HOW BAD IS BAD:

A Novel Approach To Evaluating Geohazard Risks Along Watercourses

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Agenda

- Project Background
- Assessment Approach
- Assessment Outcomes
- Next Steps

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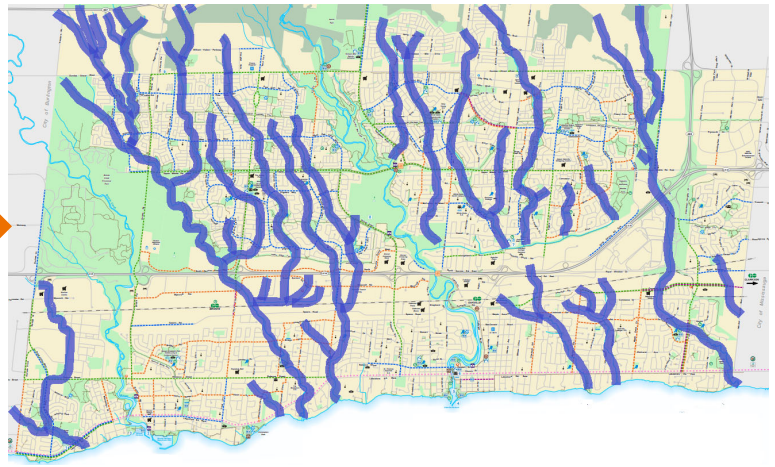
Town Creek Inspections and Inventory

- Starting in 2005, the Town of Oakville initiated regular creek inspection and inventory walks – 5 year intervals.

- Focus on minor creek systems
  - Joshua's Creek
  - 14 Mile Creek/McCraney Creek
  - Morrison/Wedgwood
  - Sheldon Creek
  - Several other smaller tributaries



- Field walks are conducted to assess watercourse conditions and identify risks to infrastructure and property

- Develop implementation plan to prioritize works on Town-owned watercourses

Project Background

- In 2017, above average wet spring conditions resulted in saturated conditions causing slope failure in areas along the valley corridor.

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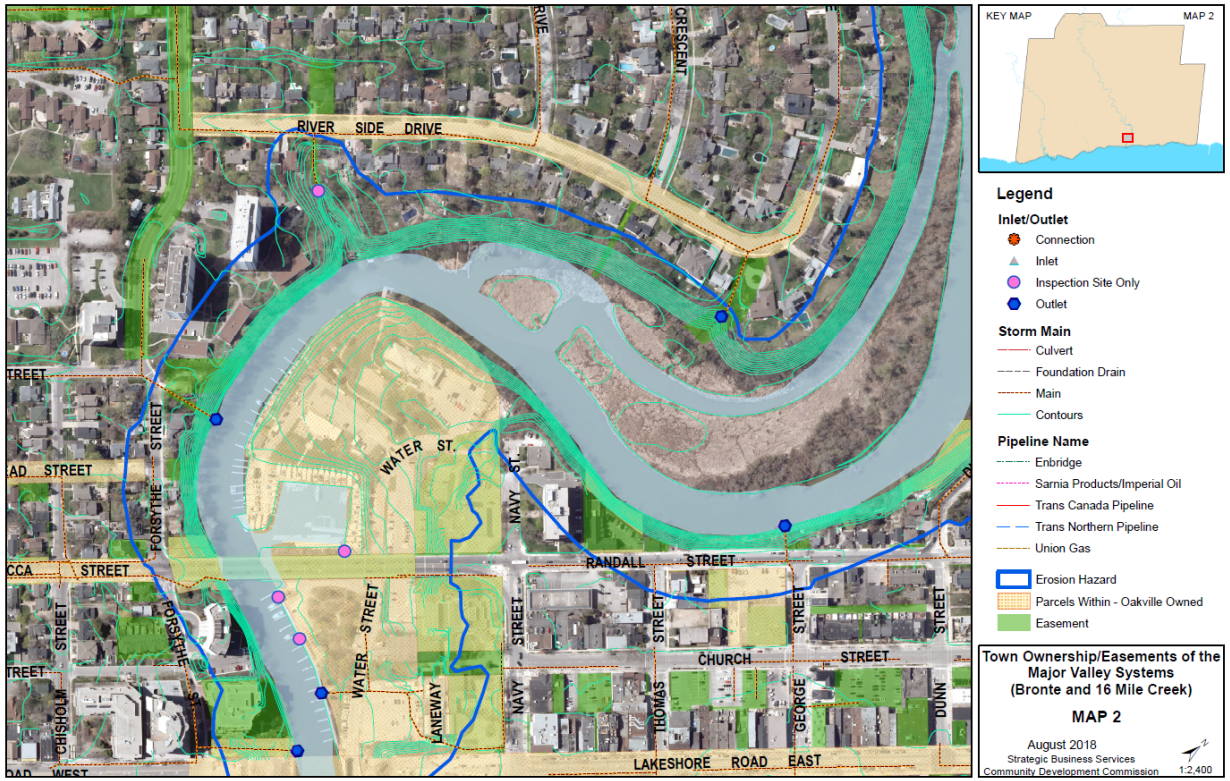
Project Background

- Investigation of the extent of town owned lands and easements within the valley corridors.
- Mapping of infrastructure such as outfalls, sewers, pipelines that may be at risk due to creek processes.



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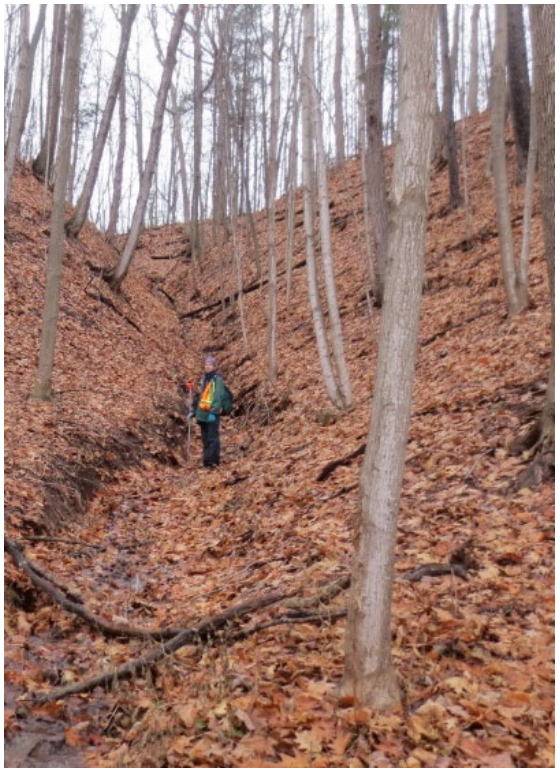
Project Background

- Sixteen Mile Creek and Bronte Creek Major Slope Inventory and Assessment – Stantec
- Project Goals:
  - Recommend and prioritize valley slopes of concern
  - Consideration of fluvial geomorphology and slope stability processes
  - Develop a prioritized list of sensitive/high risk sites.
  - Develop preliminary recommendations and cost estimates for future works



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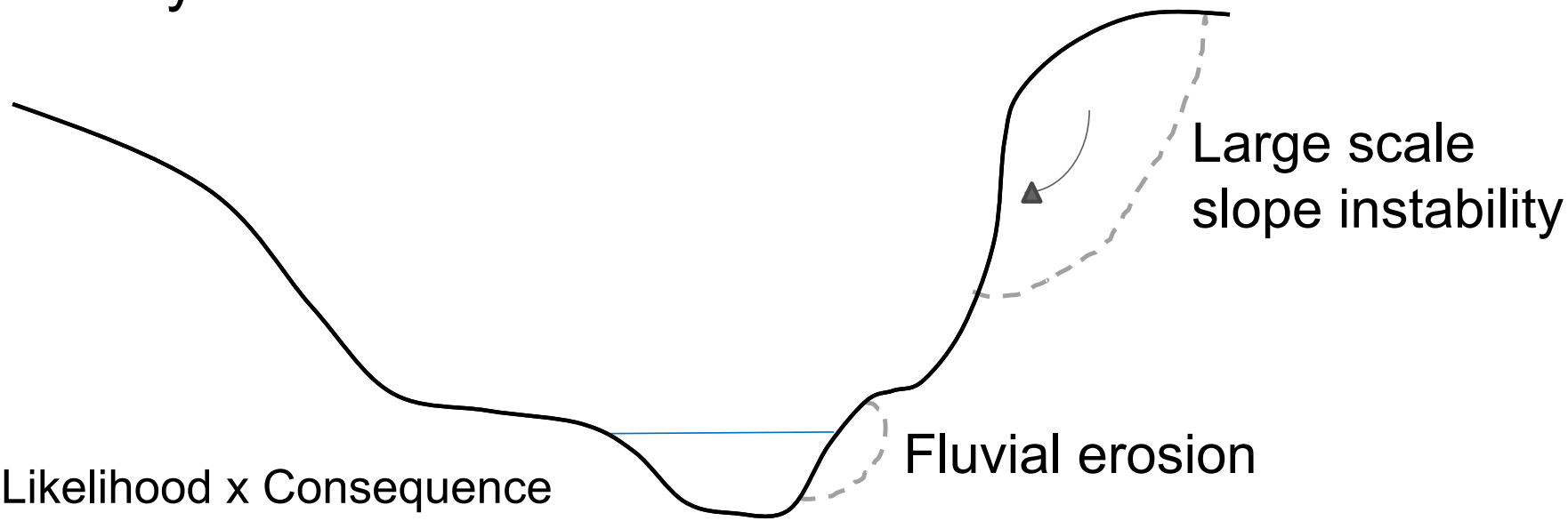
Assessment Approach

- In river valley settings, two types of geohazards may be active



Risk = Likelihood x Consequence

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Assessment Approach

- Field assessment of slope conditions including:
  - material type
  - depth to bedrock
  - slope topography
  - vegetation cover
  - indicators of instability

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Assessment Approach

- Terrain mapping
- Hillshade analysis
- Use satellite images, contours, and field observations

Assessment Approach

- Develop homogeneous terrain map units (polygons) based on the following attributes:
  - Surficial material
  - Surface expression
  - Geomorphological processes
  - Soil drainage
  - Qualitative geohazard mapping

Assessment Approach

Landslide Hazard Mapping Criteria

Landslide Hazard Class [1]	Interpretation	Notional Annual Probability [2]
I	**Slope with no evidence of previous instability**	>0.0001
II	Slopes that **show no evidence of previous instability**, but that could develop landslide in the future.	>0.001
III	Slopes with **evidence of previous landslide activity**, but that have not undergone movement in the previous 100 years.	>0.01
IV	Slopes subject to **new or renewed landslide activity**.	>0.1
V	Slopes with **active landslides**.	~1 (certain)

[1] Geohazard classes based on experience and professional judgment.
[2] Comes from Lee and Jones (2014).

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Assessment Approach

Class I - Floodplain downstream from Dundas St

Class II - Trail near Winding Creek Cove

Class III - Slope adjacent to Bronte Rd

Class IV – Slope site S-002

Class V - Slope adjacent to trail near Winding Creek Cove

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Assessment Approach

Consequence		Landslide Hazard Class			
		V	IV	III	II
A	Low potential to impact existing infrastructure.	V-A	IV-A	III-A	II-A
B	Nuisance and/or maintenance, with a potential to impact minor infrastructure within the next 10 years	V-B	IV-B	III-B	II-B
C	Potential to impact secondary infrastructure within the next 10 years	V-C	IV-C	III-C	II-C
D	Potential to impact human life or primary infrastructure within the next 10 years	V-D	IV-D	III-D	II-D

Very high High Moderate Low Very low

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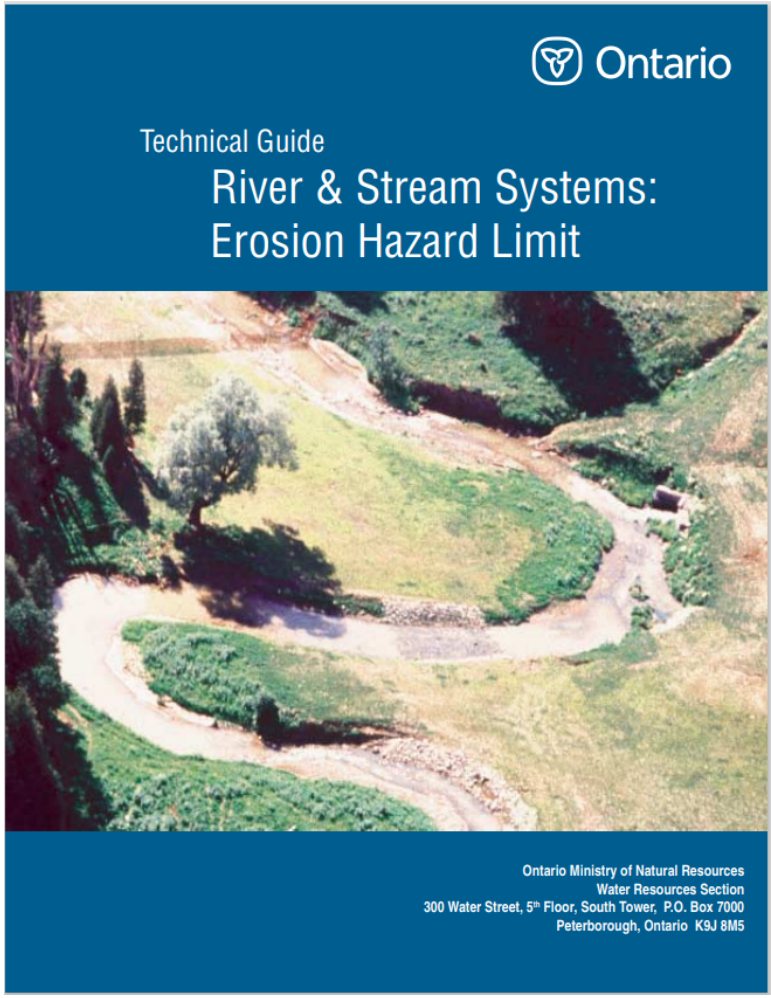
Assessment Approach

- Comparison Method
  - Slope Stability Rating Chart
  - Erosion Hazard Limit for confined systems
  - Primarily desktop methods (less detailed)



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Assessment Approach

- Compare to Standard MNRF methods

Landslide Hazard Class	V	IV	III
Site no.	MNRF Score		
S-001	45		
S-002		45	
S-003		43	
S-004	44		
S-005	42		
S-006		43	
S-007			33
S-008	44		
S-009	53		
S-010	46		

1. Low potential < 24
2. Slight potential 25-35
3. Moderate potential > 35

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Assessment Outcomes

Slope Sites	QRA	Risk to EOR
S-020	V-D	Very High
S-025		
S-040		
S-044		
S-045		
S-048		
S-001	V-C	High
S-009		
S-010		
S-016		
S-021		
S-023		
S-029		
S-039		
S-046		
S-002	IV-C	
S-004	V-B	Medium
S-008		
S-013		

Slope Sites	QRA	Risk to EOR
S-014	V-B	Medium
S-015		
S-017		
S-022		
S-024		
S-028		
S-031		
S-032		
S-034		
S-012	IV-B	
S-033		
S-043		
S-102		
S-018	III-C	
S-005	V-A	Low
S-026		
S-027		
S-105		
S-003	IV-A	

Slope Sites	QRA	Risk to EOR
S-006	IV-A	Low
S-019		
S-037		
S-047		
S-104		
S-036	III-B	
S-041		
S-108		
S-007	III-A	Very Low
S-030		
S-035		
S-038		
S-042		
S-101		
S-103		
S-109		
S-011	II-A	
S-106		
S-107		

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Assessment Approach

- Evaluation for fluvial sites

Hazards Hydraulic Stress – cross-sectional shape (confined/unconfined, bend/straight) Erodibility – bank material, bank vegetation Area Potentially Impacted – m^2	50
Exposure of element at risk Distance to Element at Risk – proximity in m	
Identification of elements at risk (Consequence) Resource Type - vegetation to bridges People at Risk – 0 to >25 people	50
Total Fluvial Ranking Score	**100**

Risk Category	Score range
Very Low	35 - 43
Low	44 - 53
Medium	54 - 62
High	63 - 72
Very High	73 - 81

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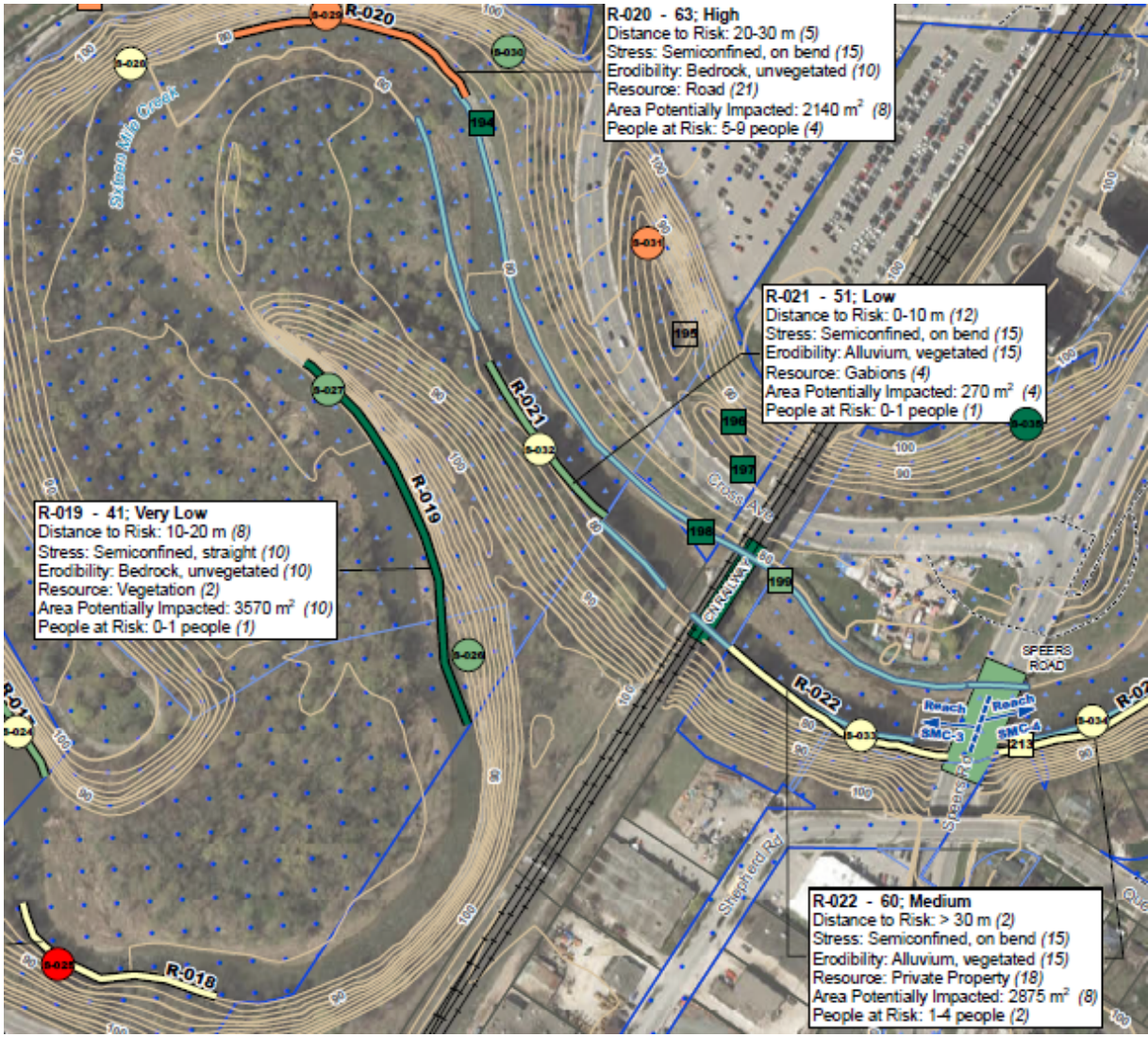
Assessment Outcomes

R-022 - 60; Medium
Distance to Risk: > 30 m *(2)*
Stress: Semiconfined, on bend *(15)*
Erodibility: Alluvium, vegetated *(15)*
Resource: Private Property *(18)*
Area Potentially Impacted: 2875 m^2 *(8)*
People at Risk: 1-4 people *(2)*



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Assessment Outcomes

- Combine slope and fluvial results for ranking

			Slope Risk result				
		Ranking	Very Low	Low	Medium	High	Very High
	Ranking	Score	1	2	3	4	5
Fluvial Risk Result	Very Low	1	1	2	3	4	5
	Low	2	2	4	6	8	10
	Medium	3	3	6	9	12	15
	High	4	4	8	12	16	20
	Very High	5	5	10	15	20	25

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Assessment Outcomes

Rank	Fluvial site(s)	Resource(s) at risk	Reach	Fluvial Risk	Slope site(s)	Slope Risk	Combined Score
1	R-026, 027	Buildings, Road	SMC-4	Very High	S-044, 045, 046	Very High	25
2	R-016	Bridge	SMC-3	Very High	S-023	High	20
	R-028	Bridge	SMC-4	High	S-048	Very High	20
4	R-008	Buildings	SMC-1	High	S-009, 010	High	16
	R-020	Road	SMC-3	High	S-029	High	16
6	R-018	Road	SMC-3	Medium	S-025	Very High	15
	R-013	Parking Lot	SMC-2	Medium	S-020	Very High	15
8	R-014	Road	SMC-2	Medium	S-021	High	12
	R-010	Buildings	SMC-2	Medium	S-016	High	12
10	R-015	Road/ Storm sewer	SMC-2	Medium	S-022	Medium	9

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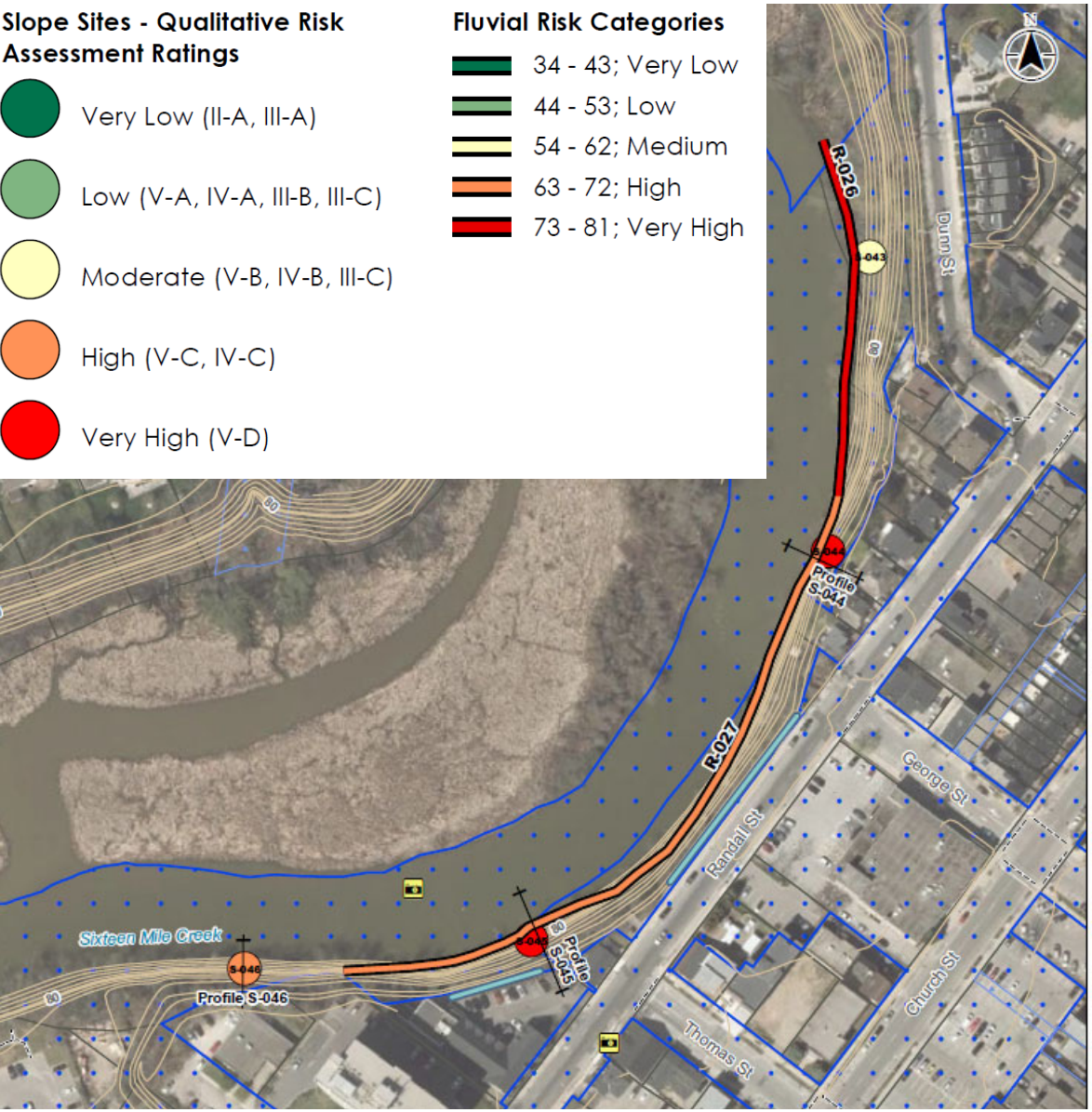
Slope Sites - Qualitative Risk Assessment Ratings

- Very Low (II-A, III-A)
- Low (V-A, IV-A, III-B, III-C)
- Moderate (V-B, IV-B, III-C)
- High (V-C, IV-C)
- Very High (V-D)

Fluvial Risk Categories

- 34 - 43; Very Low
- 44 - 53; Low
- 54 - 62; Medium
- 63 - 72; High
- 73 - 81; Very High



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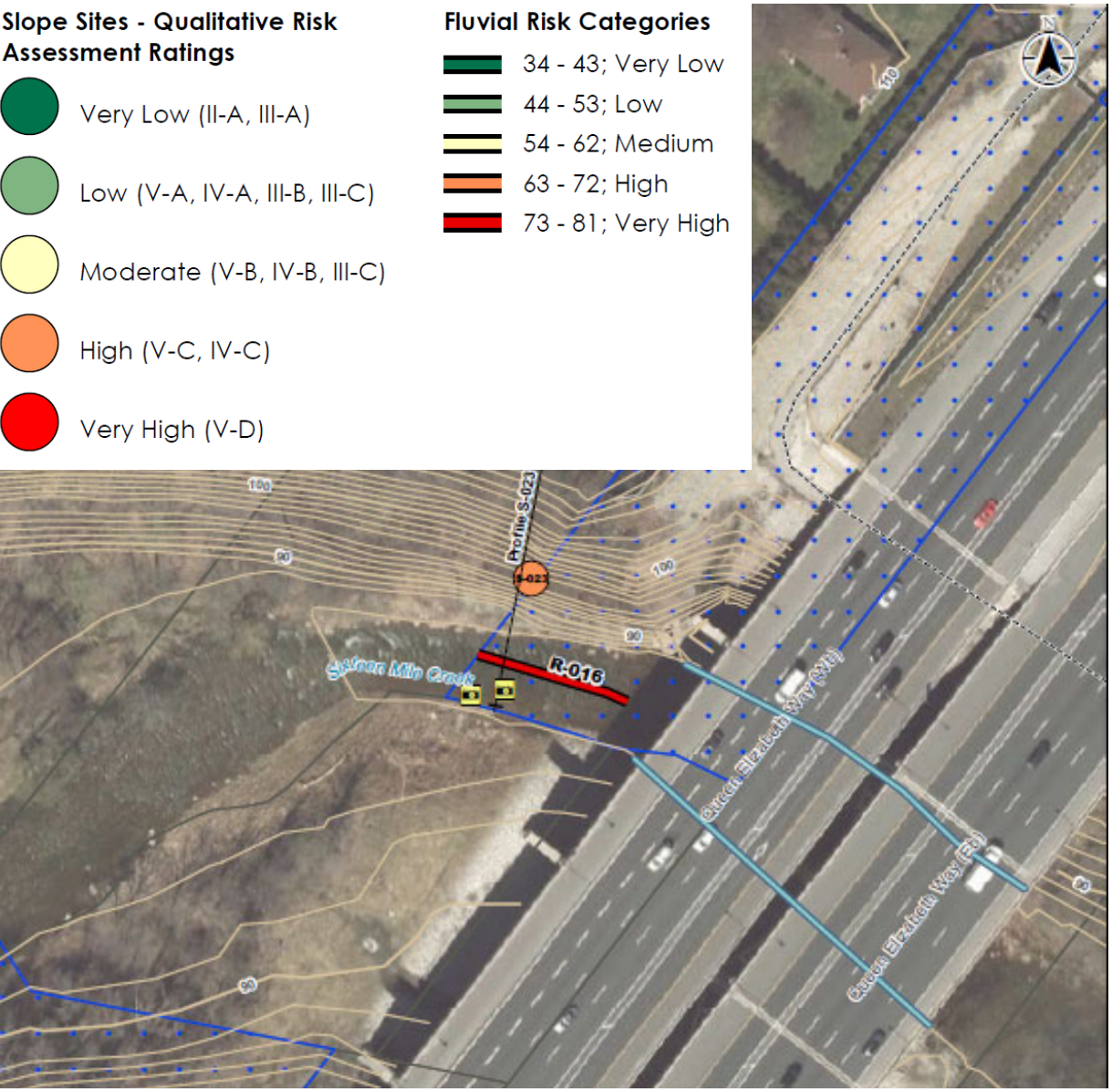

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Assessment Outcomes

- Study also reviewed the conditions of stormwater outfalls and crossing infrastructure
- Made recommendations from monitoring / routine maintenance to priority maintenance

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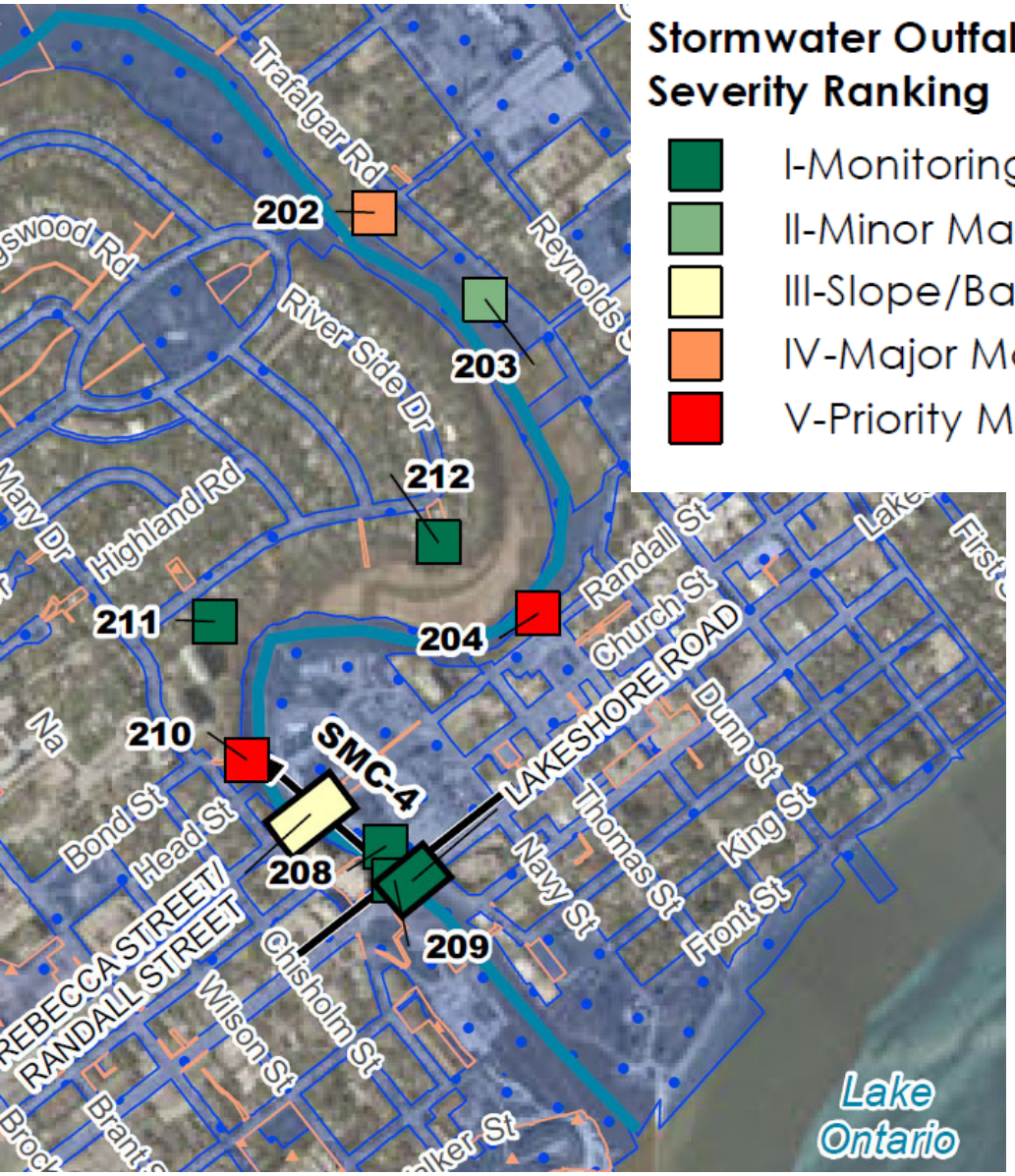

Stormwater Outfall Severity Ranking -

- I-Monitoring
- II-Minor Maintenance
- III-Slope/Bank Maintenance
- IV-Major Maintenance
- V-Priority Maintenance

Creek Crossing Severity Ranking -

- I-Routinary Monitoring
- II-Further Assessments
- III-Maintenance

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Summary

- Understand hazards – both fluvial & slope (in combination)
- Understand goals – ranking (need discrete outcomes)
- Prepare a detailed field program to collect required data

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Next steps

- Summary of potential future works and probable costs for the “Top Ten”.
- Many sites will require more detailed investigations with agency consultation (CH, MECP, DFO).
- Town to consider how to move forward from cost benefit Perspective.
  - Reinforces Soil Slope (RSS System)
  - Toe Protection (Amour stone, riprap materials)
  - Retaining wall systems
  - **Applying a Monitoring Plan (Fall 2021)**
  - Purchasing the properties
- Capital budget planning – increased cost due access.
- Study and design for top 3 priority outfall sites. Construction 2022.

Photo 18 – Outfall 210

Questions?

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