

Risk-based Approach to Prioritizing Stormwater Pond Needs

AMBC Conference

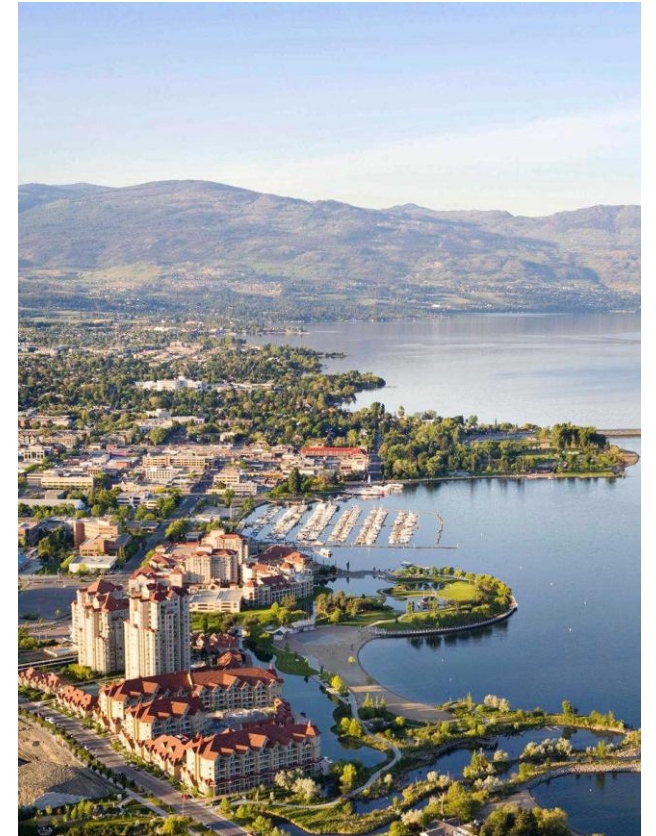
November 6, 2025

Presented by: Jim Hager, City of Kelowna & Nancy Hill, AECOM



Agenda

1. City of Kelowna's stormwater challenges
2. Developing a risk-based approach
3. Prioritizing & inspecting ponds
4. Bylaw review
5. Quantification of required resources
6. Funding needs
7. Lessons Learned



City of Kelowna's AM Framework

- The City has adopted the AMBC Framework for sustainable service delivery (in principle)
- Study included aspects of:
 - PEOPLE
 - ASSETS
 - FINANCES
 - INFORMATION
- Focused on engineered assets, with a blurry line between natural assets.



Kelowna: Geography and climate

Geography:

- Situated in the heart of the Okanagan Valley, surrounded by mountains, lakes and vineyards. Characterized by a string of lakes created by glaciation, including Okanagan Lake.

Climate classification:

- Cold semi-arid climate – in the valley
- Humid continental climate – in the hills



Location	Precipitation (mm)	Rainfall (mm)	1-hr, 100-yr (mm/hr) *
Kelowna, BC	387	311	29
Richmond, BC	1262	1228	27
Calgary, AB	419	327	49
Waterloo, ON	917	777	88
Region of Peel, ON	786	682	60

* From IDF CC Tool, historical data

Kelowna: Population and growth

KELOWNA'S POPULATION IS GROWING FAST AND IT'S GETTING YOUNGER.

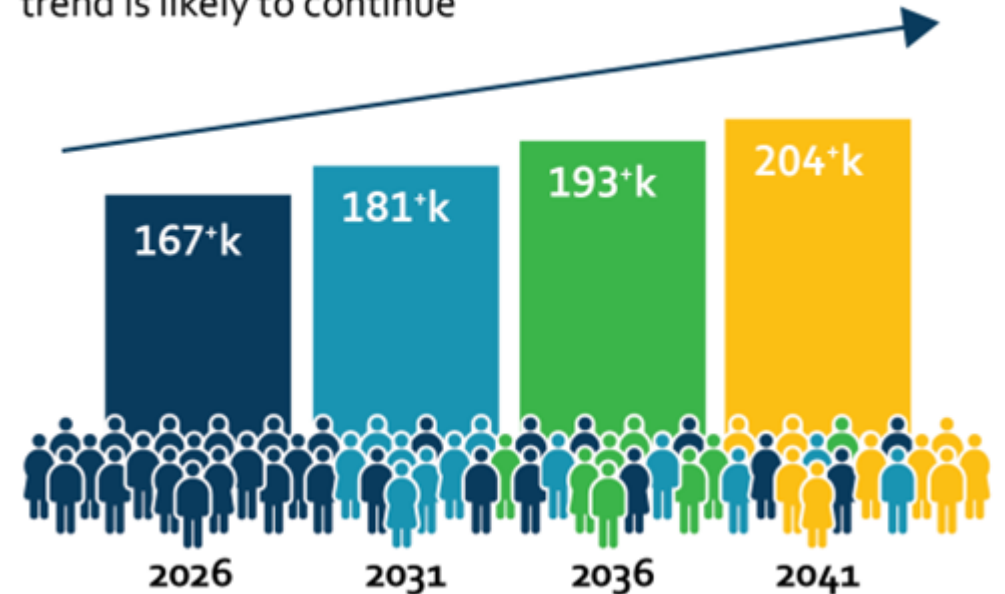
Population: ~150,000

Growth rate continues to exceed regional, provincial and federal rates

...

Some predicting a population decline in coming years.

Kelowna's population has **grown faster** than expected, placing further pressure on housing affordability; this trend is likely to continue



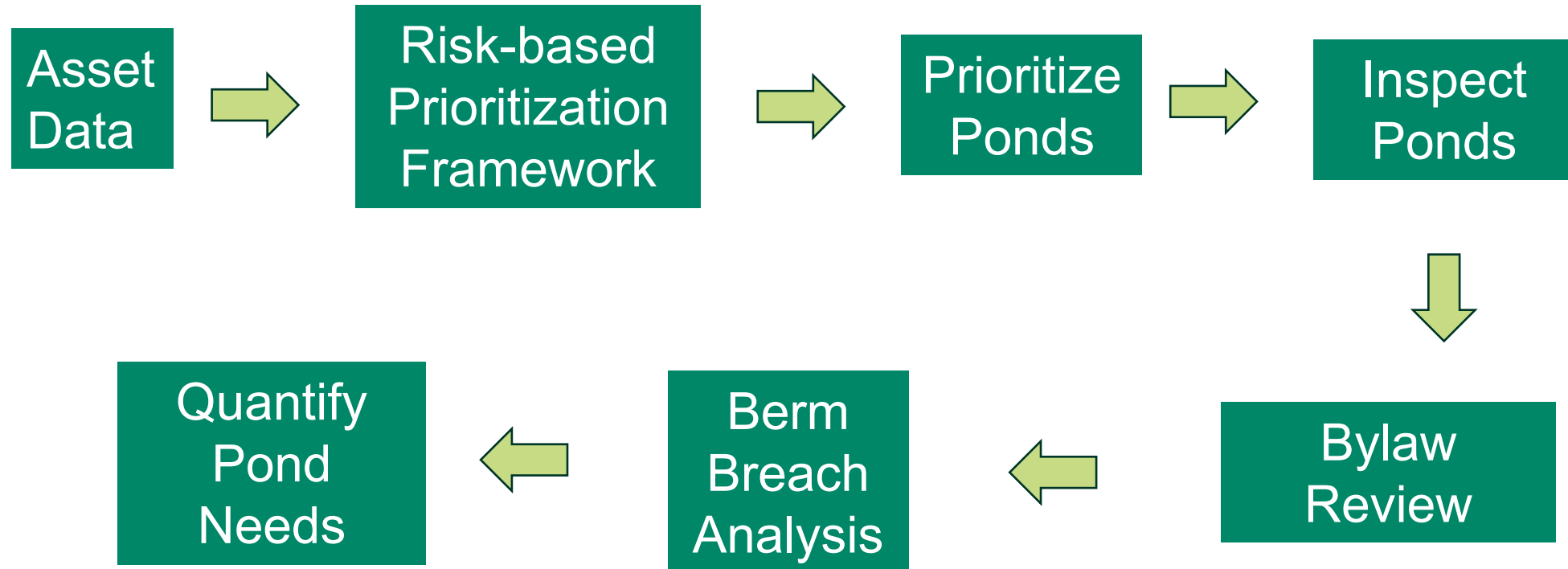
City of Kelowna's Stormwater Challenges

- Stormwater runoff to Lake Okanagan = region's drinking water source
- City's 97 ponds are critical for protecting/preventing:
 - Water quality within the City's watercourses & Okanagan Lake
 - Erosion within the creeks/lake
 - Flooding streets and properties
- 97 stormwater ponds (some > 30 years old)
- Have not fully defined:
 - An inspection/maintenance program
 - A dredging/rehab program
 - Staffing and financial needs



Project Objective & Plan

Develop a system to inventory, maintain and manage existing and proposed stormwater ponds



Developing a Risk Based Approach

Risk = probability of failure X consequence of failure

City of Kelowna's Enterprise Risk Management Framework:

- **Financial:** actions that have a significant impact on long-term financial sustainability.
- **Operational:** premature asset failure, failure to meet service commitments and community expectations.
- **Staff/Public/Social:** activities that result in foreseeable and preventable harm.
- **Legal/Compliance:** failure to comply with legal obligations.
- **Environmental:** failure to meet environmental commitments, minimize significant impacts on biodiversity, or reduce our ecological footprint.

Developing a Risk Based Approach

How Does a Pond 'Fail'?

- **Fills up with sediment:** can't provide quality and/or quantity treatment
- **Inlet/Outlet/Control structure failure:** flooding or lack of water quality treatment
- **Berm collapse:** downstream flooding.
- **Legal/Compliance:** 'dam' regulatory requirements
- **Human Safety:** drowning
- **Community expectations:** aesthetics/odour



Risk Based Prioritization Framework

How Does a Pond Fail?	Risk Types	Impact Description	Impact Measures (Score 1-5)	Likelihood Description	Likelihood Measure (Score 1-5)
Fills up with sediment – Downstream flooding or erosion due to insufficient detention (quantity ponds only)	Financial; operational; staff/public/social	Flooding causes damage to infrastructure, properties and/or service interruptions	Sensitivity of downstream area to flooding	Pond has filled up with sediment and can no longer provide the necessary SW quantity control	Age
	Environmental	Quantity of flow causes erosion in receiving waterbodies	Natural receiving body		
	Financial, Operational, staff/public/social, environmental	Both impacts described above	Size of pond (active capacity) i.e. amount of detention being compromised		
Fills up with sediment resulting in lack of quality treatment due to insufficient detention time, resuspension of solids, etc. (quality ponds only)	Environmental	Discharge quality causes damage to receiving waterbodies	Natural receiving body	Pond has filled up with sediment and can no longer provide the necessary SW quality control	Age

‘Scoring’ Risk and Prioritized Ponds

Risk Score = Impact Measure x Likelihood of Failure Measure

Impact Measure	Extreme (5)	Major (4)	Moderate (3)	Minor (2)	Insignificant (1)
Sensitivity of downstream area to flooding	Flat and emergency services or hill-like in developed areas	Flat & commercial or industrial or hill-like not in developed areas	Flat & high density residential	Flat & low density residential	Everything else
Natural receiving body	-	Fish-bearing creek	non-fish bearing creek/wetland	lake	-
Size of pond (active capacity) i.e. amount of detention being compromised	Largest 20%	60-80%	40-60%	20-40%	Smallest 20%

Likelihood Measure	Almost certain 91-100% (5)	Likely 71-90% (4)	Possible 26-70% (3)	Unlikely 11-25% (2)	Improbable 0-10% (1)
Age	>30 years	25-29 years	20-24 years	15-19 years	<15 years
Years since last inspection	≥40 years	35-39 years	30-34 years	25-29 years	<25
Depth from outlet and pond bottom	≤10cm	11-20cm	21-30cm	31-40cm	>40cm
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Proximity to children	-	-	Adjacent to school or playground	Adjacent to family orientated housing	All others

Resulting Pond Risk Score Distribution



Modified Prioritization for Sediment Survey

- Pond clean-outs can be expensive
- Use sediment surveys to help determine (along with risk scoring) which ponds should be cleaned out first
- Sediment surveys can cost thousands \$
- Which ponds to survey first?



Pond Inspection

- Developed pond inspection form
- Inspected 10 'highest risk' ponds + 5 ponds chosen by the City



Pond Cell Inspection

- Access Road Condition
- Gate locked
- Slide Slope Conditions
- Algae growth
- Evidence of sheen/spill
- Sediment accumulation
- Signage Condition
- Vegetation Condition
- Erosion issues
- Odours
- Trash/graffiti
- Fencing/guardrails
- Vegetation to Prevent Pond Access
- Aquatic Species Observed
- Community Amenities
- Berm Condition

Control Structure Inspection

- Control Structure type
- Sediment accumulation
- Control structure condition
- Sediment depth
- Functional

Inlet/Outlet Inspection

- Inlet/Outlet Condition
- Sediment Depth
- Functional
- Sediment Accumulation

Overflow/Spillway Inspection

- Overflow/Spillway Condition
- Functional

Bylaw Review

- Design standards, maintenance plan requirements, warranties, post-construction requirements, and bonding for developer constructed ponds
- Subdivision, Development & Servicing Bylaw, No. 7900
- Sanitary Sewer Storm Drain Regulation Bylaw, No. 6618
- Want to make sure that the City inherits ponds that work as intended and can be maintained
 - Maintenance plans
 - Maintenance records
 - Water quality & quantity monitoring
 - Extended warranty periods

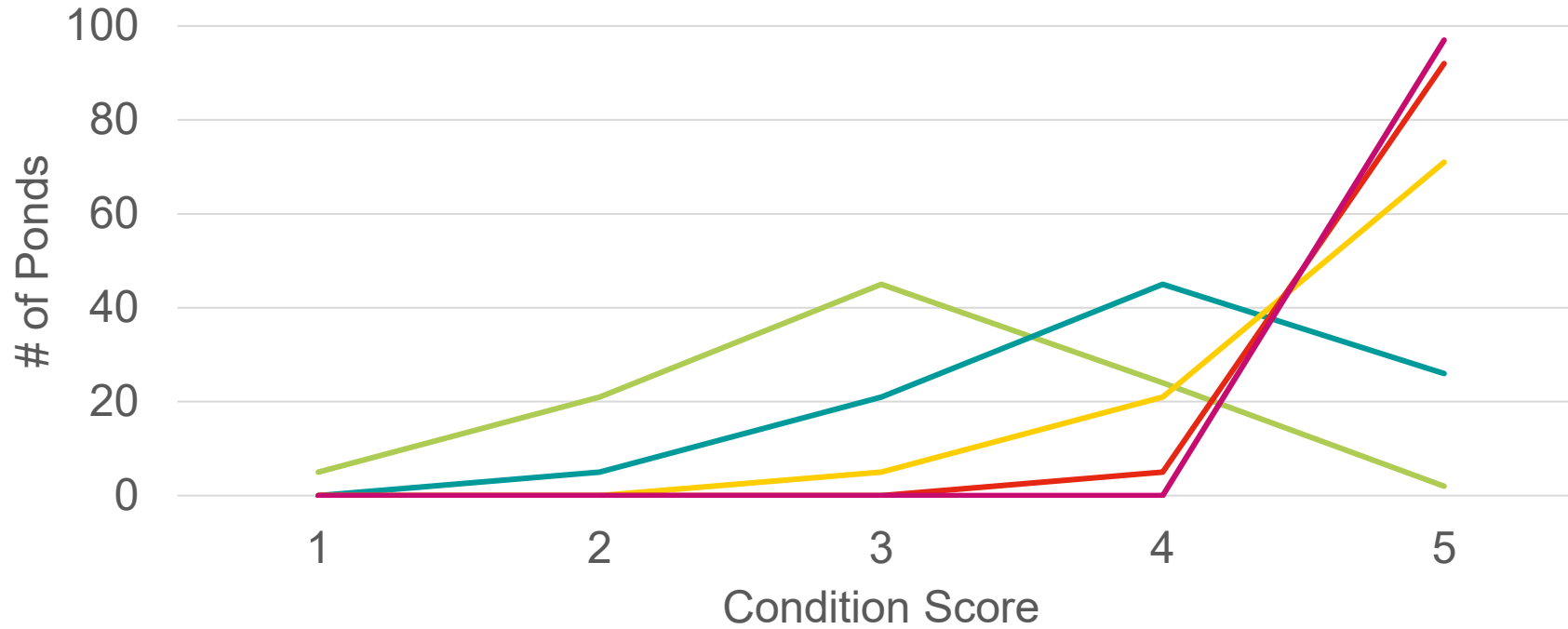


Annual Pond O&M Program and Costs

Activity	Cost
Annual Inspections (44 wet ponds & 53 dry ponds once per year)	\$115,000
Sediment Surveys: 4 wet ponds per year (10-year cycle)	\$20,000
Sediment Removal (1 per year (30-year cycle))	\$400,000 (varies)
Sub-Total	\$535,000
15% admin/contingency	\$80,000
Total	\$615,000

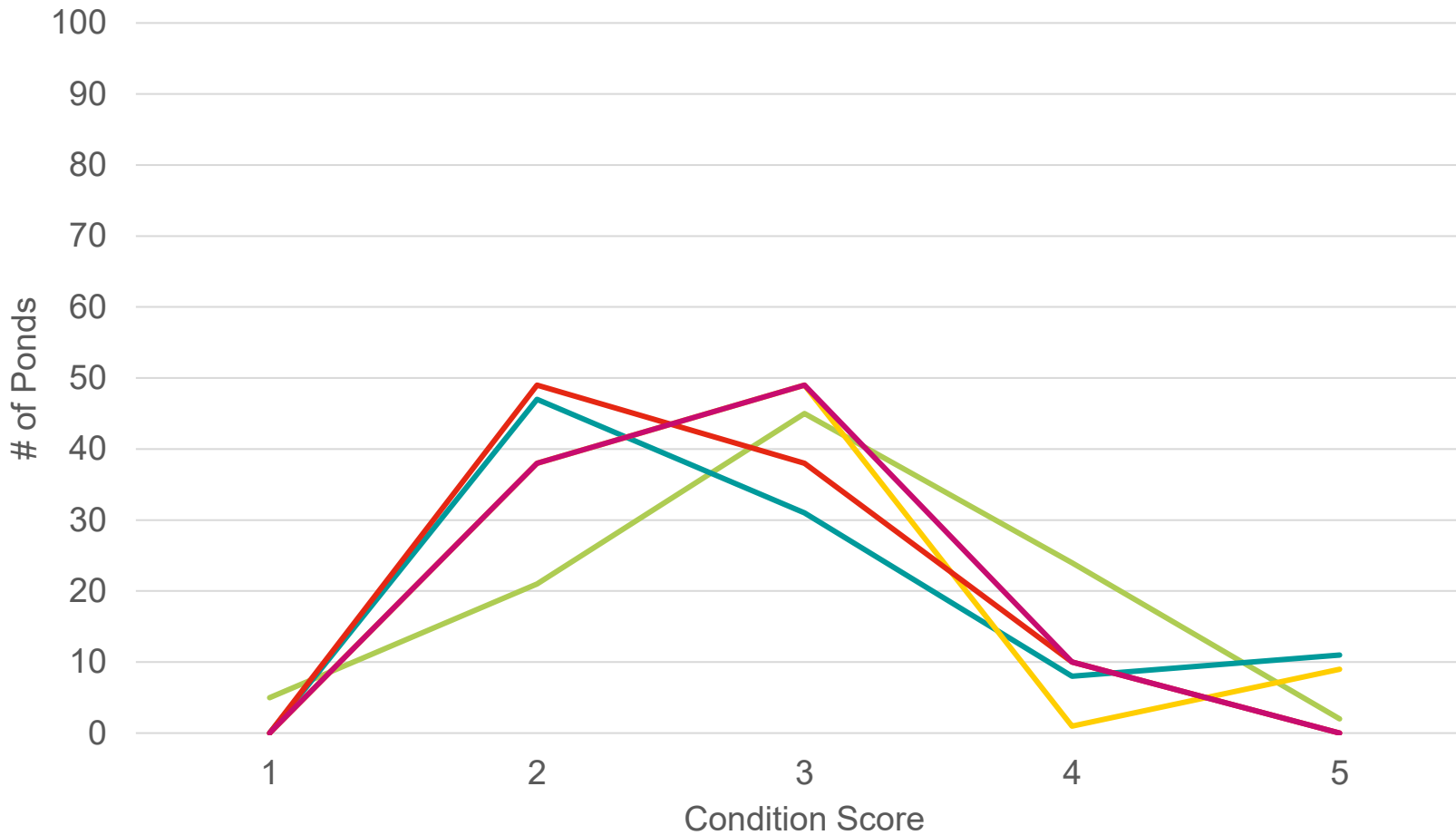
Estimated ~1100 staff hours per year for inspections and to manage sediment surveys/removal work

Distribution of Pond Scores from 2025 to 2065 Under Current Practices and Investments



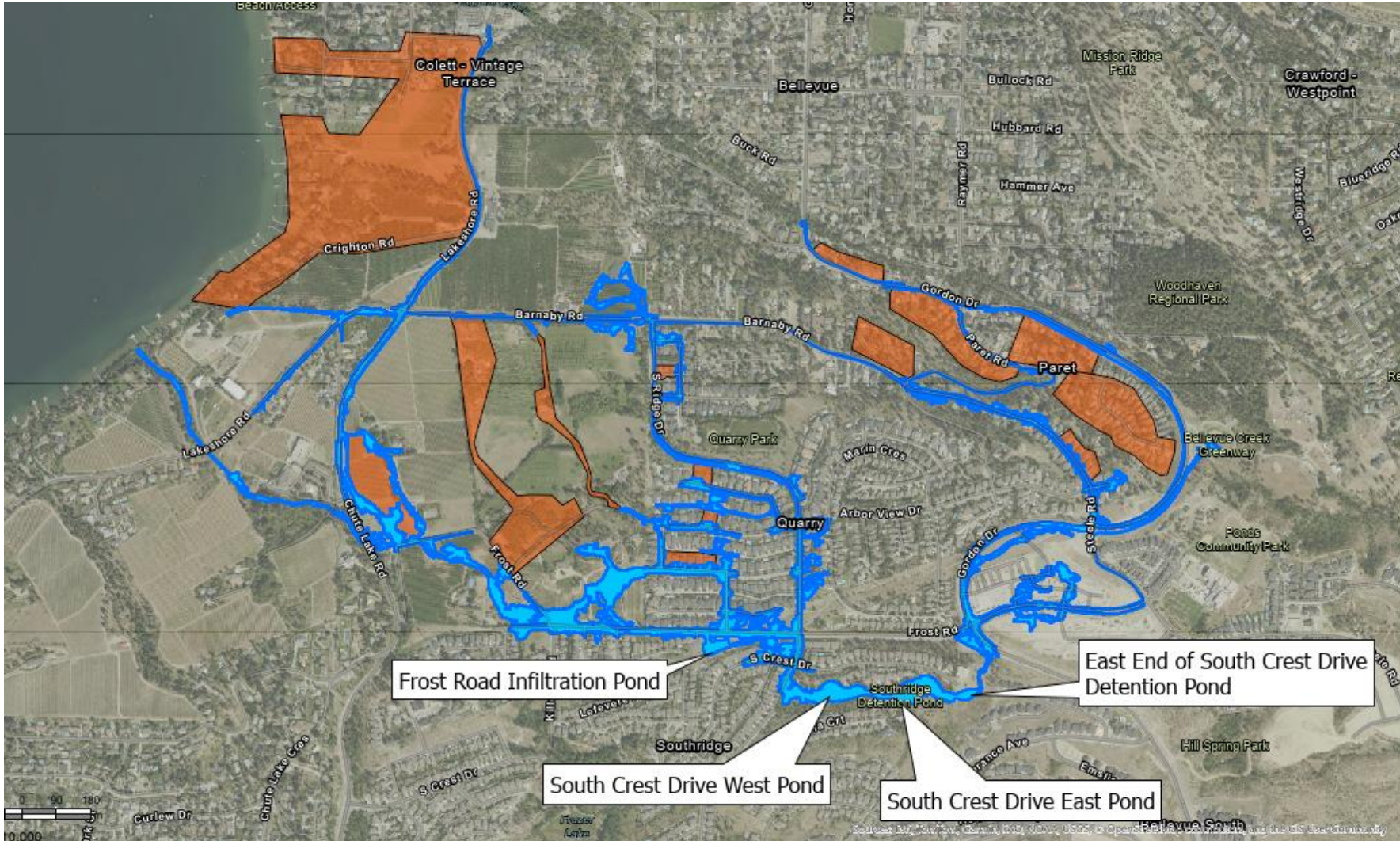
— 2025 Pond Distribution Scores — 2035 Pond Distribution Scores
— 2045 Pond Distribution Scores — 2055 Pond Distribution Scores
— 2065 Pond Distribution Scores

Distribution of Pond Scores from 2025 to 2065 Under Sustainable Resourcing & Renewal



— 2025 Pond Distribution Scores — 2035 Pond Distribution Scores
— 2045 Pond Distributio Scores — 2055 Pond Distribution Scores
— 2065 Pond Distribution Scores

Berm Break Analysis (8 ponds/3 areas)



Preliminary 2D model assessment.

Inform reviews of future downstream development

Requires survey of channels and culverts for a detailed assessment

Recommendations

- Unique AID for ponds and berms
- Collect key missing data
- Modify bylaws to require maintenance plans, maintenance records, flow and quality monitoring and extended warranty periods
- Address issues found during pond inspections
- Implement a regular pond inspection & maintenance program
- Educate staff in how ponds function and how to maintain them

Stormwater Funding Project

- City Utility Staff proposed a new stormwater funding model: fund stormwater through an impervious based fee rather than the general levy
- Initially Council embraced the idea
- Council split (insufficient support) for approving implementation. Councilors against cited concerns over public perception, even though public consultation was generally positive.
- Focused on ‘how’ to fund stormwater and not ‘how much’
- This pond study is an important step towards quantifying ‘how much’ to fund stormwater

Lessons Learned, Looking Forward & Next Steps

LESSONS LEARNED:

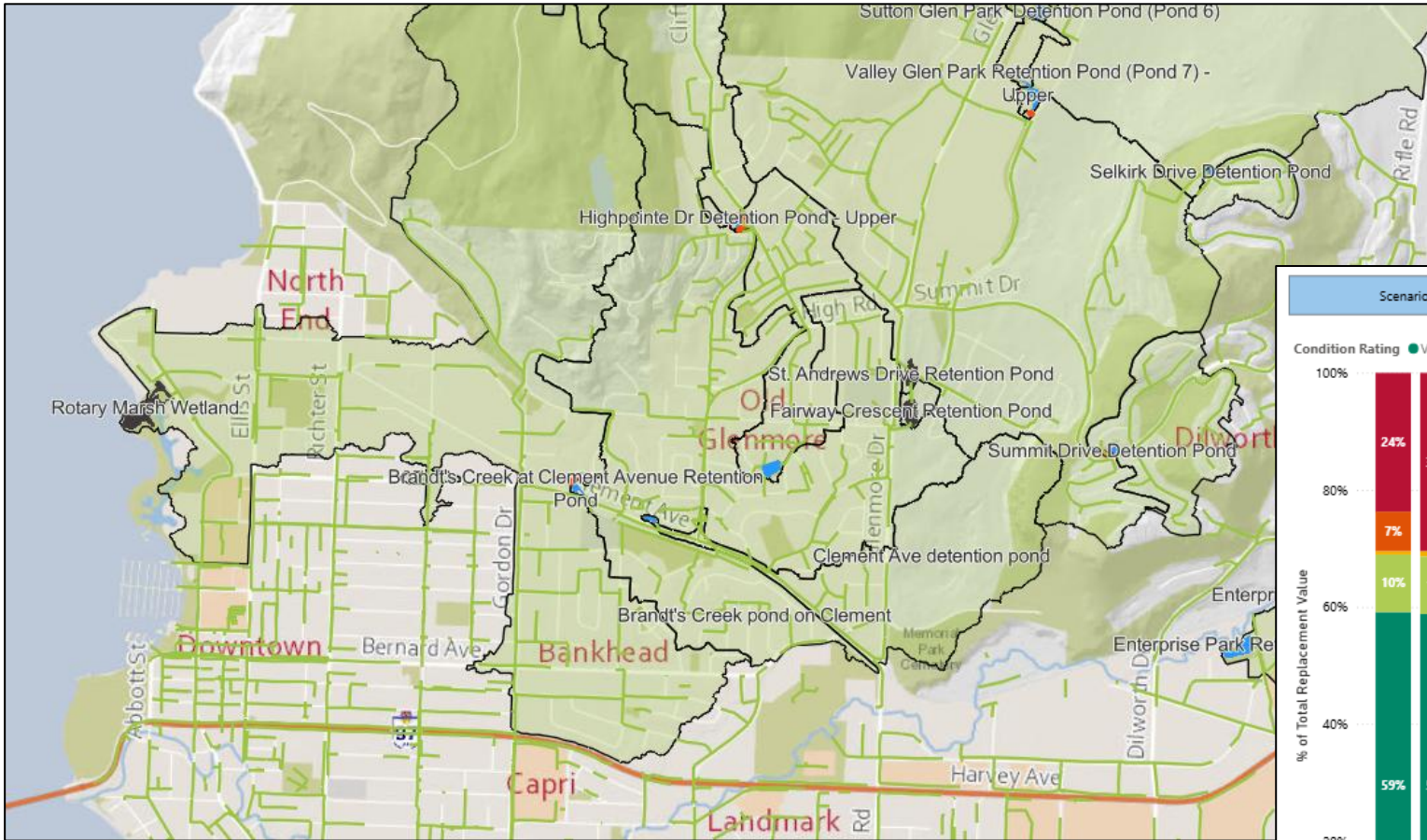
- Like many other cities in Canada, there is a gap in our capital and operational resourcing for stormwater infrastructure.
- Significant maintenance costs ahead in the coming decade.
- Status quo will increase risk exposure.

NEXT STEPS:

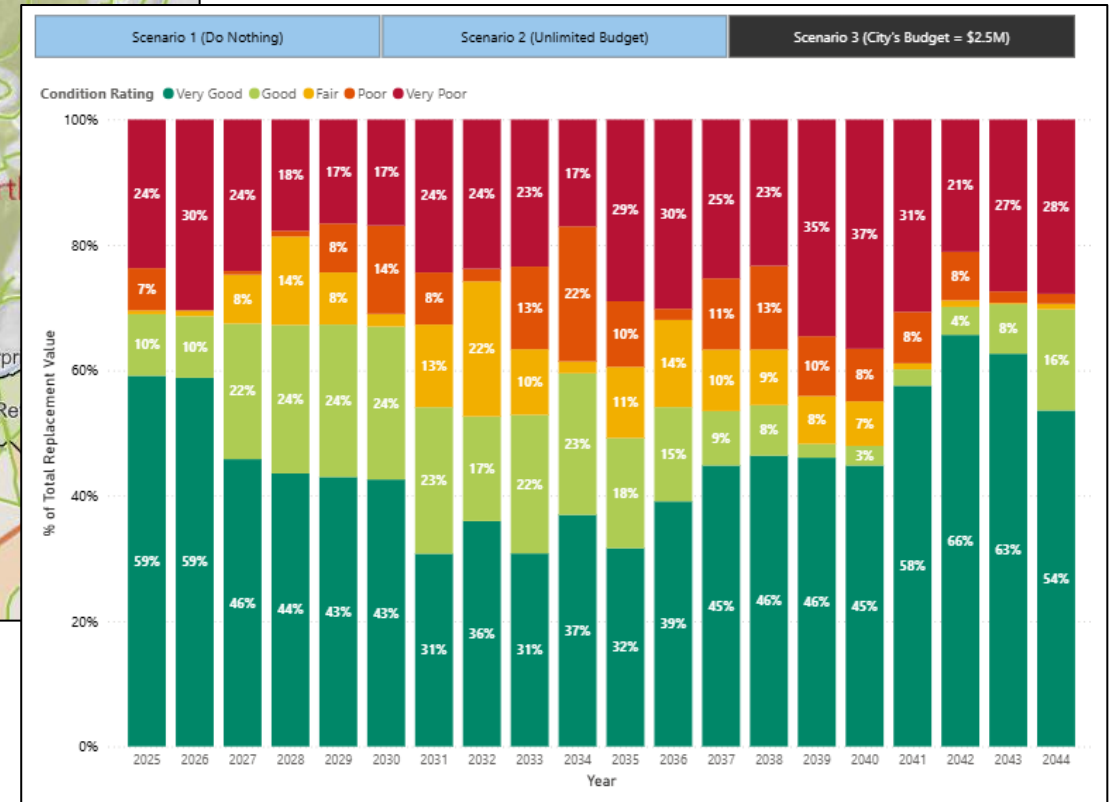
- Raise awareness and advocate internally
- Update our GIS and mapping
- Establish a CityWorks inspection program.



Sharing results across the organization



PowerBI State of Infrastructure Dashboard to share financial and condition forecasts.



ArcGIS Online dashboard to share asset information.

A photograph of a concrete structure, possibly a culvert or drainage pipe, with a metal grate. A green pipe is visible through the grate. The structure is surrounded by rocks and vegetation, including willow trees and reeds. The word "Questions?" is overlaid in white text in the center of the image.

Questions?

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