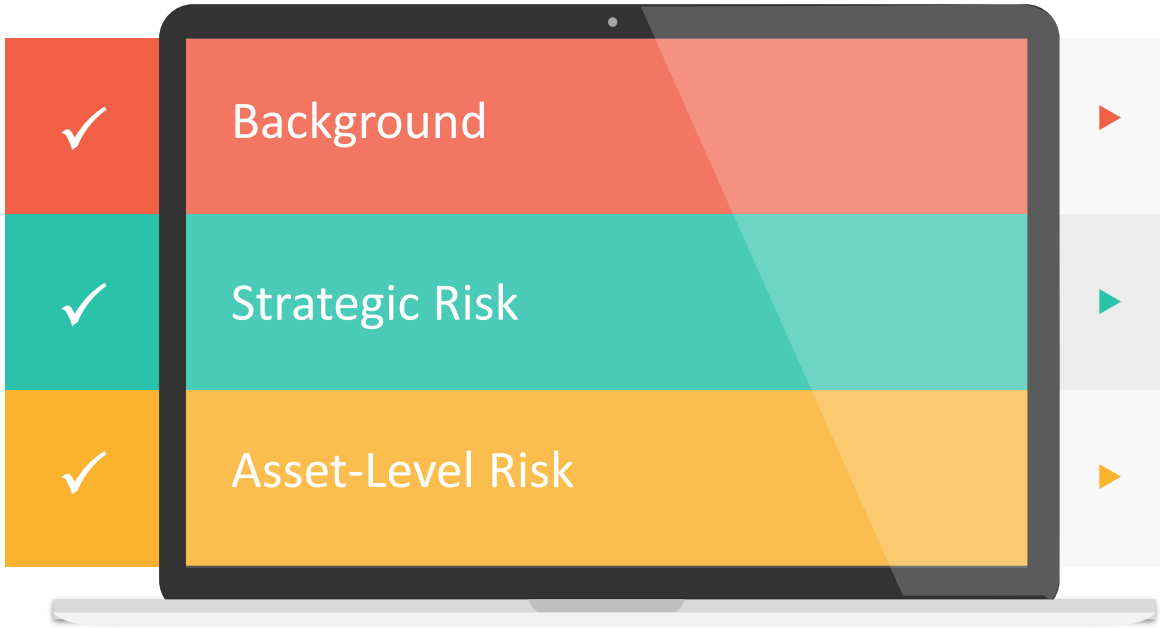
INFRASTRUCTURE CRITICALITY AND RISK

City of Burnaby

PRESENTATION OUTLINE



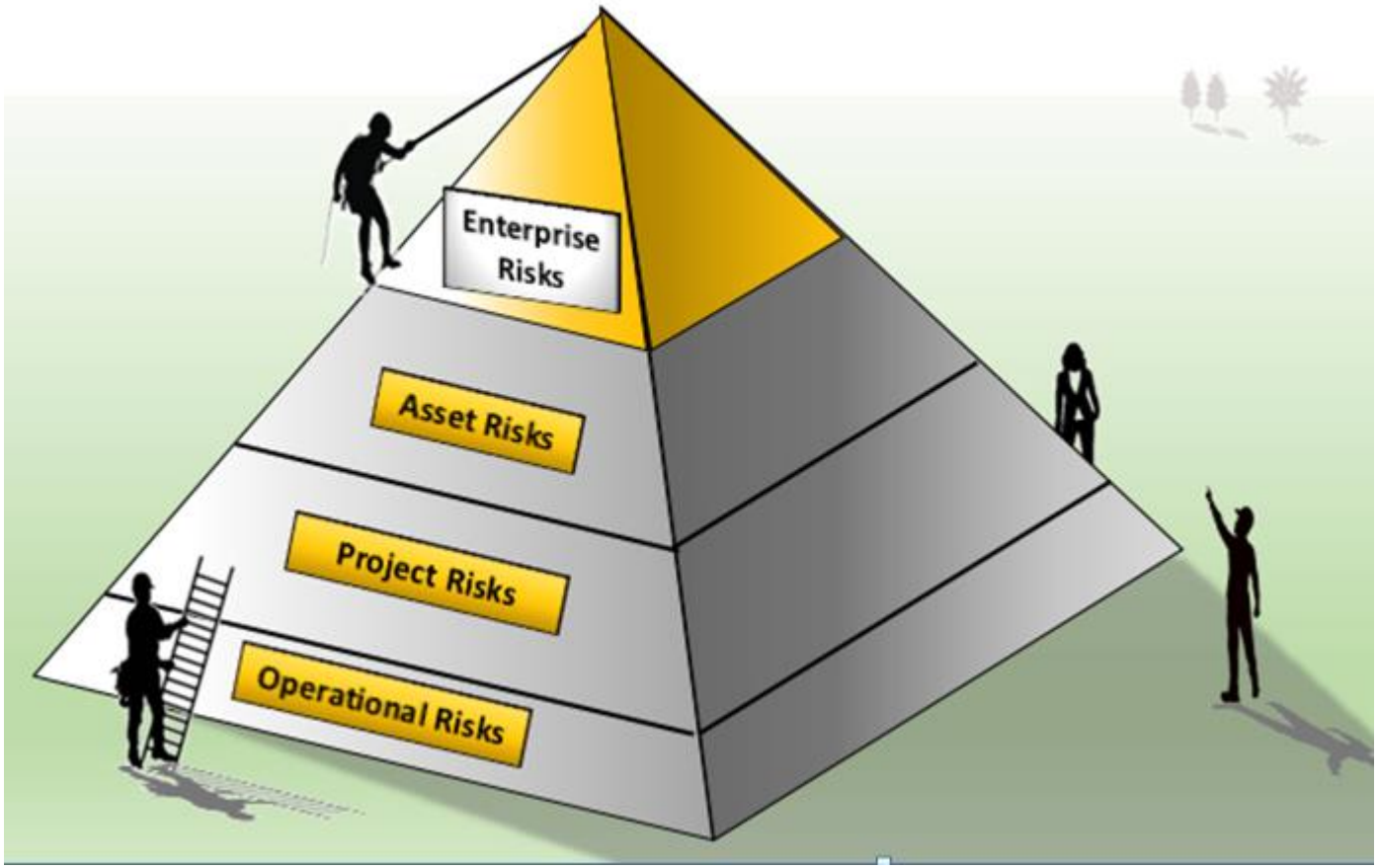
- ✓ Background
- ✓ Strategic Risk
- ✓ Asset-Level Risk

- ▶ Understanding Risk
- ▶ Burnaby's first steps
- ▶ Detailed GIS risk model

BACKGROUND

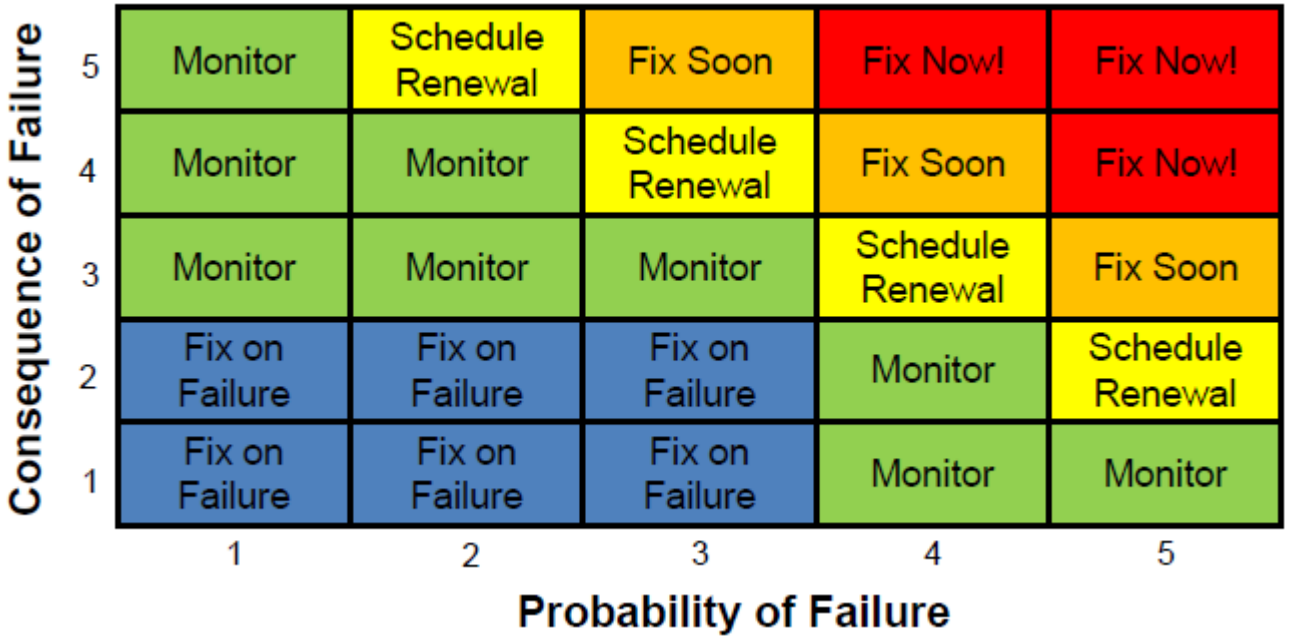
- Understanding Risk
- Calculating Risk

IDENTIFYING RISK



CALCULATING RISK

- **Risk** = Consequence of Failure x Probability of Failure



PROBABILITY OF FAILURE

CLASSIFICATION	EQUIVALENT TO
Very Low	Conceivable but highly unlikely to occur within the specified time horizon
Low	Possible but unlikely to occur within the specified time horizon
Moderate	There is a 50/50 chance that this will occur within the specified time horizon
High	Probable that this will occur within the specified time horizon
Very High	Almost certain that this will occur within the specified time horizon

CONSEQUENCE OF FAILURE

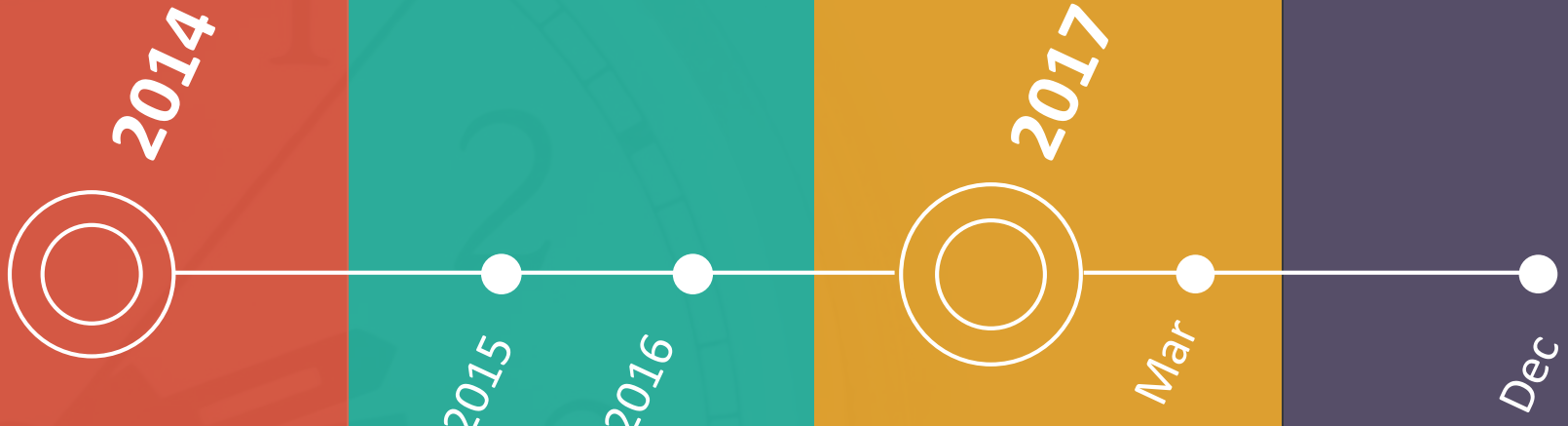
CONSIDERATIONS
Financial
Operational
Social
Environmental
Health & Safety
Compliance

CONSEQUENCE OF FAILURE

Delivery of service	Minor deficiency in service typically affecting < 20% of total yearly customers	Minor deficiency in service typically affecting 20-50% of total yearly customers Or moderate deficiency affecting < 10%	Moderate deficiency affecting <30% of total yearly customers or minor deficiency affecting >50%	Moderate deficiency affecting 30-50% of total yearly customers or major deficiency affecting < 10%	Major deficiency in service affecting >10% of total yearly customers or moderate deficiency affecting > 50%
Health and Safety	Minor injuries	Reportable injury for public or employee	Major injury to public or employee requiring hospitalization	Fatality or long term health issue for public or employee	Multiple fatalities or long term health issues for public or employees
Reputational	Adverse Internal communications only - within own BU	Adverse corporate communications. Short term local media interest	Sustained local media reports. Adverse contact from Regulators, Aldermen etc. but manageable	Negative reports on national media. Significant adverse contact from Regulators, Aldermen	Protracted adverse local and national media coverage. Sustained criticism of organization by regulators and politicians.
Financial	< $250k	$250k-$1m	$1m - $3m	$3m-$10m	> $10m
Environment / Social	Managed incident – no public effects	Localized and short term effects on local ecosystem / amenity value / commerce	Widespread but short term effects on local ecosystem / amenity value / commerce	Widespread and long term effects on local ecosystem/ amenity value/ commerce. Likely to lead to prosecution and fines.	Widespread and persistent effects requiring specialist and extensive long term clean up and/or rehabilitation plan

STRATEGIC RISK

BURNABY'S JOURNEY



AM Policy

'Risk-based' perspective

AM Plans

- Sewer
- Water

Risk – Phase 1

Criticality
(Consequence of Failure)

AM Plans

- Roads

Risk – Phase 2

Condition
(Probability of Failure)

STRATEGIC RISK

1. Failure Events

2. Probability & Consequence

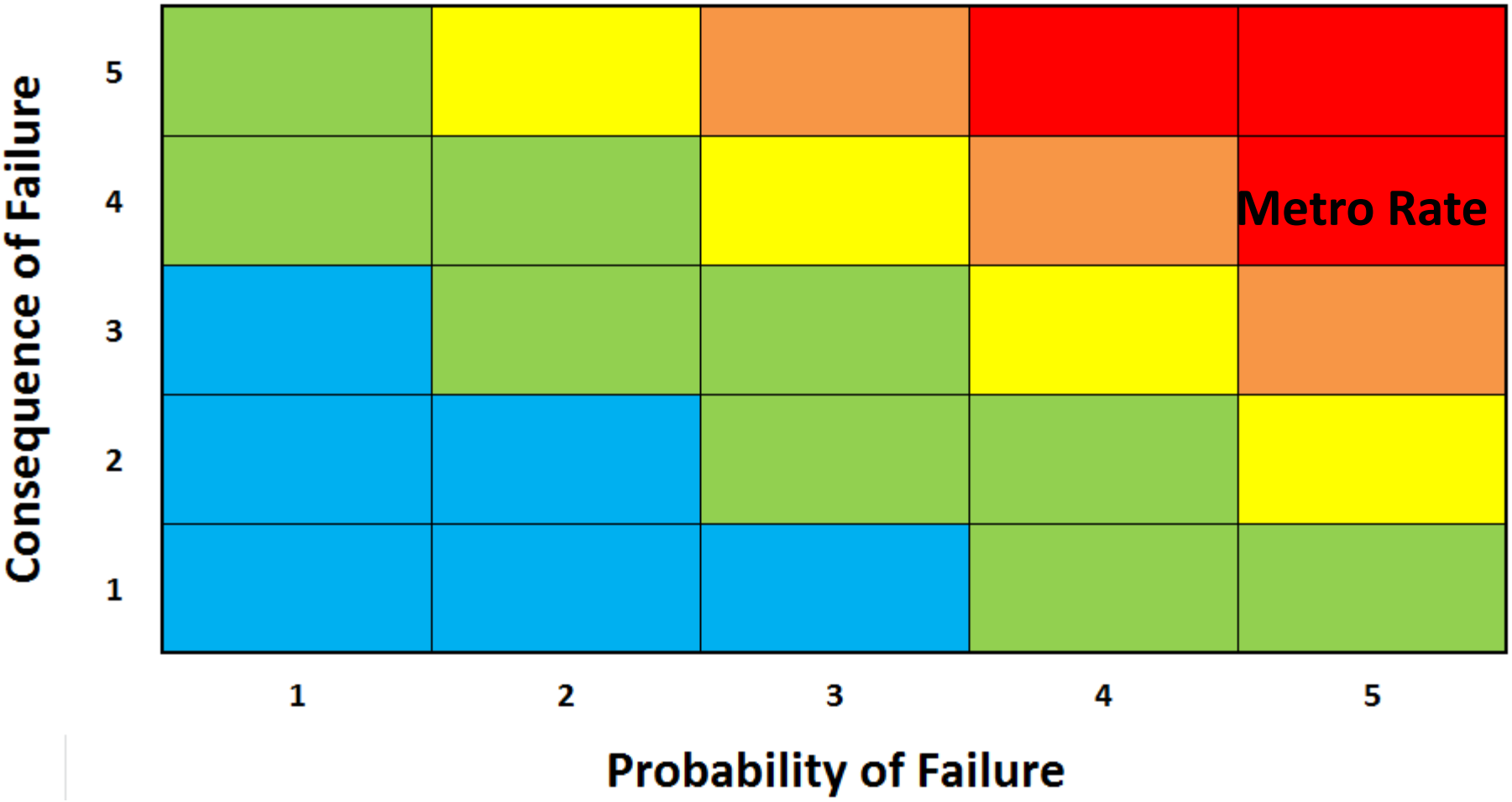
3. Mitigation

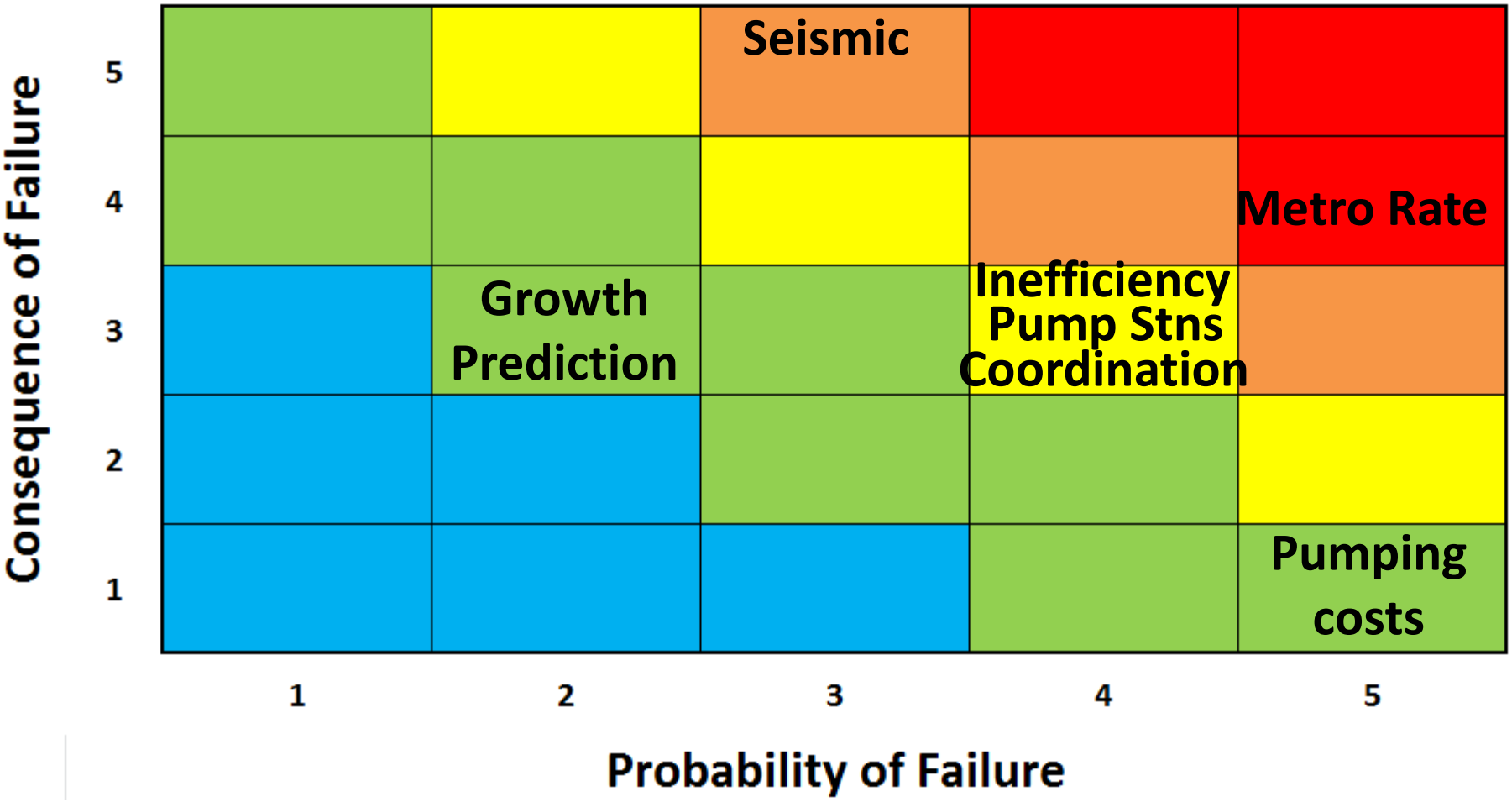
Number	Failure or Adverse Event	Causal Chain	LH 5 YRS	CONS	RISK 5 YRS	Comments	Existing Mitigations	Potential Mitigations
1	Reduction in available budget from rate increases	Due to Metro Van treatment charges eating into availabl budgets	5:VH	4:H	70	Would expect to be >$1m per year impact on budget. Would be a significant consquence in the short term that could lessen over time due to law back via rate increase. Currently have not considered opting out.	Sewer reserve ~ $60M	Improved Metro Vancouver rate forecasting
2	Severe and/or widespread damage to critical sewer assets	Due to serious seismic event	3:M	5:VH	40	Christchurch, NZ approx same size as Burnaby. Consquence on sewer was hundreds of millions. Took long time to recover.		
3	Significant decrease in service performance	Due to underinvestment in rehab/replacement of assets Due to projected spike in funding needs due to aging infrastructure and cohort of assets all at similar age	4:H	3:M	28		Long-term capital plan Sewer reserve ~$60M	
4	Significant decrease in service performance from pump stations	Due to insufficient operational staff resourcing due to limitations on operational funding (excerbated by aging asset base)	4:H	3:M	28	Not perceived to be a true funding limitations but political policies drive funding allloction and there is a general reluctance to take new permanent staff. Spend $1m of capex through operations but could be done outwith ops to save resources. Would become more of an issue if regulation requirements change. New staff work ethic is not as good as older staff so problem is getting worse.	Improved job descriptions, training, and coverage	
5	Disjoint between Burnaby and Metro Capital Investment programs	Due to differening priorities which don't align with Burnaby priorities	4:H	3:M	28	Could cause increasing number of spills and reputational damage for Burnaby. No consequences for Metro Van. Particular concern around Brentwood area. Metro Van not prohibiting development which doesn't help Burnaby.	Improved identification of issues with Metro Vancouver. Sharing flow data and consultant reports	Model various scenarios
6	Significant inefficiencies in operation of system	Due to loss of institutional knowledge due to staff leaving business without knowledge capture	5:VH	2:L	20	No succession planning. Personnel selection issues preventing upskilling of staff and recruitment. Recent improvements on bringing staff in early to improve handover.		
7	Cost implications of new I&I regulation	Due to regulation becoming mandatory rather than guidance	2:L	5:VH	20	Cost implications to comply. Have based consequences on potential fines if non-compliant - maybe $1m per year.	Currently considered guideline only.	Private lateral rehabilitation
8	Reputational damage associated with removal of trees for tree root problems	Due to new city wide tree bylaw has created expectation from public that city will follow same protocols	5:VH	2:L	20	May need to find new ways to avoid tree removal e.g root cutting instead of tree removal. May cause increased costs - scored based on financial $50k-$200k.		
9	Increased pumping power costs	Due to Hydro cost increases and no corresponding increase in operating budget	5:VH	1:VL	10	$100k per year total cost. Increases expected to be 10-15%. Must pay hydro costs so money must come from other opex spend categories.	Incremental increases necessary	

STRATEGIC RISK

- Example – Reduced budget available due to Metro Vancouver rate increases

Regulatory compliance	Not applicable				
Delivery of service	Not applicable				
Health and Safety	Not applicable				
Reputational	Internal dept Mgmt attention	Internal dept Senior mgmt attention	Local media Council attention	National media Significant Council attention	Sustained national attention Sustained Council criticism Protest/action groups
Financial	< $250k <$50k / year	$250k-$1m $50-200K / year	$1m - $3m $200-500K / year	$3m-$10m $500K – 1M / year	> $10m > $1M / year
Environment / Social	Not applicable				


Consequence of Failure
5
4
3
2
1
Metro Rate
1
2
3
4
5
Probability of Failure


Seismic
Metro Rate
Growth Prediction
Inefficiency Pump Stns Coordination
Pumping costs
Consequence of Failure
5
4
3
2
1
1
2
3
4
5
Probability of Failure

STRATEGIC RISK - BURNABY

SEWER
Rate increases due to Metro Vancouver
Damage due to seismic event
Pump station performance (staff, funding, and system age)
Capacity coordination with Metro Vancouver
Operational inefficiency (loss of institutional knowledge)

WATER
Operational inefficiency (loss of institutional knowledge)
Ability to implement residential metering
Rate increases due to Metro Vancouver
System capacity due to population growth
SCADA communication due to more tall buildings

ASSET-LEVEL RISK

- Criticality (Consequence of Failure)
- Condition (Probability of Failure)
- Risk

CRITICALITY




1. Categories

Roads, Water, Sewer, and Drainage

2. Framework

Factors, global and individual weighting

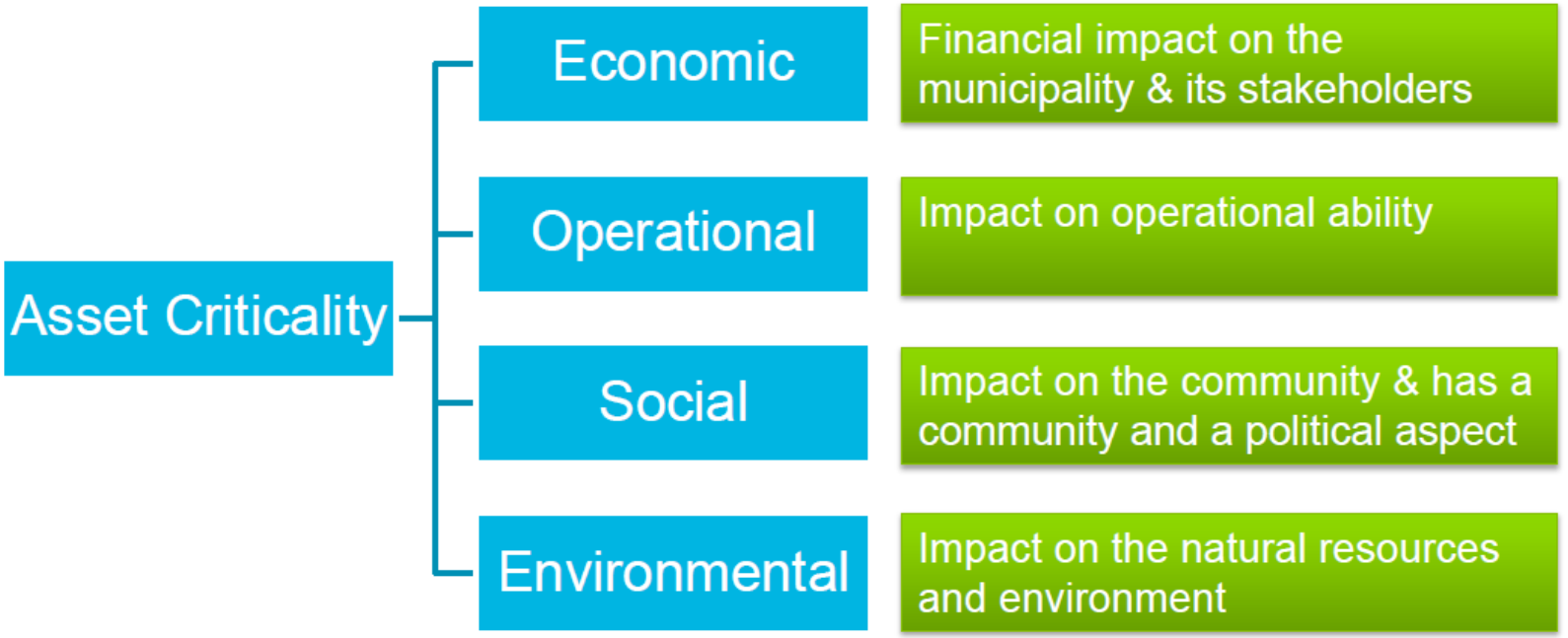
3. Data

Availability and gaps

4. Review/ Adjust

Train staff, future improvement plan, etc..

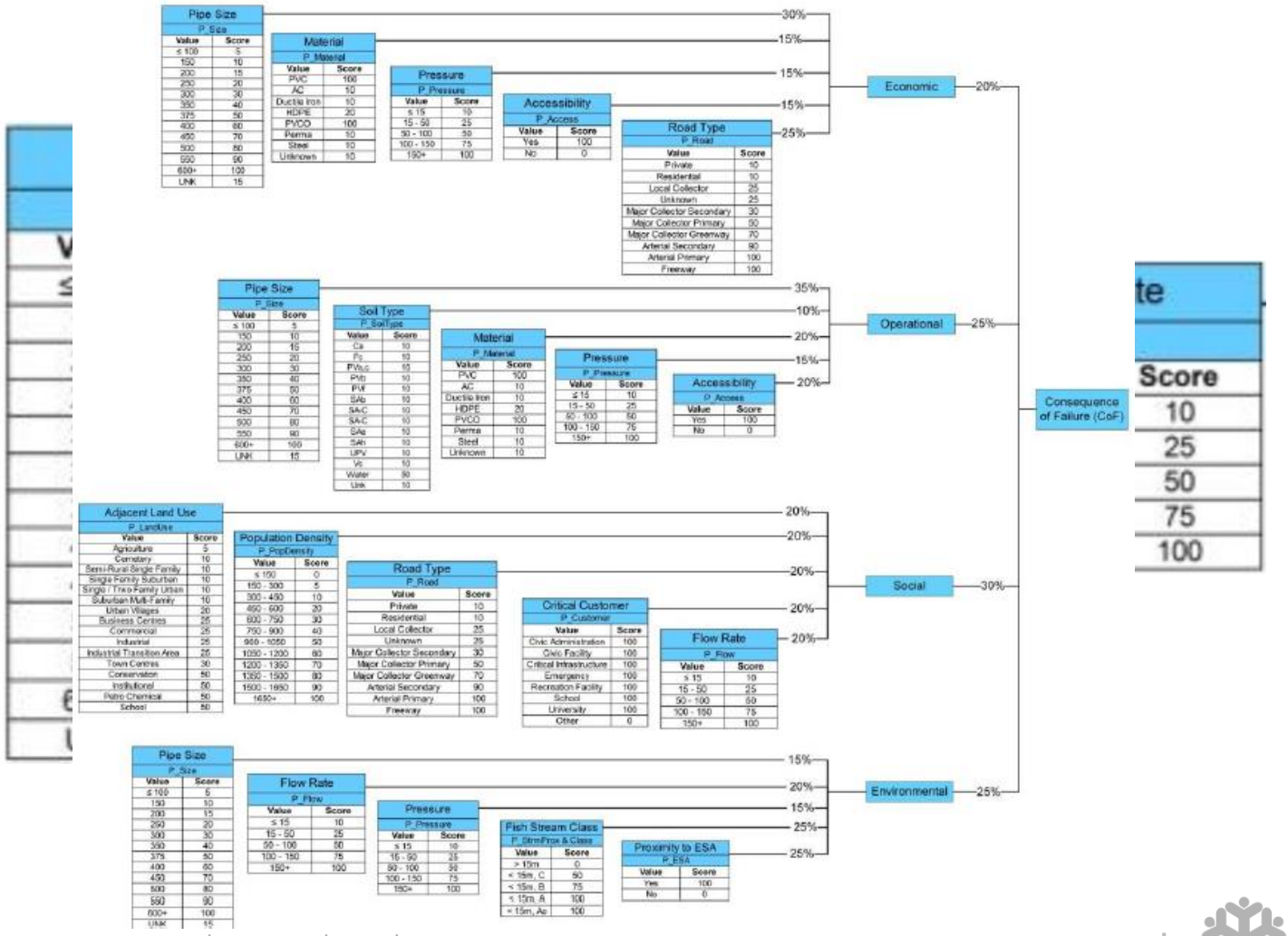
MODEL FRAMEWORK



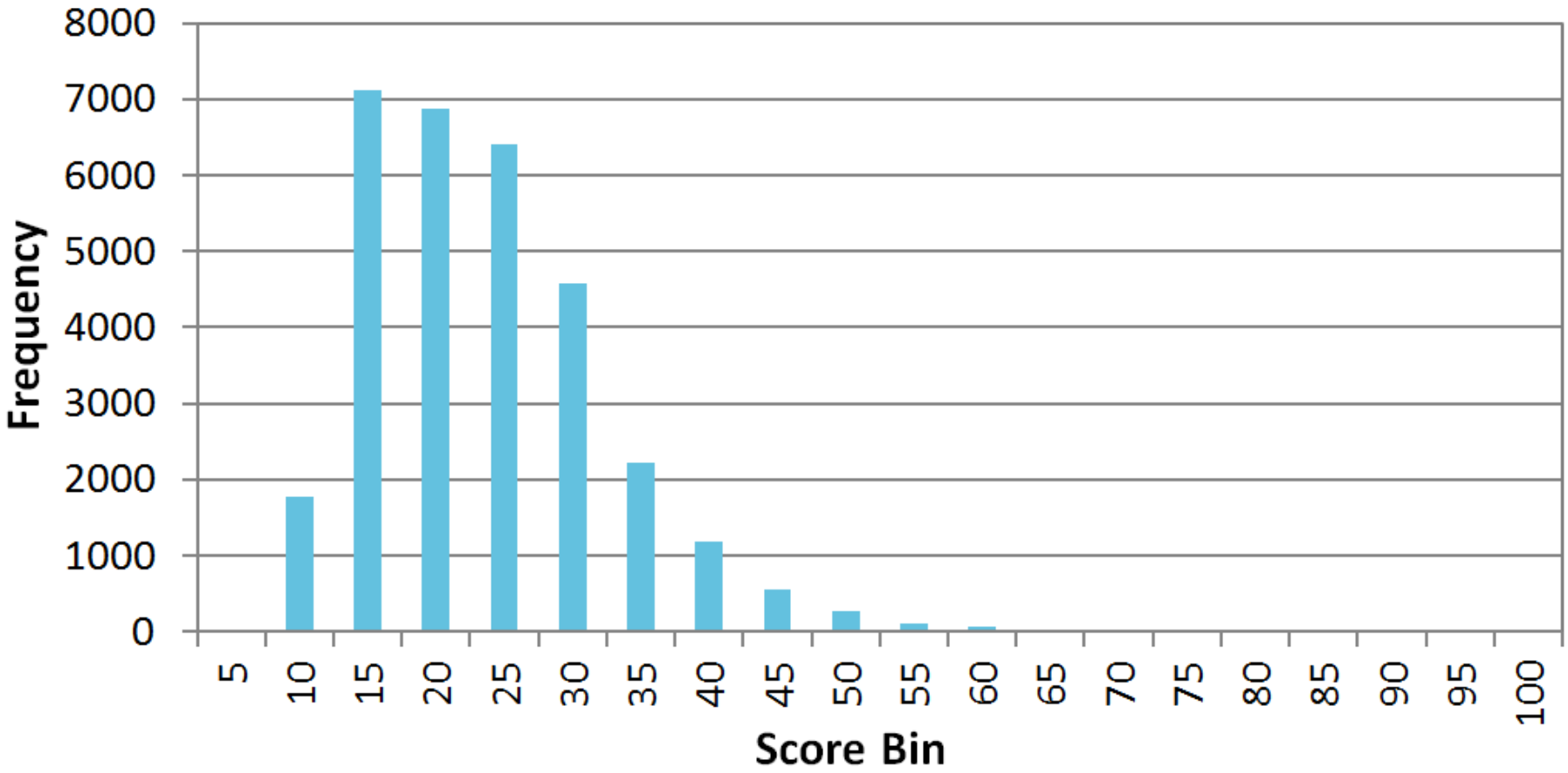
MODEL FRAMEWORK– WATER

Inputs	Economic	Operational	Social	Environmental	Combined
	20%	25%	30%	25%	100%

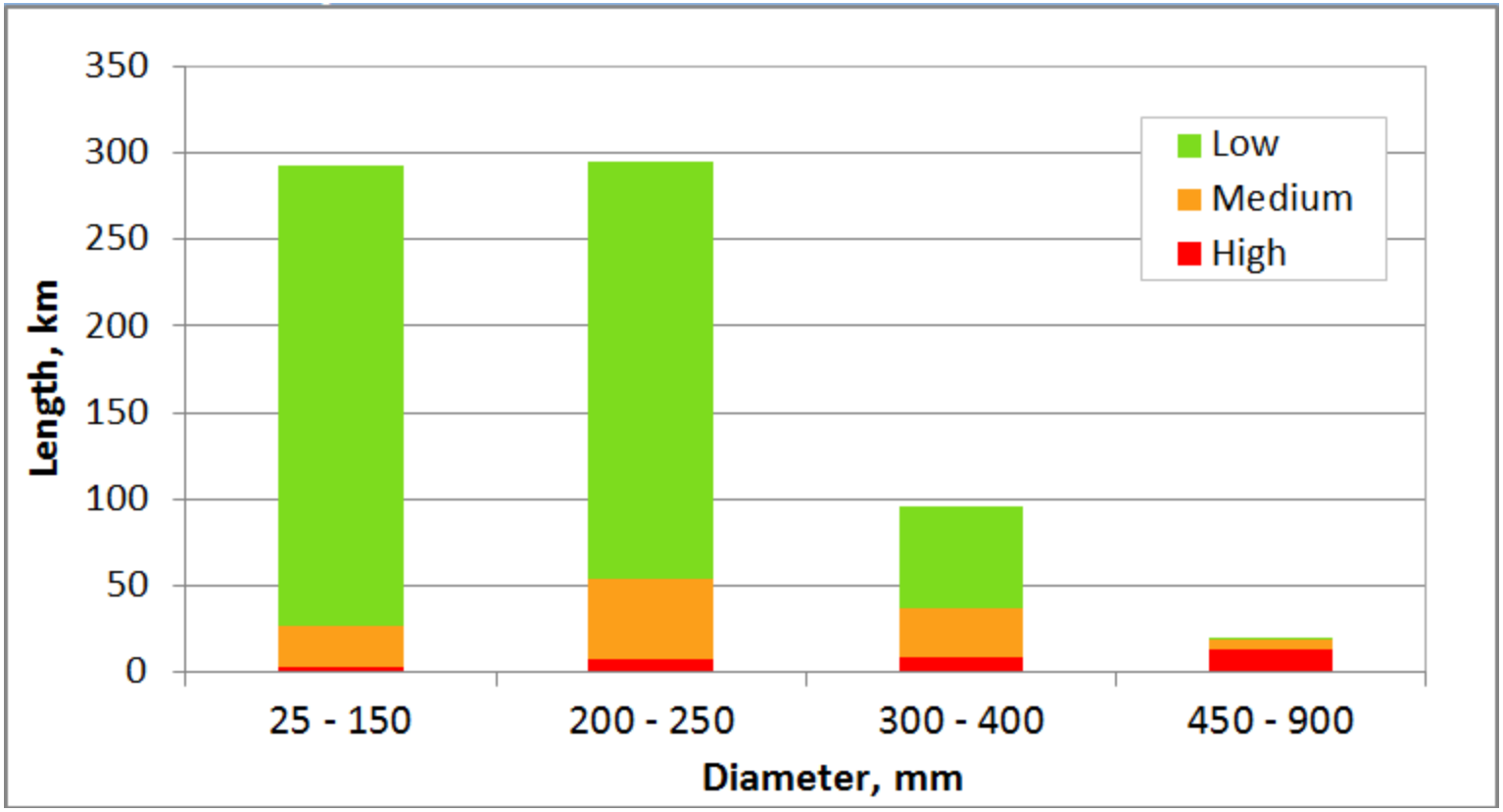
MODEL FRAMEWORK – WATER



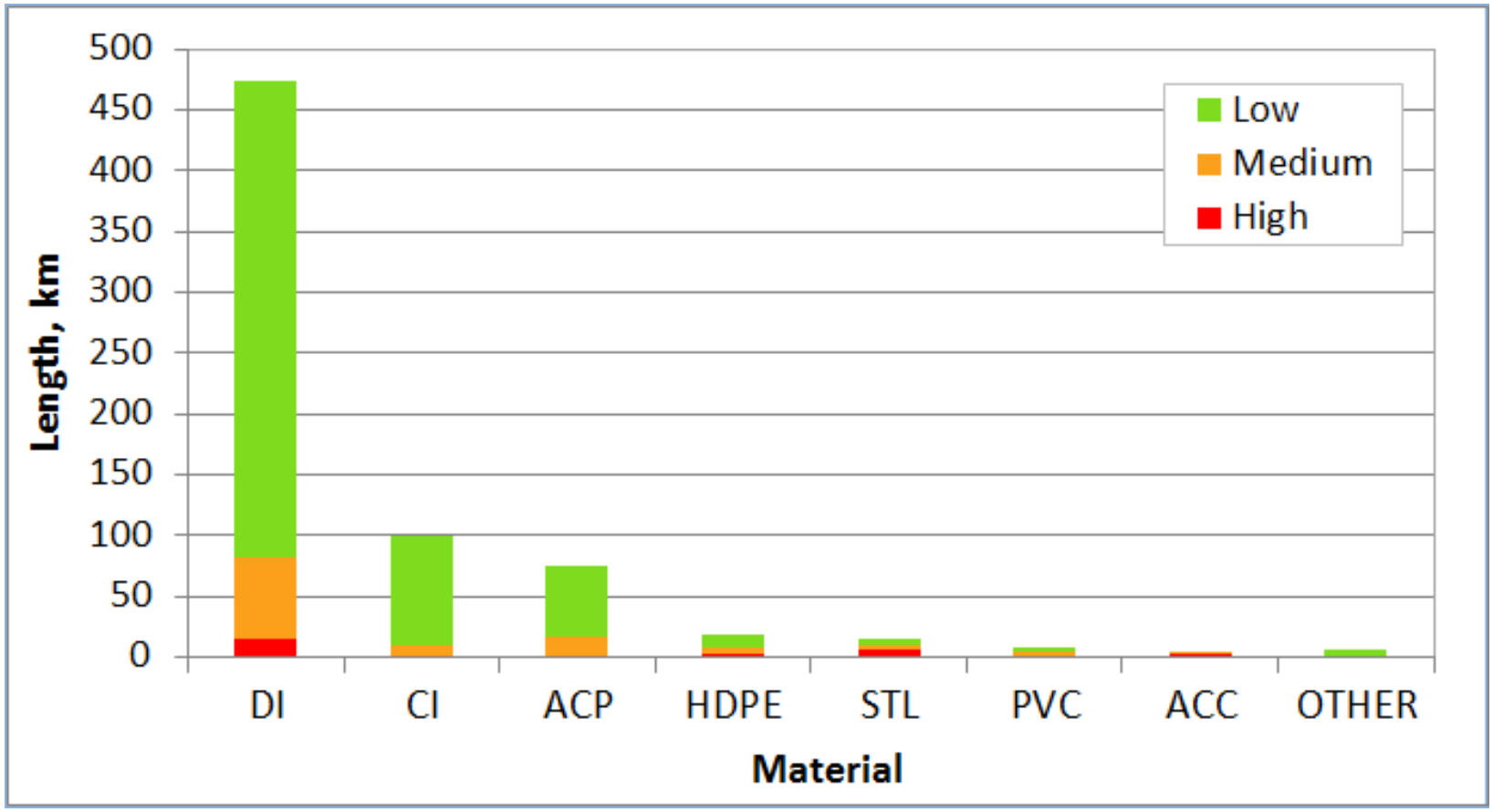
RESULTS - WATER



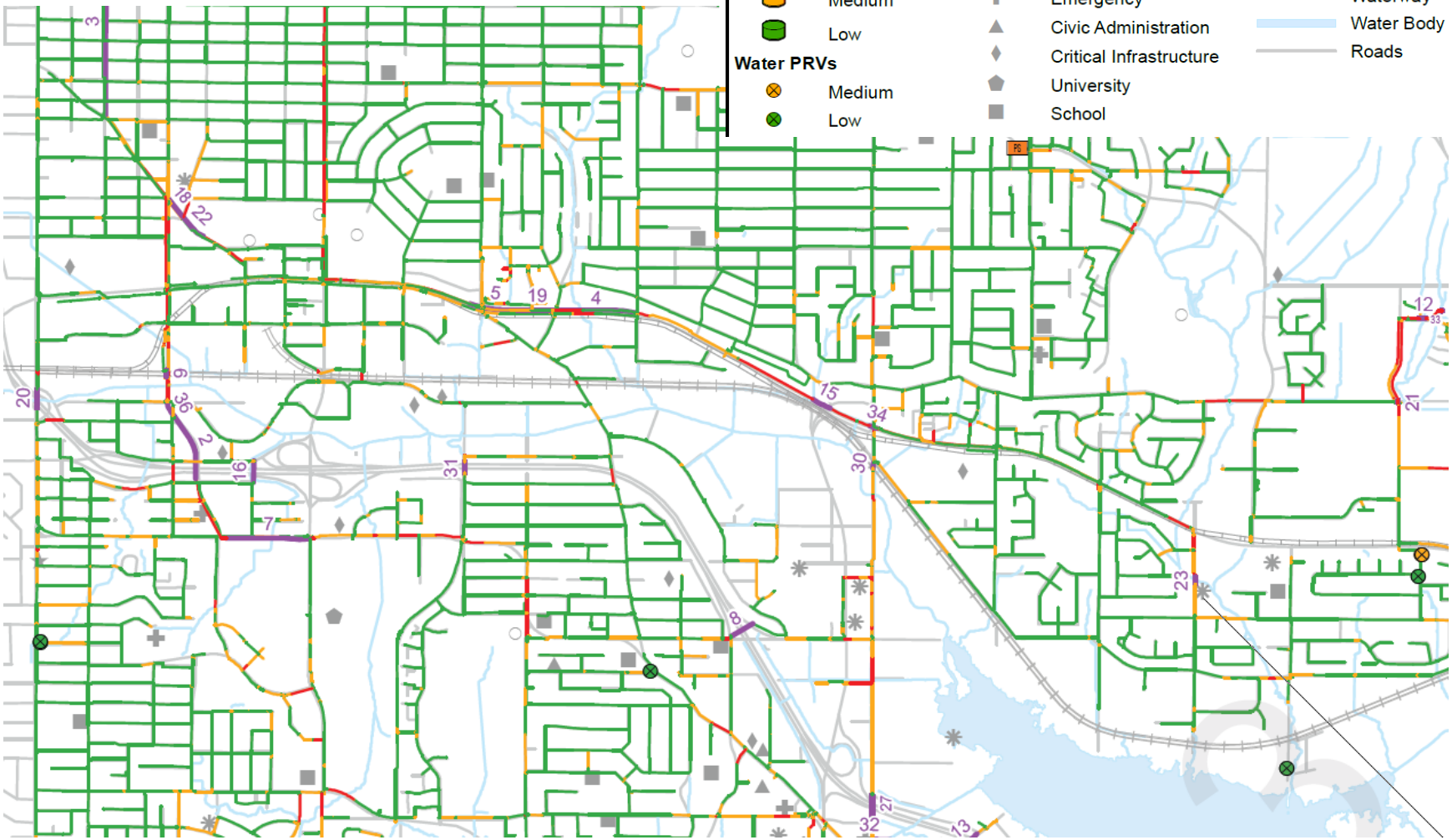
RESULTS - WATER



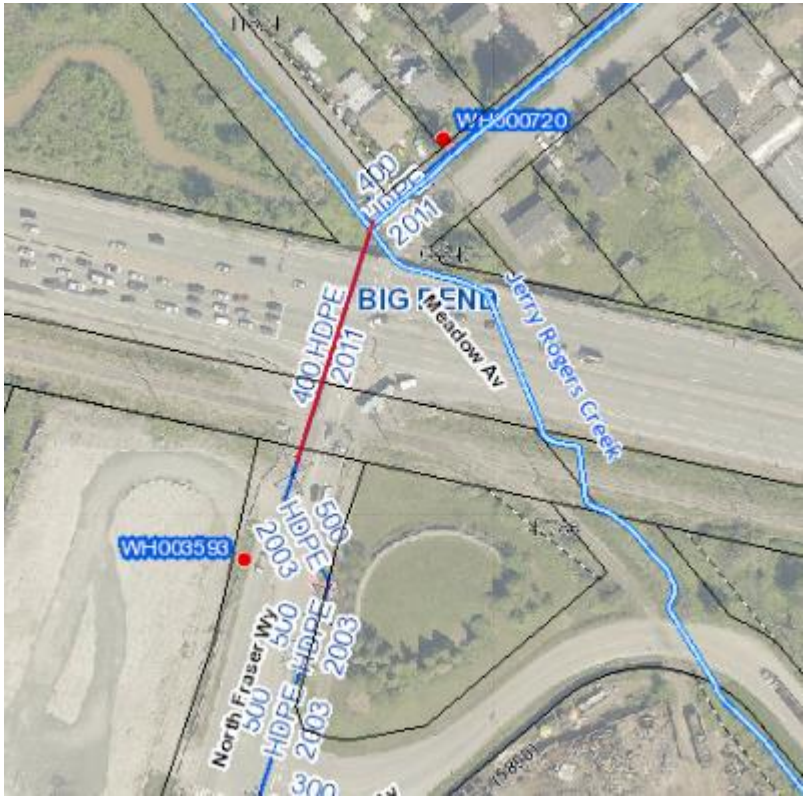
RESULTS - WATER



RESULTS - WATER



RESULTS - WATER



Highest consequence main (100)

- Crosses railway,
- Crosses arterial street
- Cross fish-bearing stream
- Large diameter

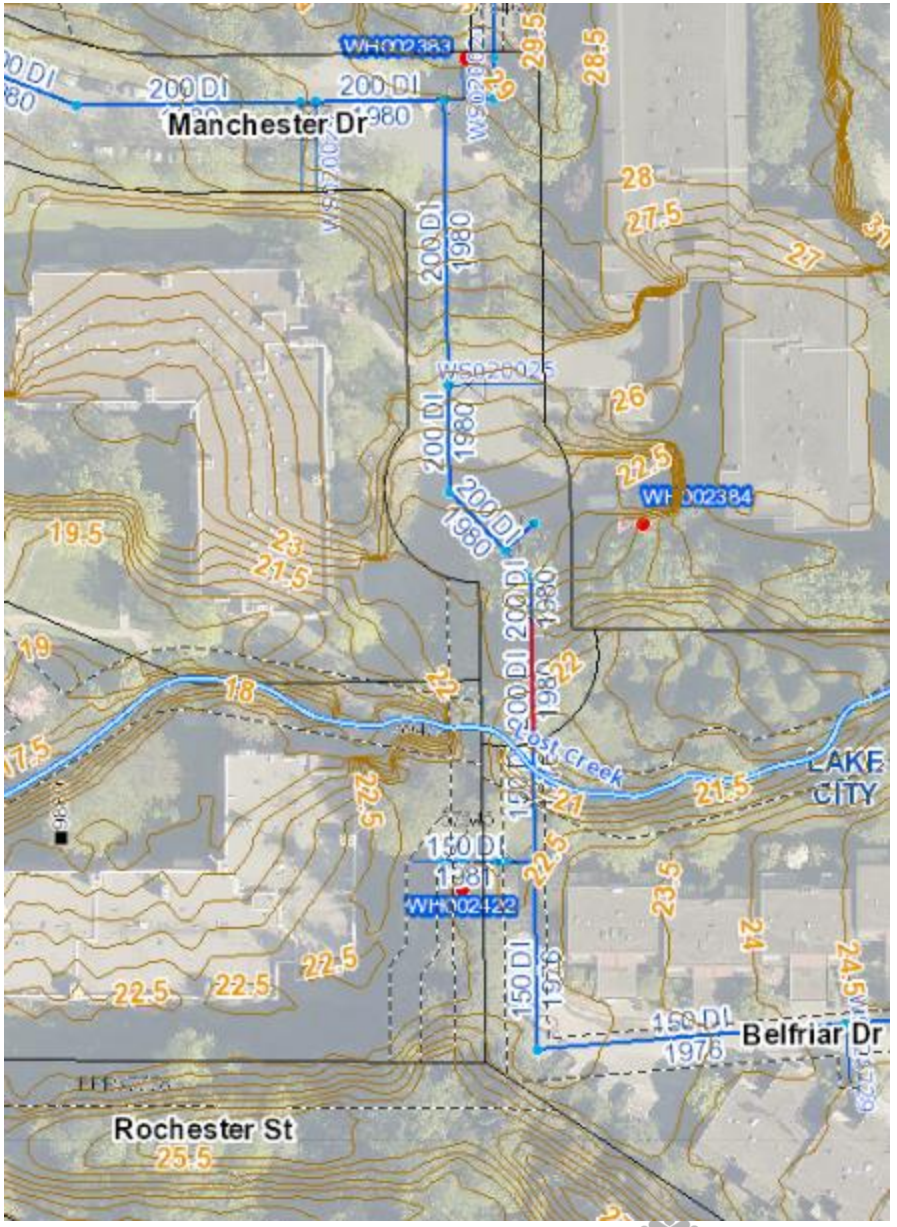
  (zone feed)

RESULTS - WATER

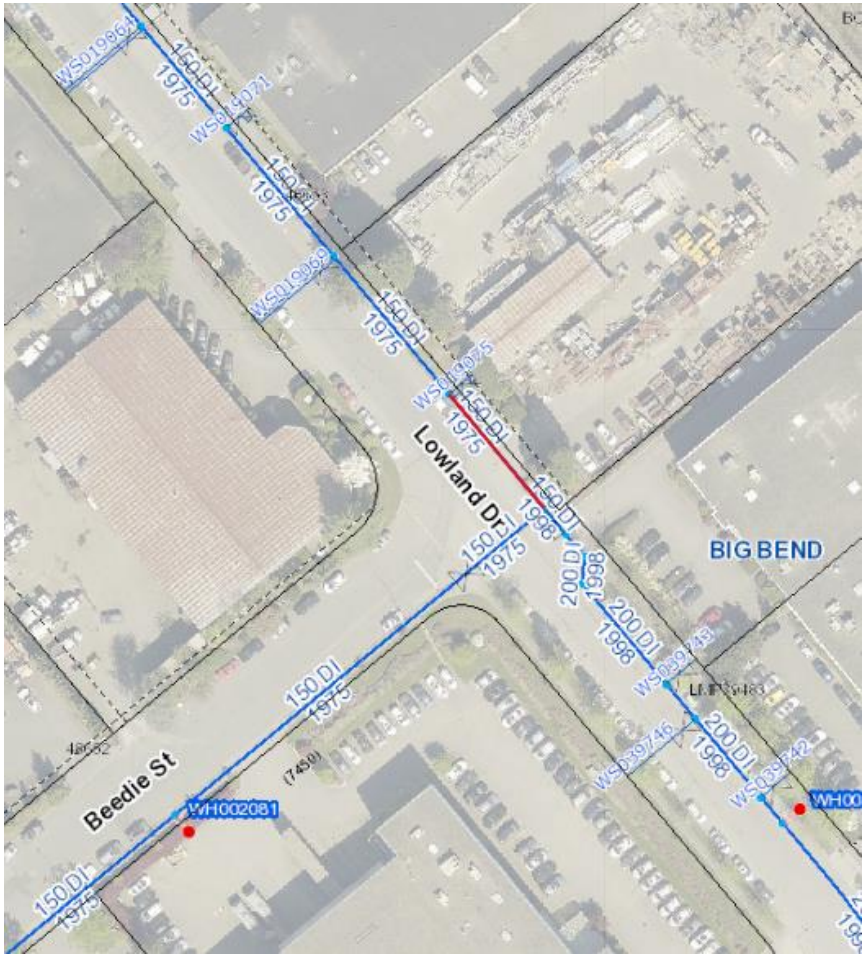
Medium consequence main (43)

- Pipe slope
- Pressure
- Proximity to creek
- High-density neighbourhood

(smaller diameter, local street)



RESULTS - WATER



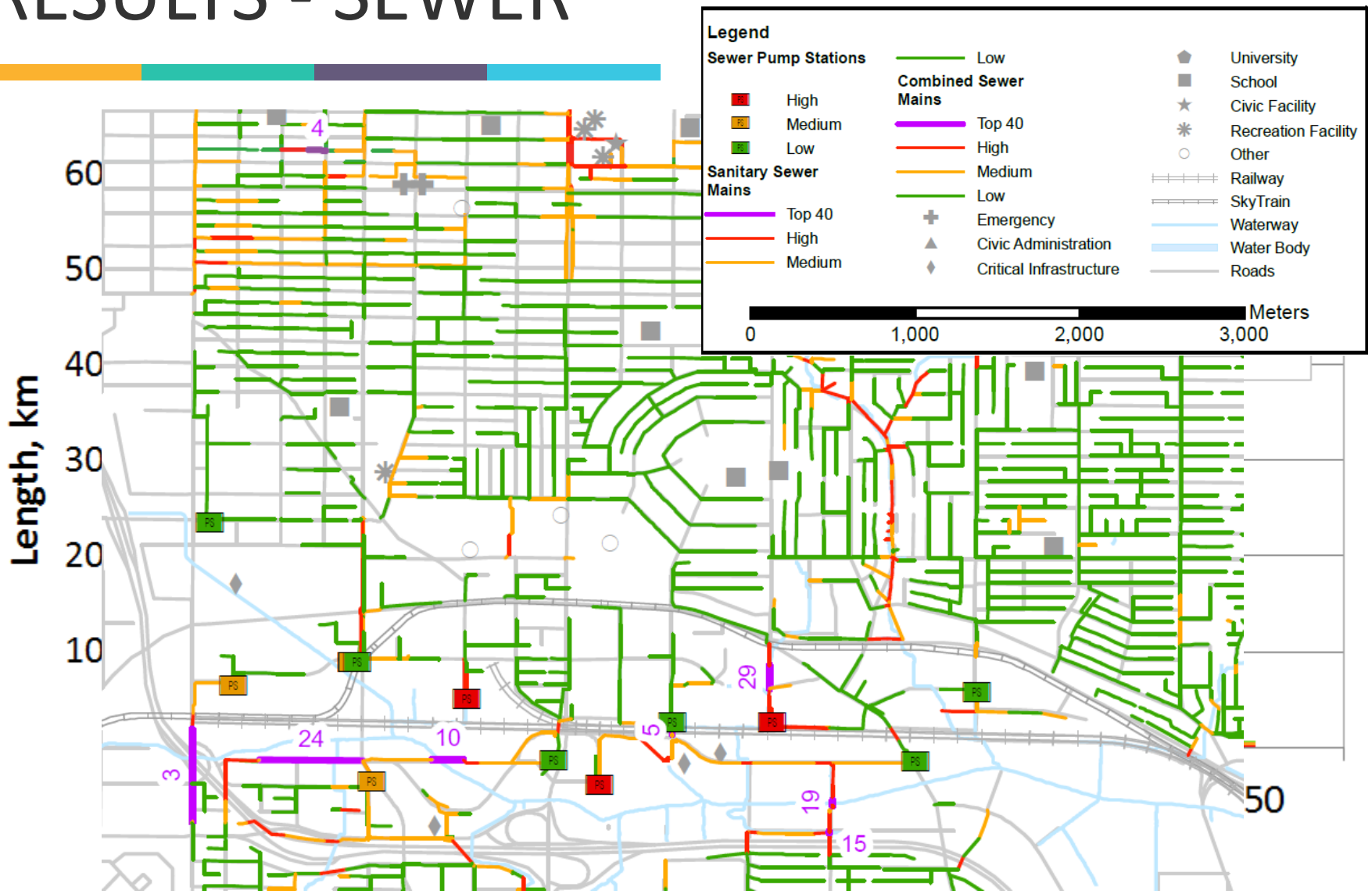
Low consequence main (11)

- Small diameter
- Low flow
- Flat street
- Local street

MODEL FRAMEWORK - SEWER

Inputs	Economic	Operational	Social	Environmental	Combined
	20%	25%	30%	25%	100%
Pipe Size	30.0%	30.0%			13.5%
Material	5.0%	10.0%			3.5%
Slope	10.0%			10.0%	4.5%
Pipe Type	10.0%	20.0%		20.0%	12.0%
Flow Rate			25.0%		7.5%
Depth	15.0%	10.0%			5.5%
Accessibility	15.0%	20.0%			8.0%
Fish Stream				35.0%	8.8%
Road Type	15.0%		20.0%		9.0%
Customer			20.0%		6.0%
Soil Type		10.0%			2.5%
Pop. Density			20.0%		6.0%
ESA Proximity				35.0%	8.8%
Land Use			15.0%		4.5%

RESULTS - SEWER



MODEL FRAMEWORK - DRAINAGE

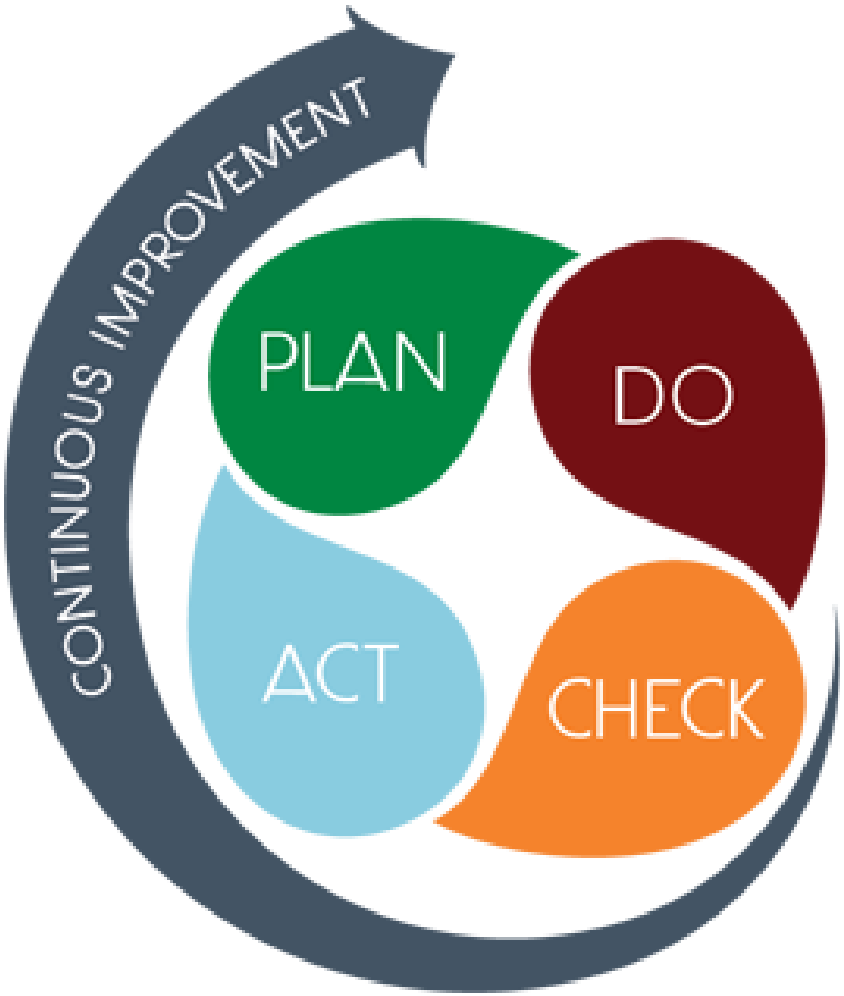
Inputs	Economic	Operational	Social	Environmental	Combined
	20%	**25%**	**30%**	**25%**	**100%**
Pipe Size	30.0%	30.0%		10.0%	16.0%
Material	5.0%	10.0%			3.5%
Pipe Type	10.0%	20.0%		20.0%	12.0%
Slope	10.0%			20.0%	7.0%
Depth	15.0%	10.0%			5.5%
Accessibility	15.0%	20.0%			8.0%
Fish Stream				25.0%	6.3%
ESA Proximity				25.0%	6.3%
Road Type	15.0%		25.0%		10.5%
Customer			25.0%		7.5%
Land Use			25.0%		7.5%
Soil Type		10.0%			2.5%
Pop. Density			25.0%		7.5%

MODEL FRAMEWORK - ROADS

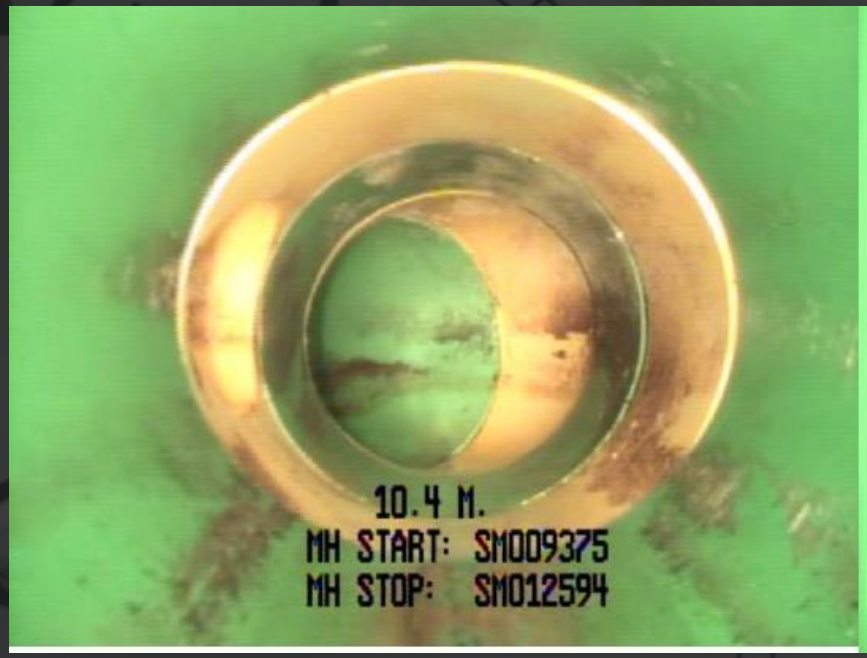
Inputs	Economic	Operational	Social	Environmental	Combined
	30%	30%	30%	10%	100%
Road Class	40.0%	50.0%			27.0%
AADT	40.0%		35.0%		22.5%
Truck Route				35.0%	3.5%
Bus Route			25.0%		7.5%
Accessibility		50.0%			15.0%
Fish Stream Class				35.0%	3.5%
ESA Proximity				30.0%	3.0%
Land Use	20.0%		20.0%		12.0%
Population Density			20.0%		6.0%

NEXT STEPS

1. Make results accessible
2. Apply results to capital & operational planning
3. Keep model up to date
4. Improve Criticality model
5. Add ‘Probability of Failure’
   Phase 2 → RISK



PROBABILITY OF FAILURE



1. Categories

Roads, Water, Sewer, and Drainage

2. Framework

Factors, global and individual weighting

3. Data

Availability and gaps

4. Review/ Adjust

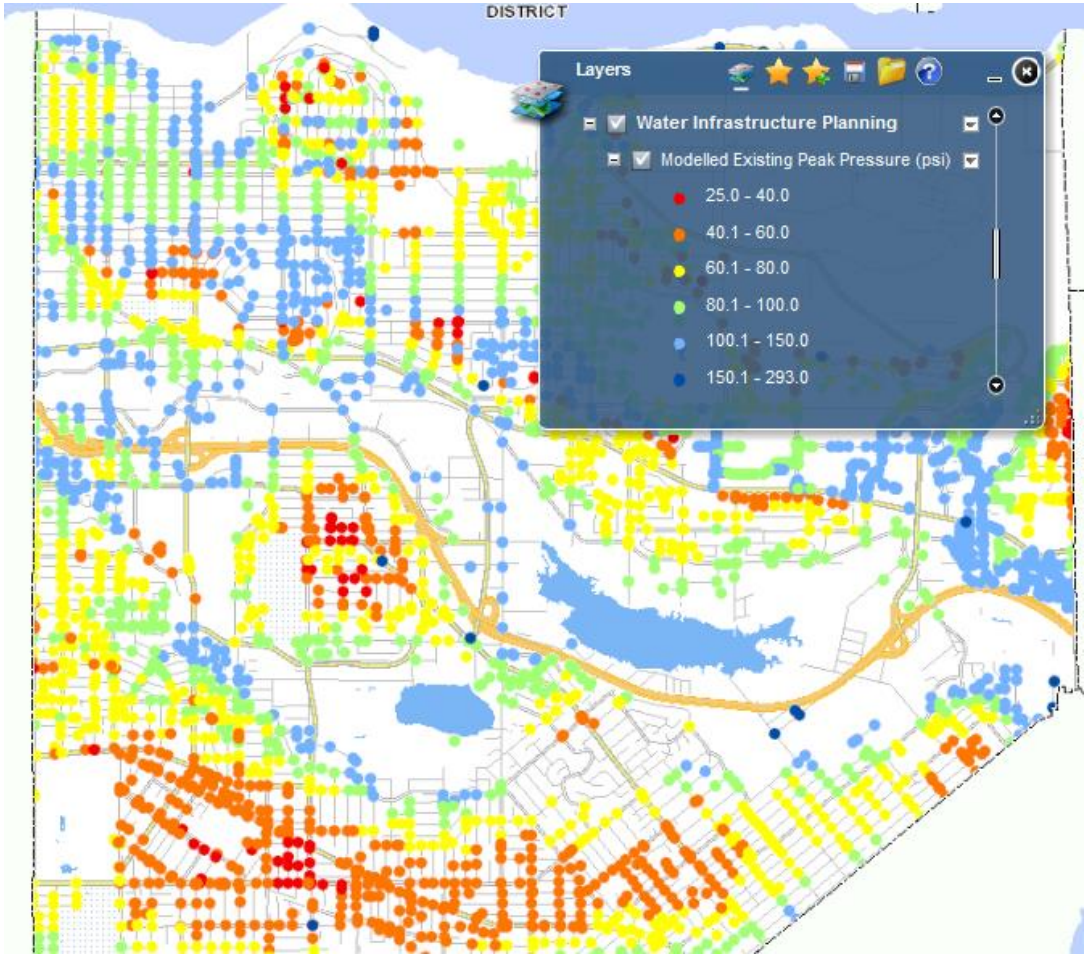
Train staff, future improvement plan, etc..

PROBABILITY OF FAILURE - DEFINITION

- Physical condition

PROBABILITY OF FAILURE - DEFINITION

- Demand condition



PROBABILITY OF FAILURE - FACTORS

WATER MAIN	Very Low	Low	Medium	High	Very High
Break count	0	0	1	2	3+
Material			AC		
Age*	0-30 years	30-60 years	60+ years		
Pressure					
Diameter		<= 150mm			
Fire Flow	>20% design	5 to 20% design	5 to -20% design	-20 to -50% design	>-50% design
Peak Hour Demand	60-140 psi	45-60 psi	35-45 psi >140 psi	20-45 psi	<20 psi

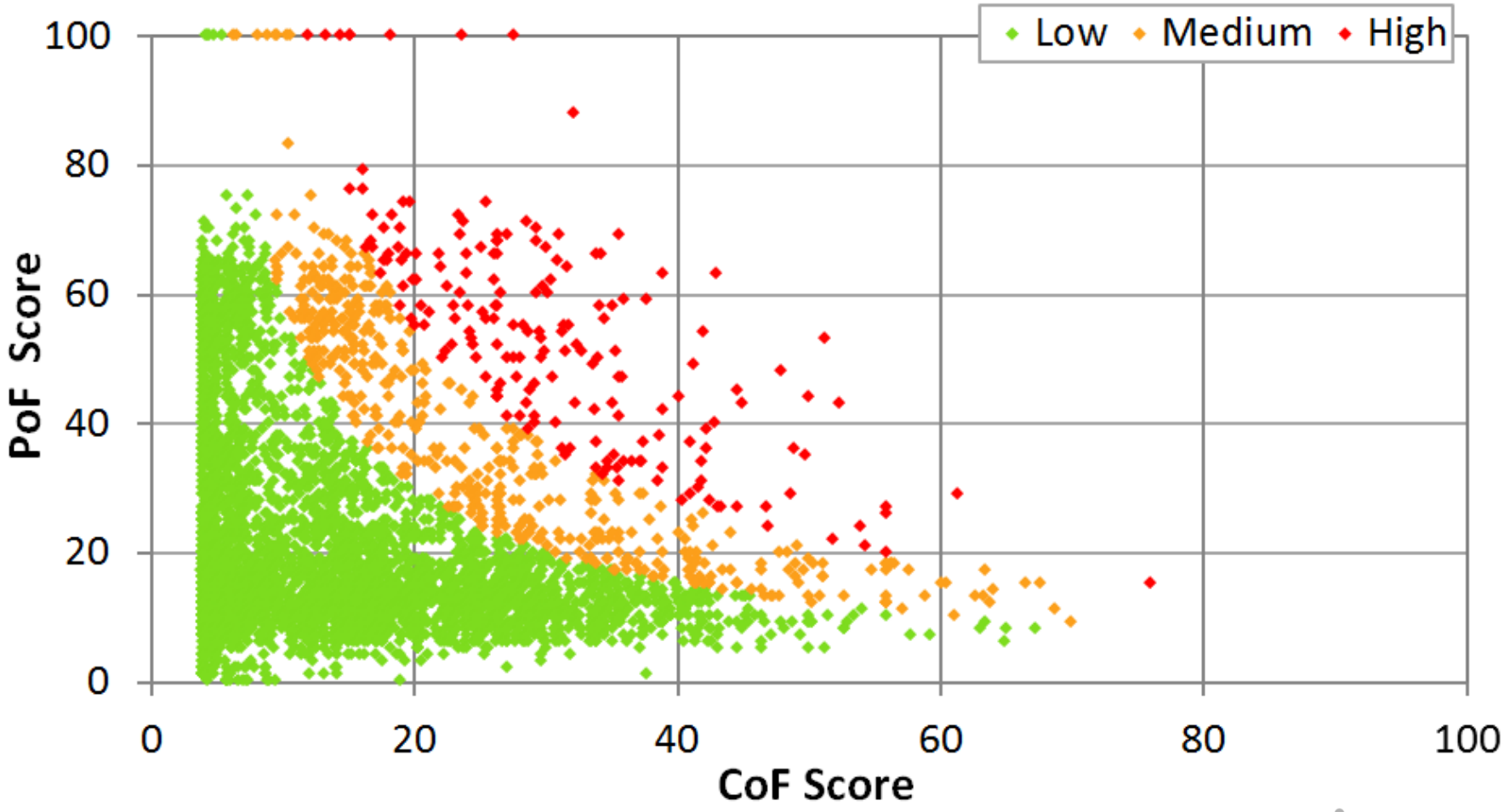
PROBABILITY OF FAILURE - FACTORS

ROADS	Very Low	Low	Medium	High	Very High
PQI	85-100	75-85	55-75	25-55	0-25
v/C**					

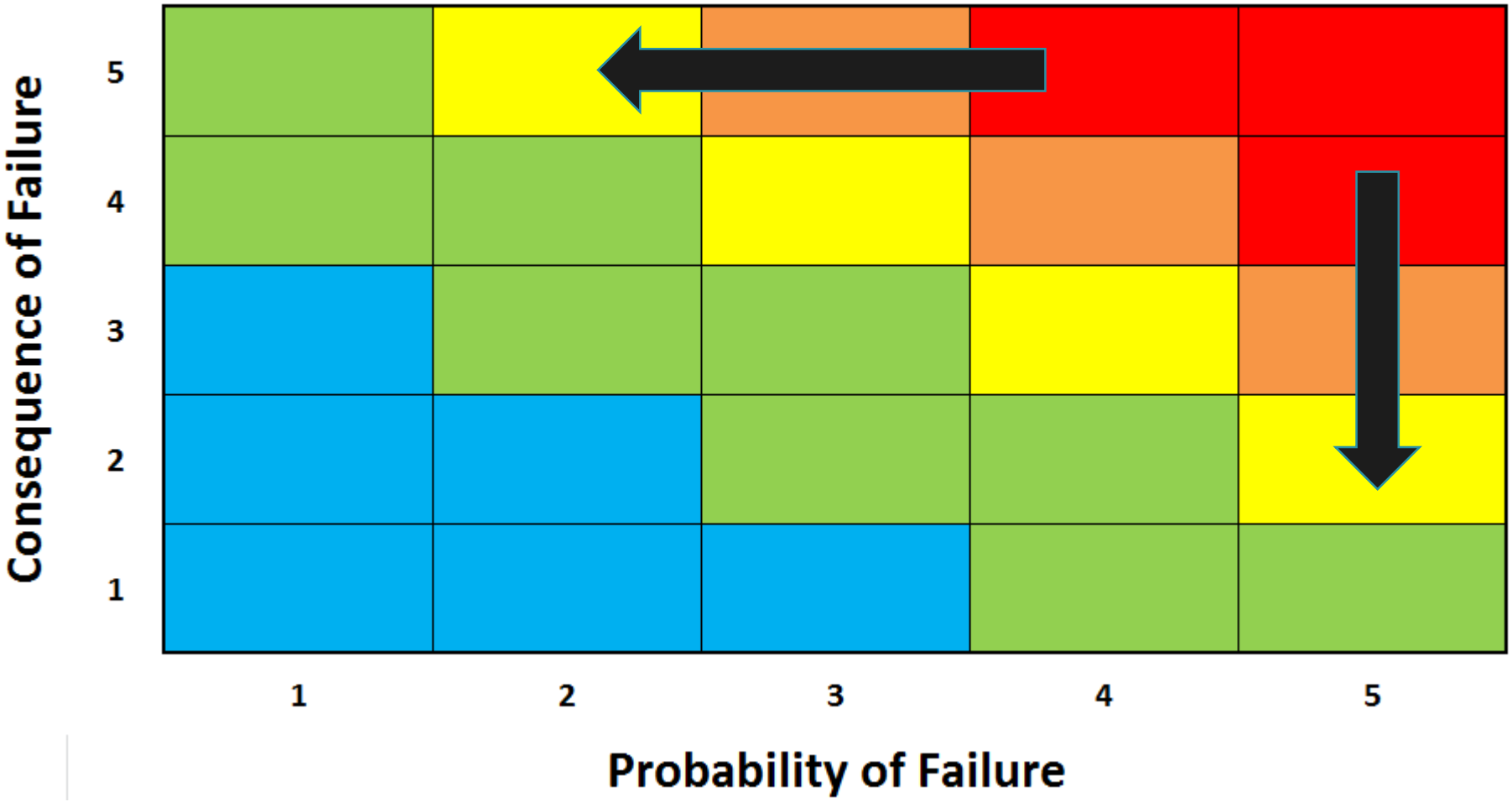
SAN MAINS	Very Low	Low	Medium	High	Very High
WRC/PACP	0-1	2	3	4	5
Age*	0-30 years	30-60 years	60-90 years	90+ years	
d/D ratio	<= 50%	50-70%	70-90%	90-100%	>100%

RESULTS

- Roads – Risk Scatter Plot



RISK MITIGATION




QUESTIONS?