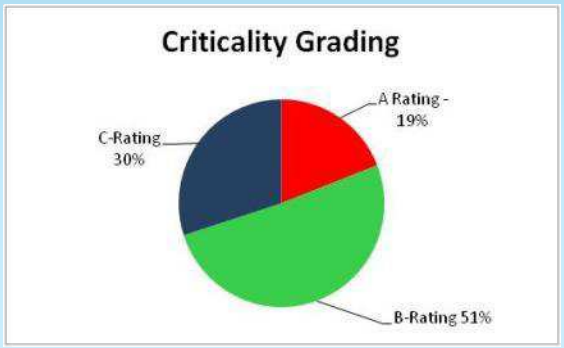
Index	Operational					
Weight	0.2					
Category	Operational Impact					
Weight	1					
Variable	Redundancy		Retention Time		Flow rate	
Weight	0.5		0.25		0.25	
Table	Main.shp				Firm Capacity	
Attribute	GIS query		to be built in separate table		to be built in separate table	
Valid Entries	Value	Score	Value	Score	Value	Score
	Yes	1	> 120	1	0 -25	1
	No	100	>60 < 120	50	25 - 100	25
			< 60 Min	100	100 - 500	75
					> 500	100

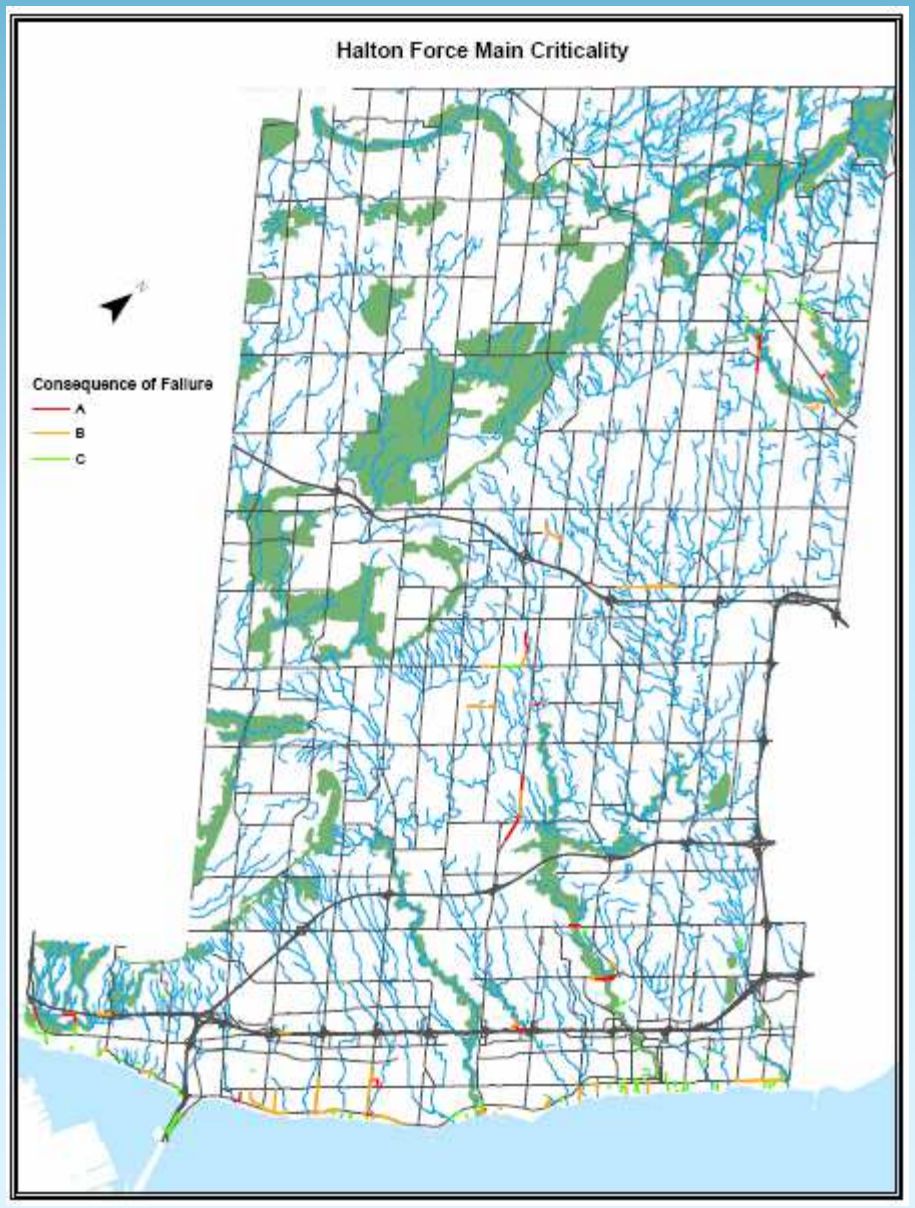
Index	Environmental					
Weight	0.4					
Category	Environment Impact					
Weight	1					
Variable	Water Proximity		Sensitive Area		Flow rate	
Weight	0.25		0.5		0.25	
Table	Water Body/Streams		EA Layer		SanitaryPumpingStation	
Attribute	Distance		EA Layer		Firm Capacity	
Valid Entries	Value	Score	Value	Score	Value	Score
	> 200	1	No	1	0 -25	1
	101 - 200	5	Yes	100	25 - 100	25
	51 - 100	10			100 - 500	75
	1 - 50	25			> 500	100
	0	100				

Consequence of Failure – Social

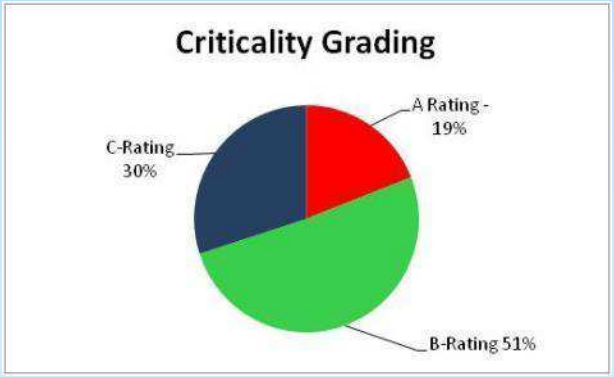
Index	Social					
Weight	0.2					
Category	Customer Impact					
Weight	1					
Variable	Land Use		Road Type		Flow rate	
Weight	0.25		0.25		0.5	
Table	MPAC_Parcel		Street_IMS		SanitaryPumpingStation	
Attribute	Prop_Code		Street_Desc		Firm Capacity	
Valid Entries	Value	Score	Value	Score	Value	Score
	Vacant	1	Other	1	0 -25	1
	Agricultural	1	Local	5	25 - 100	25
	Special Purpose	5	Collector		100 - 500	75
	Commercial	50		10	> 500	100
	Industrial		Major Arterial			
	Institutional		Multi-Purpose Arte			
	Government		Provincial Highway	100		
	Residental	100	Provincial Freeway			
			Toll			

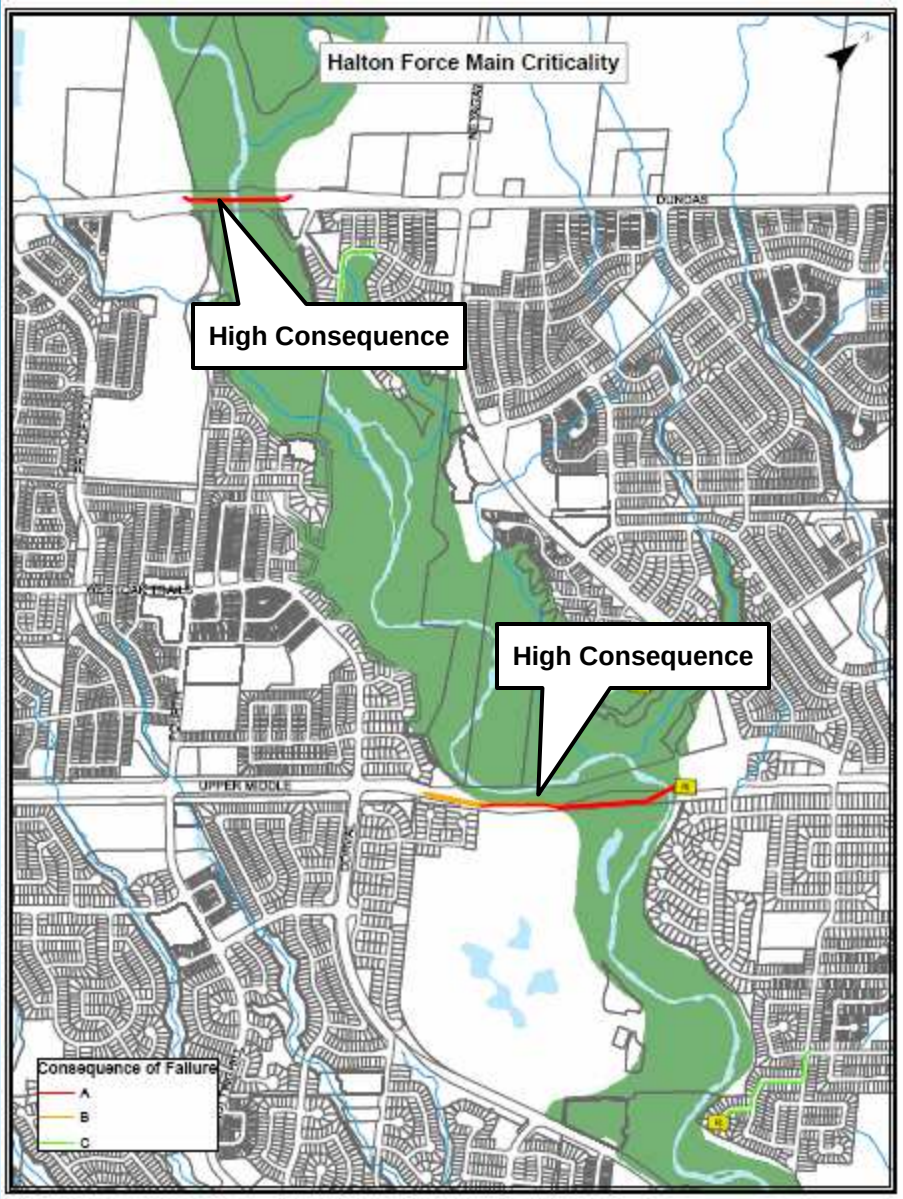
Consequence of Failure Results





Consequence of Failure Results





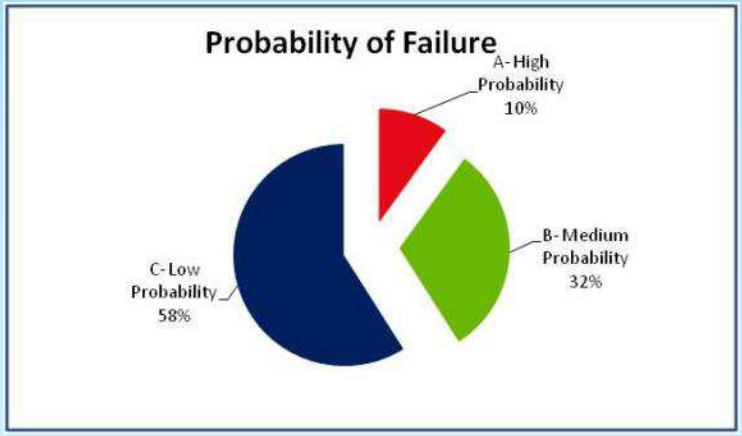

ROAD
WORK
AHEAD
Probability of failure

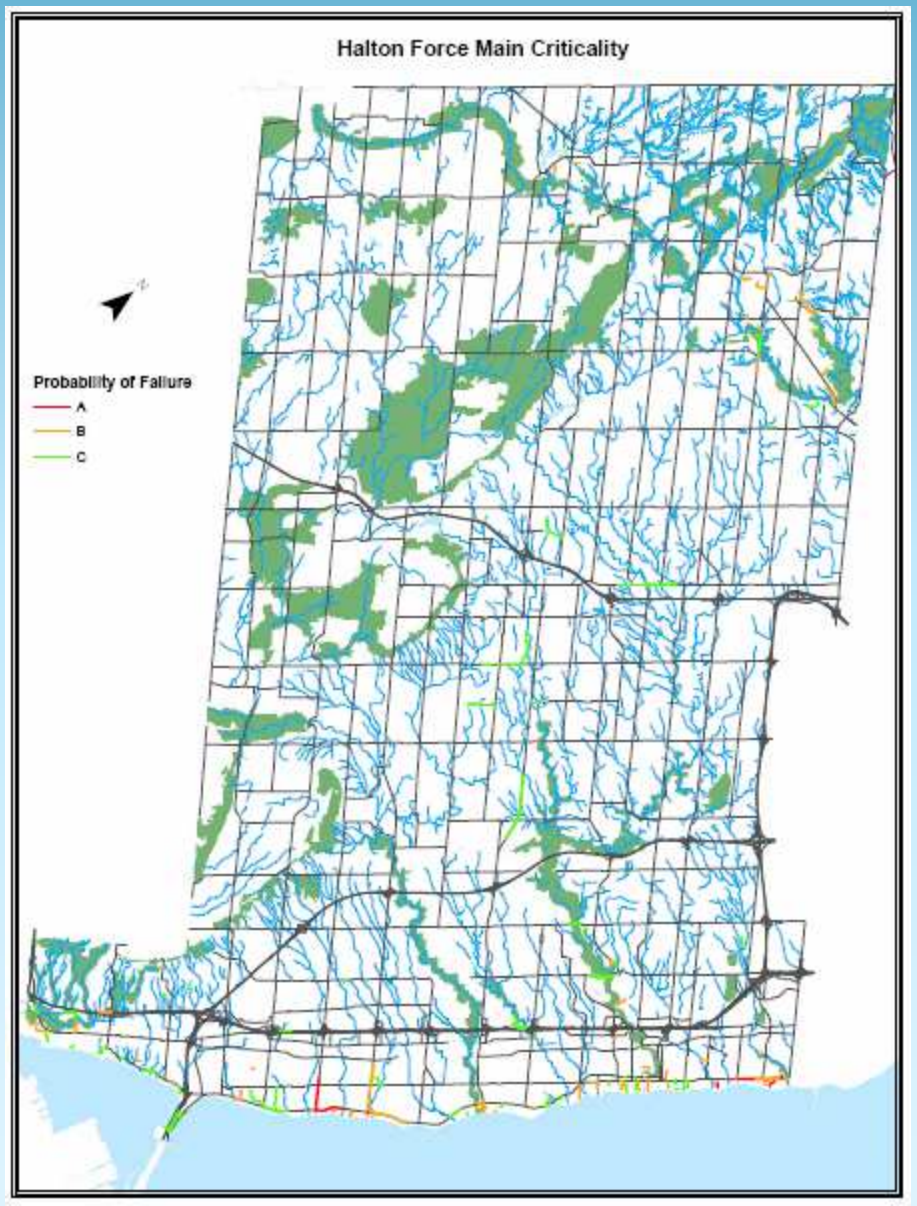
Probability of Failure

Index	Probability of Failure					
Weight	1					
Category	Condition					
Weight	1					
Variable	Age versus ESL		Number of Breaks		Under Influence of Corrosion	
Weight	0.25		0.5		0.25	
Valid Entries	Value	Score	Value	Score	Value	Score
	< 50%	1	0	0	Good	1
	50-80%	50	1	25	Poor	50
	> 80%	100	2	50	Very Poor	100
			>3	100		

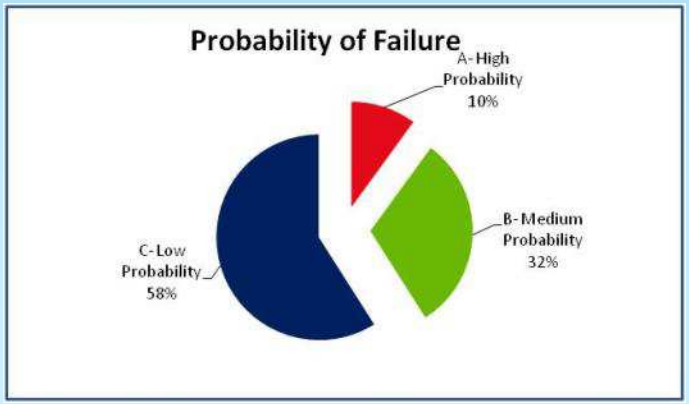
Probability	Description
A	High Probability of Failure, Confirm Condition
B	Medium Probability, Consider long term condition
C	Low Probability, Consider condition assessment in future

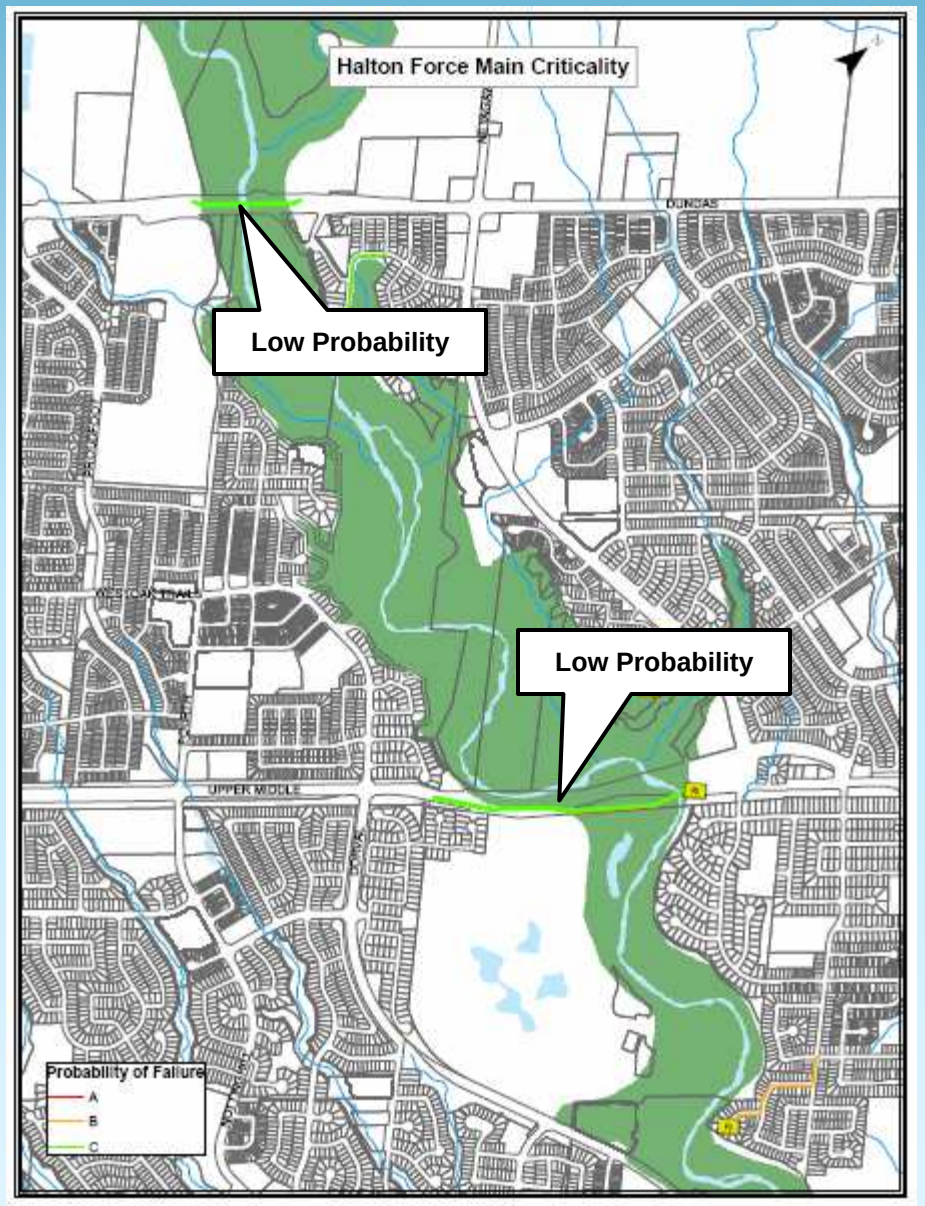
Probability of Failure Results





Probability of Failure Results





Summary of Overall Risk

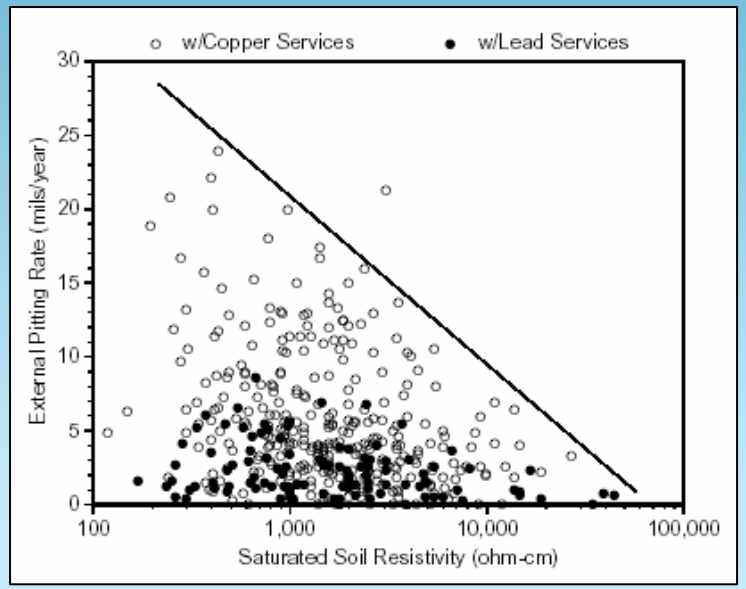
Risk = Consequences x Probability

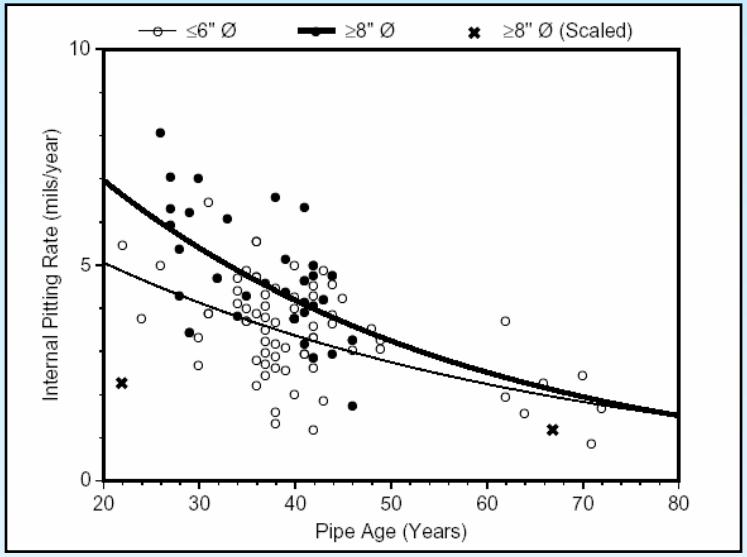
Low Risk	Moderate Risk	Highest Risk
Failure can be addressed through normal operations	Failure can be accommodated but strains operation	Failure cannot be handled in an effective manner
R/R on Failure	Failure Management	Failure Avoidance
Monitor and Forecast	Structured assessment to Plan	Continuous proactive maintenance & rehab

Condition Assessment Strategy

For all levels of risk

- Consider staged approach to increase understanding of exposure environment and applied loads
  - Importance of doing this increases with increasing failure consequence
- Maximize the use of understanding the material degradation process
  - Learn from every project you and everyone you know has undertaken
  - Never throw out an observation you or anyone else makes





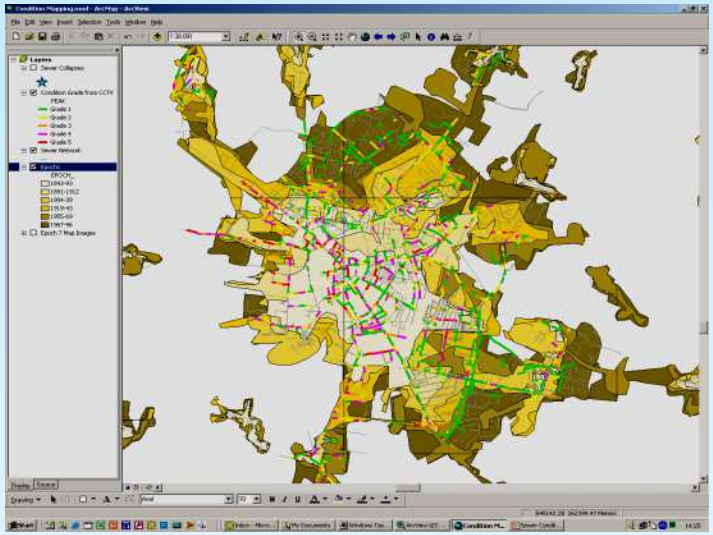
Condition Assessment Strategy

- Balanced approach driven by risk exposure & cost to gain necessary information.
  - **Highest** Priority Assets
    - Requires **accurate** understanding of deterioration mechanism
    - Multi-modal assessment strategy to compensate for weaknesses of individual techniques
    - Focus on attaining a **high degree** of certainty
    - Ensure assessment can be repeated so that performance can be tracked over time

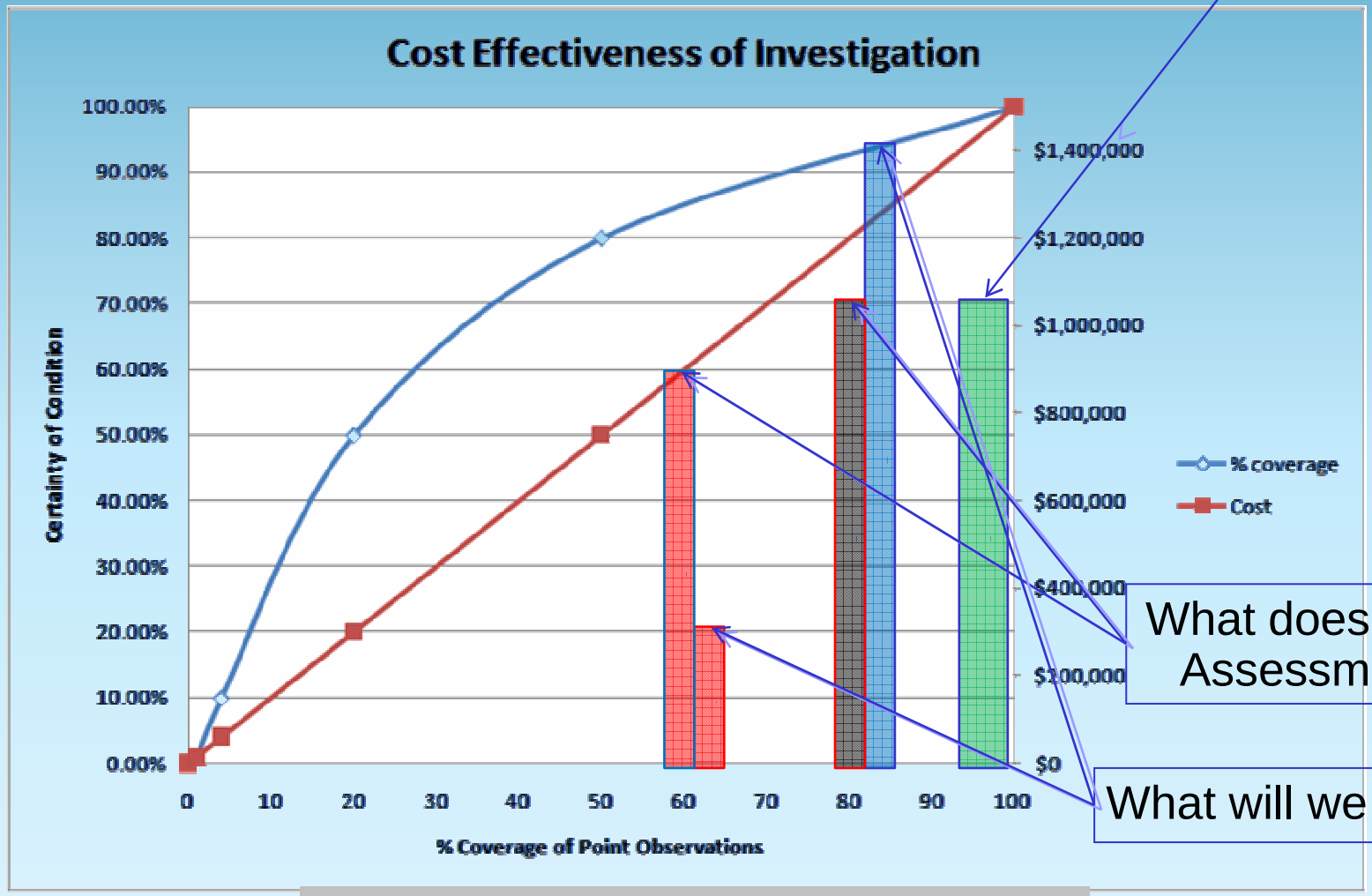
Condition Assessment Strategy

- Balanced approach driven by risk exposure & cost to gain necessary information.

  – **Medium** Priority Assets
    - Increase **frequency** of assessment as condition deteriorates
    - Increase **certainty** of data as condition deteriorates
    - Establish baseline and track performance over time



Remember Cost Effectiveness



Cost to Rehab

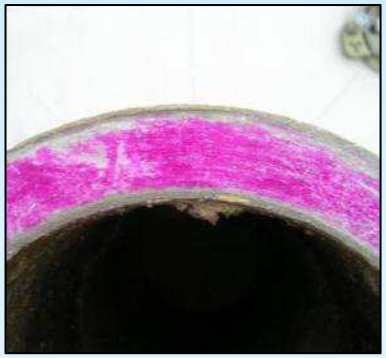
What does Condition Assessment cost?

What will we learn?

$$Effectiveness = \frac{\$}{KnowledgeGained}$$

Condition Assessment “Toolbox”

	Low Consequence	Moderate Consequence	High Consequence
Iron/Steel	Break-History Review, Soil Properties, Half -Cell Corrosion Potential	Corrosion Pit Measurement (Opportunistic & Direct Sampling)	Corrosion Pit Measurement (RFEC, Direct Sampling)
AC	Break-History Review, Soil Properties, Opportunistic Sampling (Calcium Hydroxide Leaching)	Opportunistic, Direct Sampling, & NDT	Direct Sampling, NDT
PVC/HDPE	Break History; Opportunistic Sampling	Opportunistic & Direct Sampling	Direct Sampling
PCCP	Not Applicable		Wire Break Detection (RFEC)



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Questions ??