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Presented by:

Toronto and Region Conservation Authority

In association with:

Lake Simcoe Region conservation authority

Credit Valley Conservation – inspired by nature

Reading the Reach: A Novel, Systematic, GIS-Based Approach to Erosion Hazard Mapping in Asset Management

March 27, 2024

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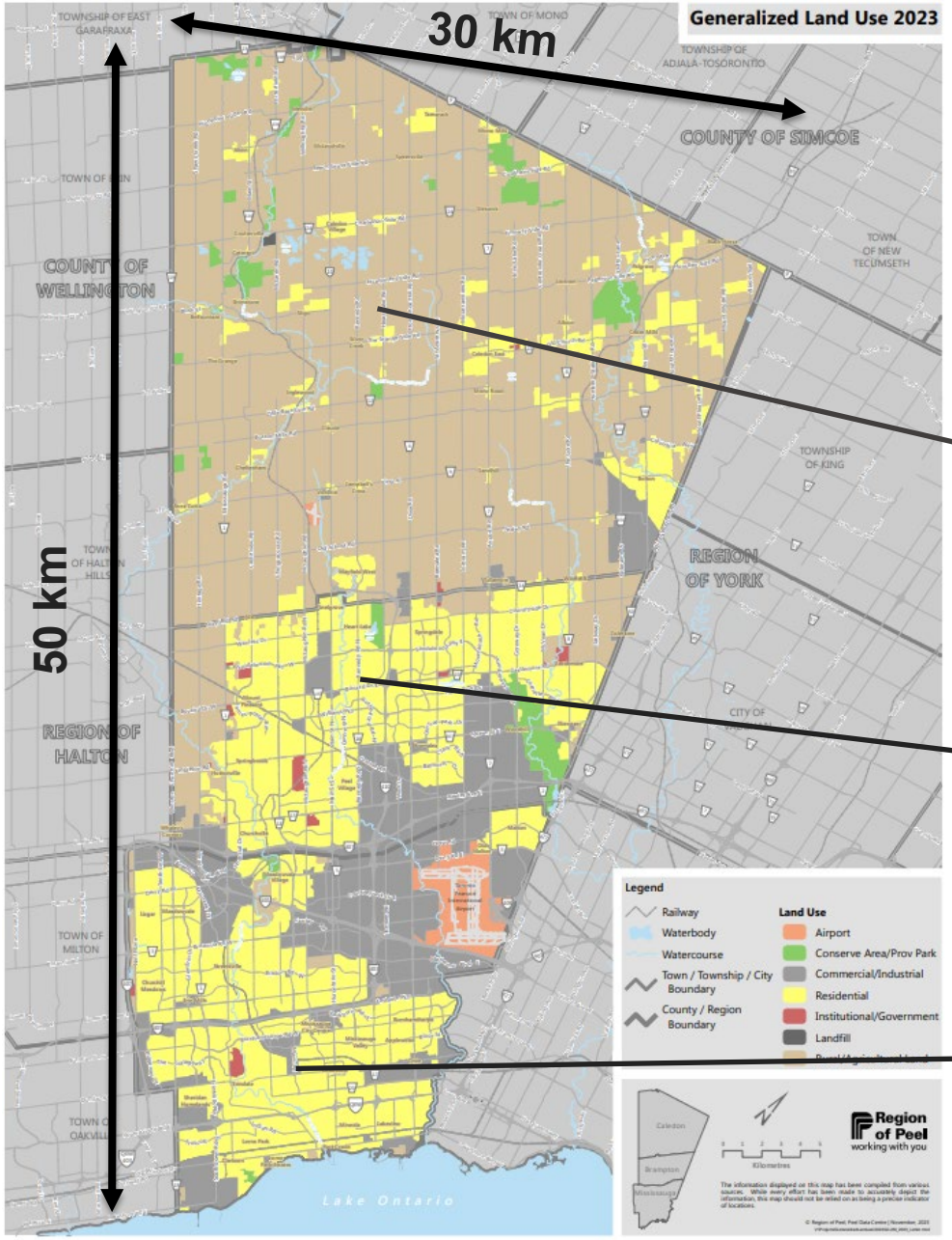
REGION OF PEEL



Caledon

Brampton

Mississauga

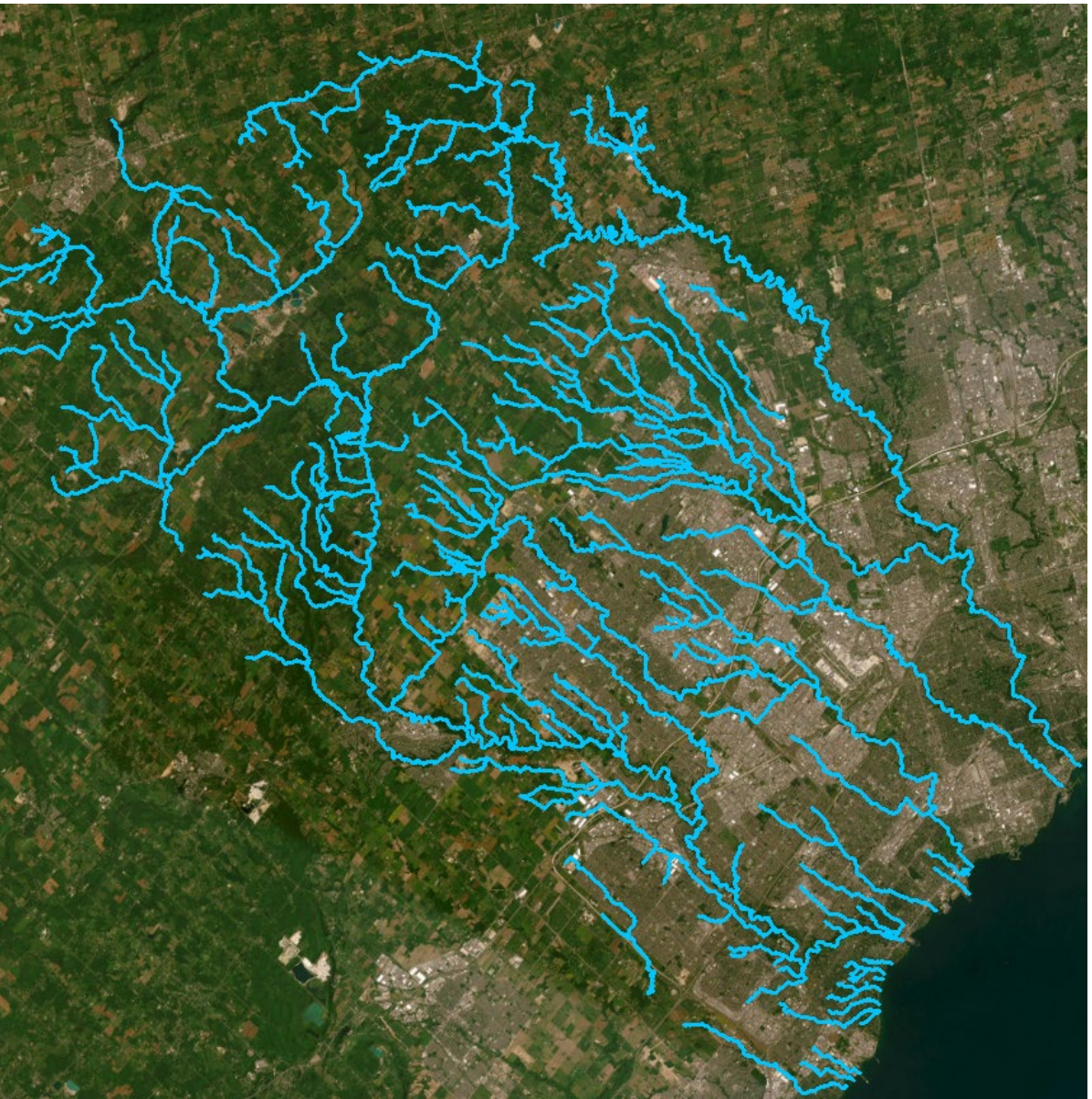
Large – geographically diverse

~ 1.3 million people

Land Use

- Airport
- Conserve Area/Prov Park
- Commercial/Industrial
- Residential
- Institutional/Government
- Landfill
- Rural/Agricultural Land

REGULATED WATERCOURSES

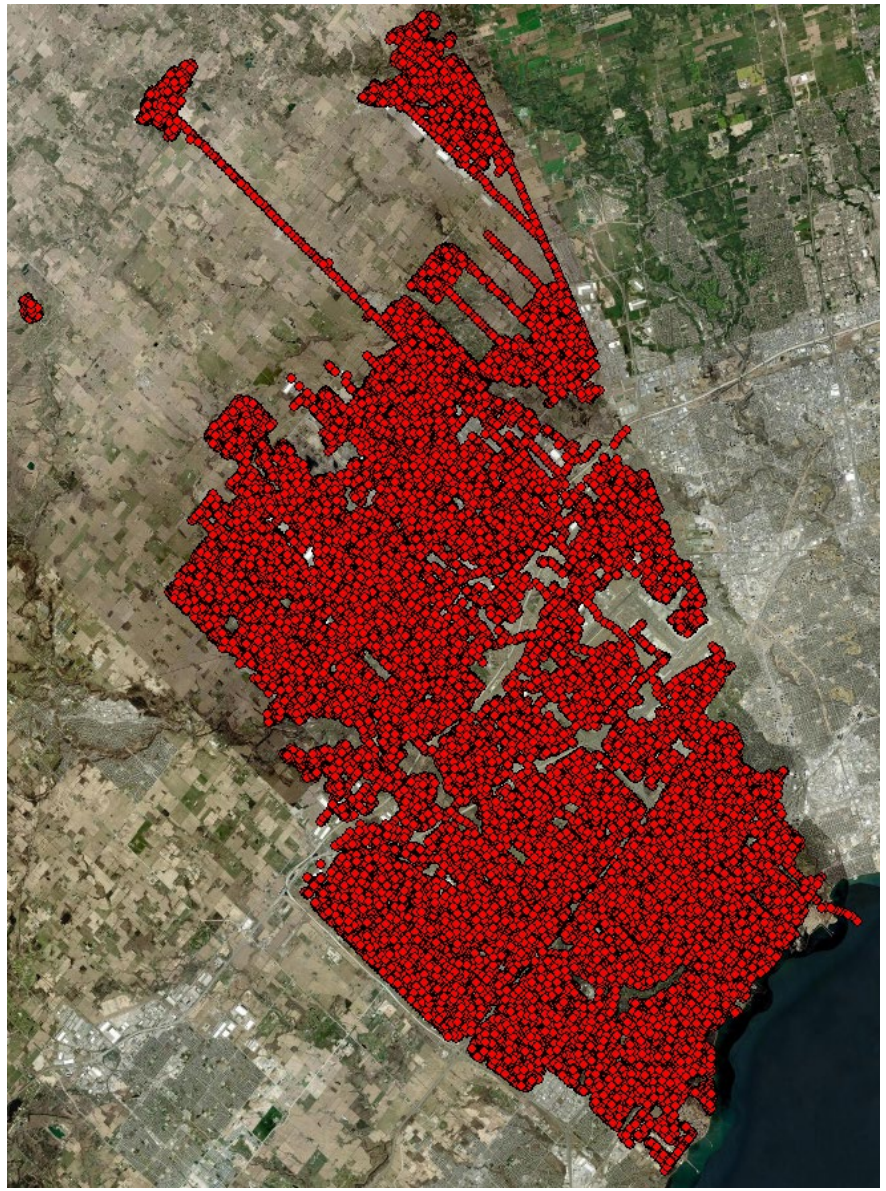


~1.3 million linear meters of regulated watercourse (1,300 KM)

SANITARY MAINTENANCE HOLES

~ 56,000 sanitary maintenance holes

Significant potential for interaction between watercourses and sanitary MH



HISTORICAL APPROACH TO IDENTIFYING EROSION ISSUES

Routine annual site assessments of a portion of MH dataset (100-200 per year)

Annual site assessments – erosion is a concern!

Challenge: earmarking funding for maintenance / mitigation works is difficult

THE PILOT STUDY

Region identified 381 MH at **RISK** of further damage due to bank erosion

Provide relative **RISK** rankings for the 381 to help Region prioritize

RISK TO MH FROM LATERAL EROSION

Risk = **(Likelihood)** and **(Consequence)**

Likelihood = **Lateral Erosion Hazard** and condition

Consequence = Environmental, economic, and social

Approach to Estimate Lateral Erosion Hazard

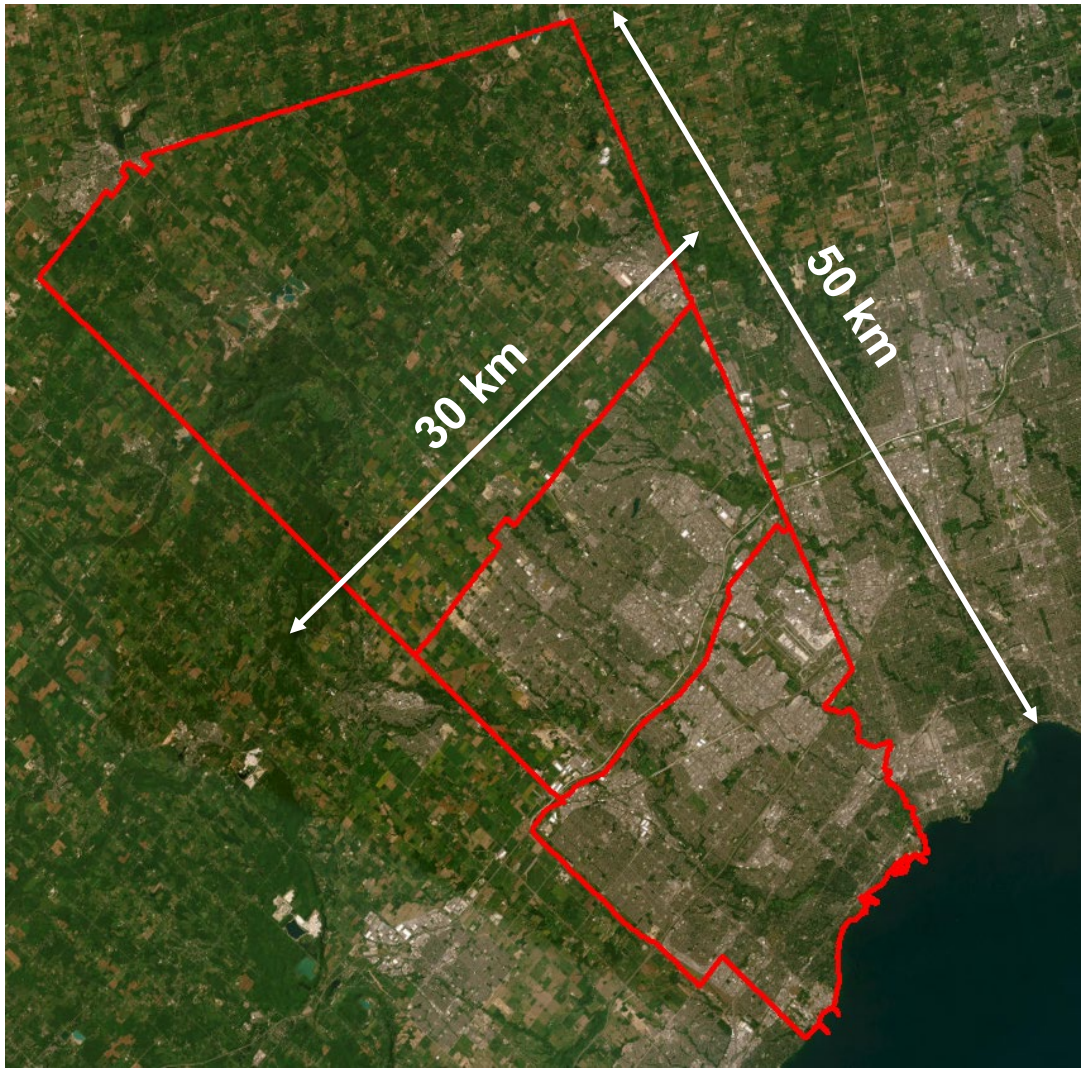
CONSTRAINTS

Data:

- Mapping of regulated watercourses – mostly polyline
- Orthophotographs (2005 and 2021)
- Mapping of MH dataset

Scale:

- The Region is geographically diverse
- Site scale and regional scale would be too fine and coarse, respectively
- **Reach-scale** approach most appropriate for desktop analysis



LIMITATIONS

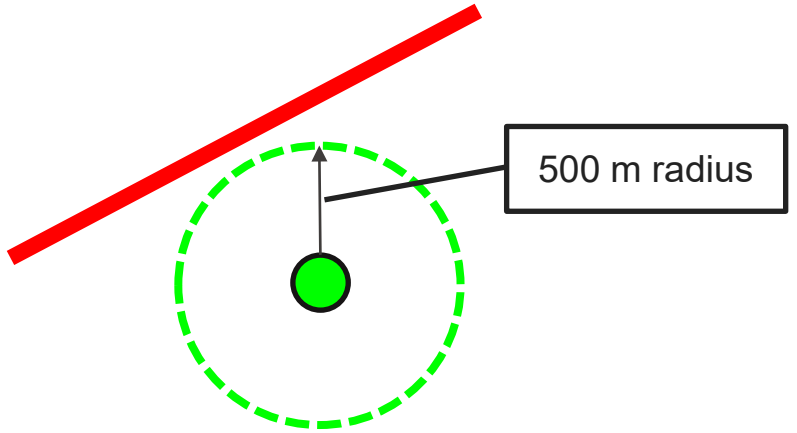
- Vertical scour not considered – available data was limited and spatial scale cost prohibitive
- Maintenance hole infrastructure only (i.e., excludes sanitary sewer)
- Orthophotograph record was limited to 2005 – 2021 (16 years)
- Lateral erosion hazard estimation based on historical observations (i.e., assumes the past will extend into the future)

METHODOLOGY

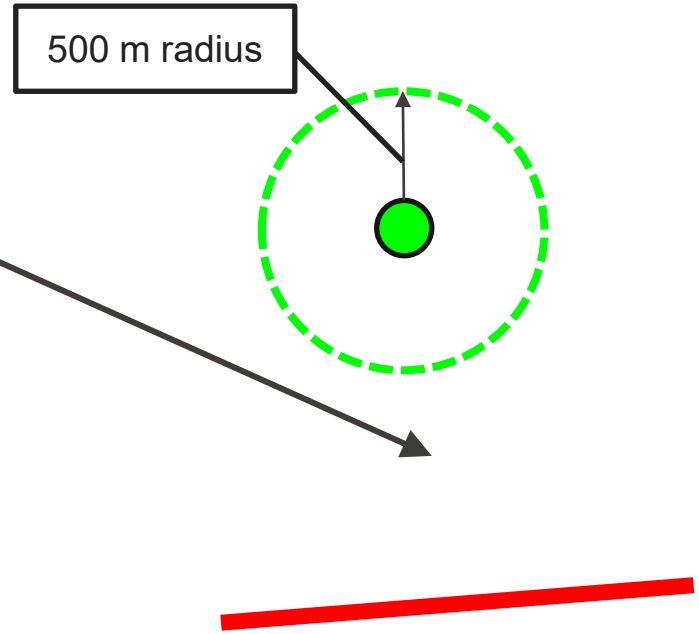
Task No.	Task Name	Task Description
1	**Reach Identification**	Identify reaches adjacent to MH
2	**Analysis**	Reach-scale estimation of average channel width and average annual migration rate
3	**Erosion Hazard Mapping**	Delineate erosion hazard zones for each reach
4	**Erosion Hazard Ranking**	Assign erosion hazard to each MH

TASK 1 – REACH SCREENING

Step 1: Radius of 500 m to identify adjacent watercourse



Step 2: Watercourse extended upstream and downstream to define reach



58 reaches were identified

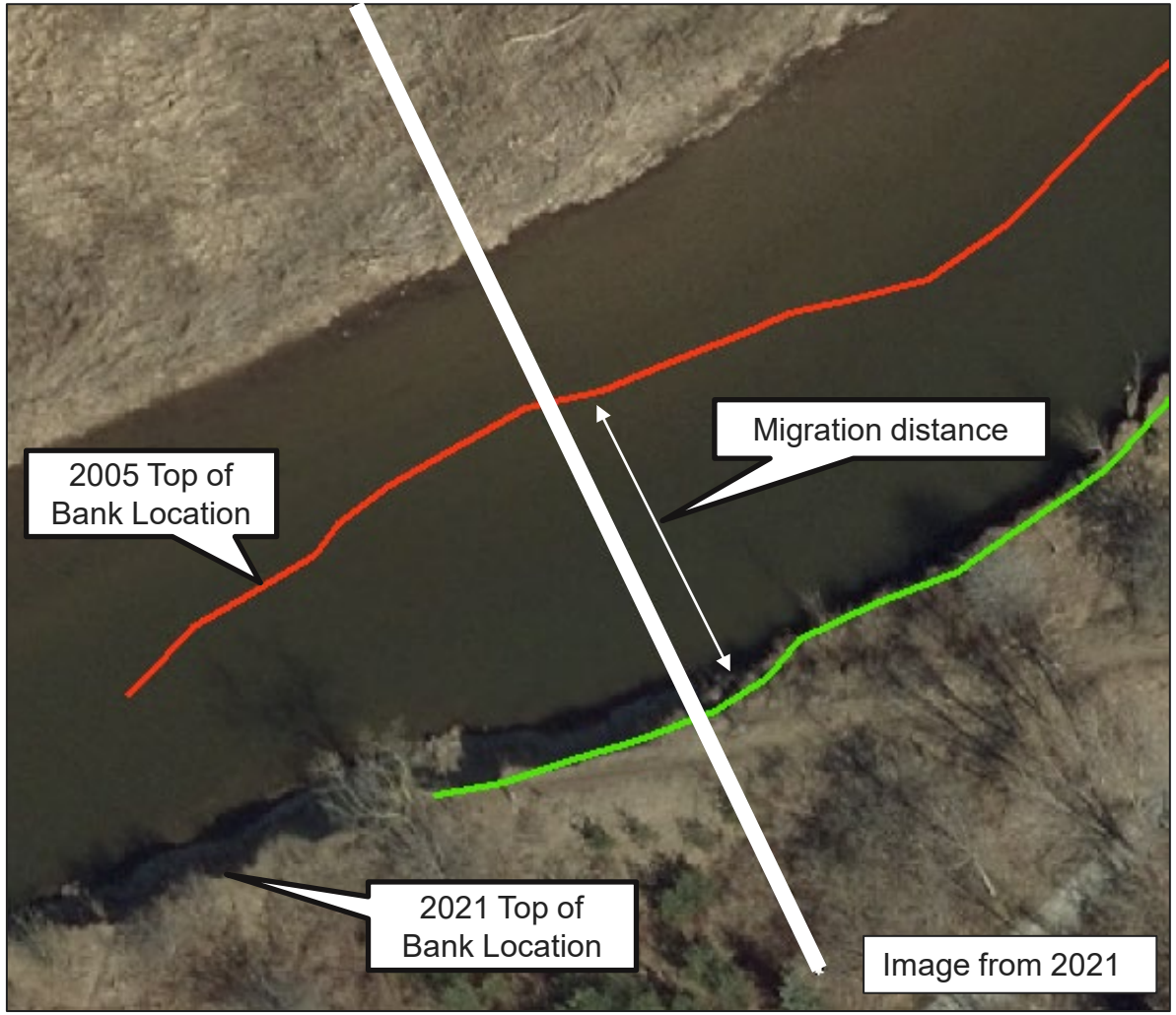
TASK 2 - ANALYSIS

Step 1: Estimate the average annual migration rate at outside bends

Looking for most extreme cases (3 locations)

Estimate average annual migration rate

Applied to entire reach



TASK 2 - ANALYSIS

Step 2: Estimate the top of bank location for the entire reach

Watercourses were provided as polylines

Estimate average reach-scale channel top width (3 locations)

+20% (natural variability in channel form and centerline mapping inconsistencies)

TASK 2 - ANALYSIS

Step 3: Reach description summary

Average annual lateral migration rate extended over selected planning horizon

Planning horizons selected by the Region (0-5, 5-15, 15-30, 30-50, 50+ years)

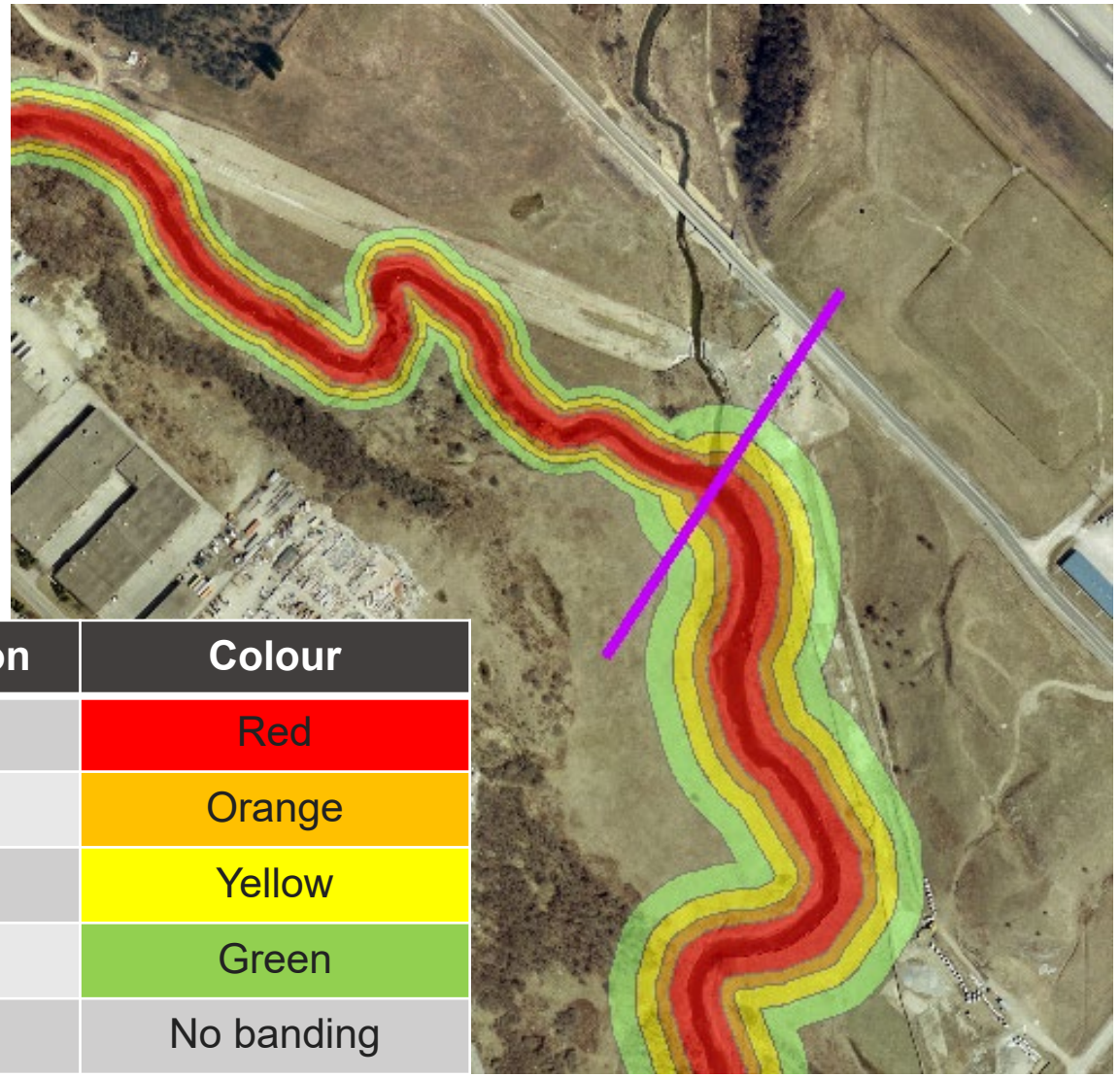
RESULTS OF REACH-BASED DESKTOP GEOMORPHOLOGICAL ASSESSMENT

Reach	Conservation Authority	Municipality	Watercourse Name	Est. Avg. Top Width (m)	Est. Avg. Annual Lateral Migration Rate (m/yr)	Estimated Erosion Hazard Offset (m)			
						5-Year	15-Year	30-Year	50-Year
TA-1	TRCA	Brampton	Tributary A	5.0	0.09	0.5	1.4	2.7	4.5
ECE-1	TRCA	Brampton	Etobicoke Creek East Branch	9.3	0.07	0.4	1.1	2.1	3.5
ECE-5	TRCA	Brampton/Mississauga	Etobicoke East Branch	15.2	0.43	2.2	6.5	12.9	21.5
T3-1	TRCA	Brampton/Mississauga	Tributary 3	5.2	0.11	0.6	1.7	3.3	5.5
SC-1	TRCA	Caledon	Salt Creek	9.2	0.07	0.4	1.1	2.1	3.5
ECW-5	TRCA	Brampton	Etobicoke Creek	16.4	0.28	1.4	4.2	8.4	14.0
ECW-1	TRCA	Brampton	Etobicoke Creek	18.6	0.24	1.2	3.6	7.2	12.0
ECW-6	TRCA	Brampton	Etobicoke Creek	18.2	0.49	2.5	7.4	14.7	24.5
LEC-1	TRCA	Mississauga	Little Etobicoke Creek	9.4	0.07	0.4	1.1	2.1	3.5
LEC-2	TRCA	Mississauga	Little Etobicoke Creek	14.0	0.13	0.7	2.0	3.9	6.5
GRTT-1	TRCA	Brampton	Tributary to Gore Road Tributary	5.1	0.03	0.2	0.5	0.9	1.5

TASK 3 – HAZARD MAPPING

Buffer top of bank by estimated lateral erosion hazard offset

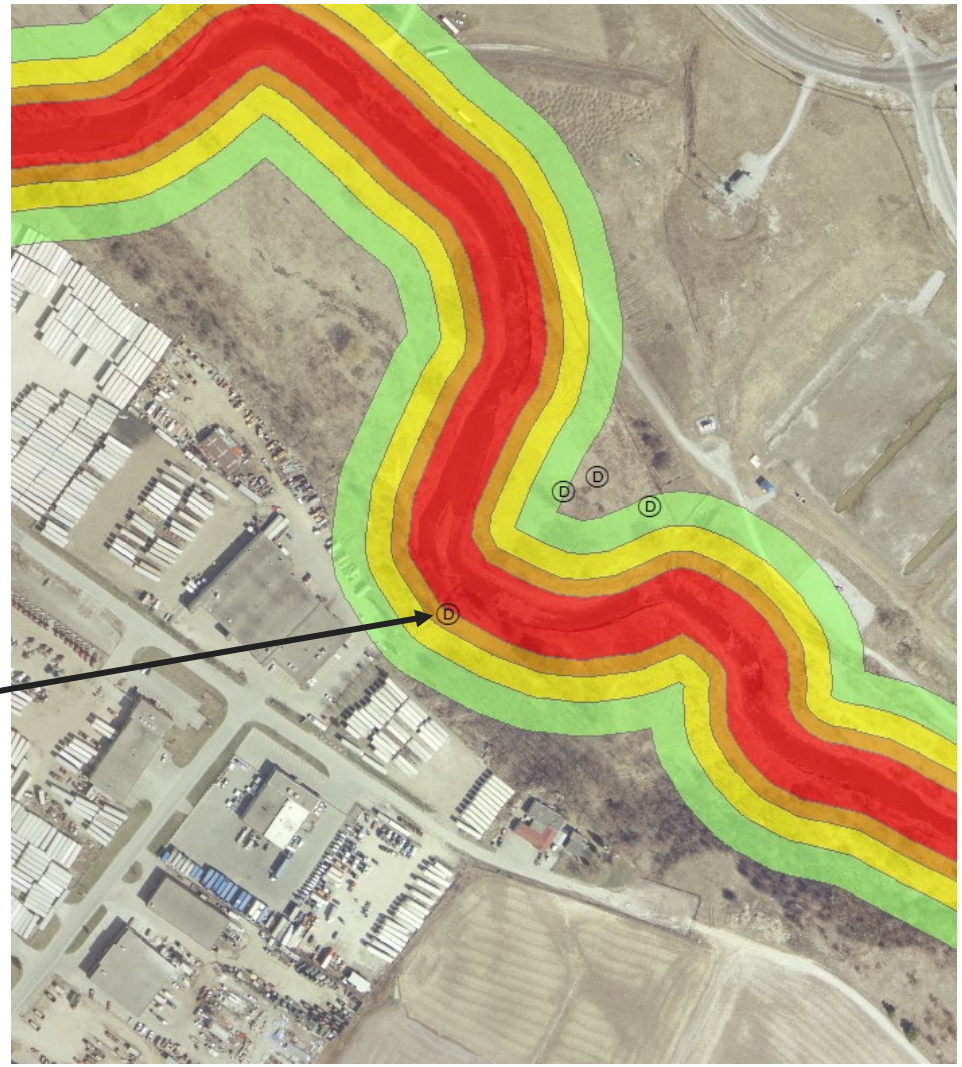
Different reaches have different erosion hazards



Planning Horizon	Colour
0-5	Red
5-15	Orange
15-30	Yellow
30-50	Green
50+	No banding

TASK 4 – ASSIGN HAZARD

Demonstration on how erosion hazard bands are assigned to MH



TYPICAL SITES WITH HIGH EROSION HAZARD

RESULTS

Summary of total number of MHs within each erosion hazard category

- Over half in 50+ bucket
- ~ 20% in 0 – 15 year buckets

Erosion Hazard (Years)	No. of Maintenance Holes	% of Dataset
50+	241	63%
30 – 50	32	8%
15 – 30	36	9%
5 – 15	24	6%
0 – 5	48	13%

Risk Assessment Summary

RESULTS – RISK ASSESSMENT

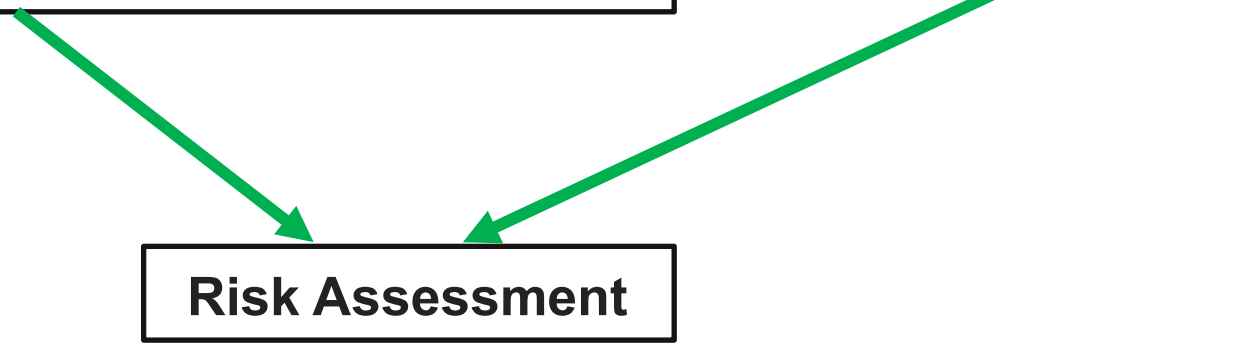
Likelihood

Erosion Hazard (Years)	No. of Maintenance Holes	% of Dataset
50+	241	63%
30 – 50	32	8%
15 – 30	36	9%
5 – 15	24	6%
0 – 5	48	13%

+ MH Condition

Consequence

Environmental, Economic, Social



RESULTS – RISK ASSESSMENT

Results can be used to prioritize resources for site investigation and potentially mitigation

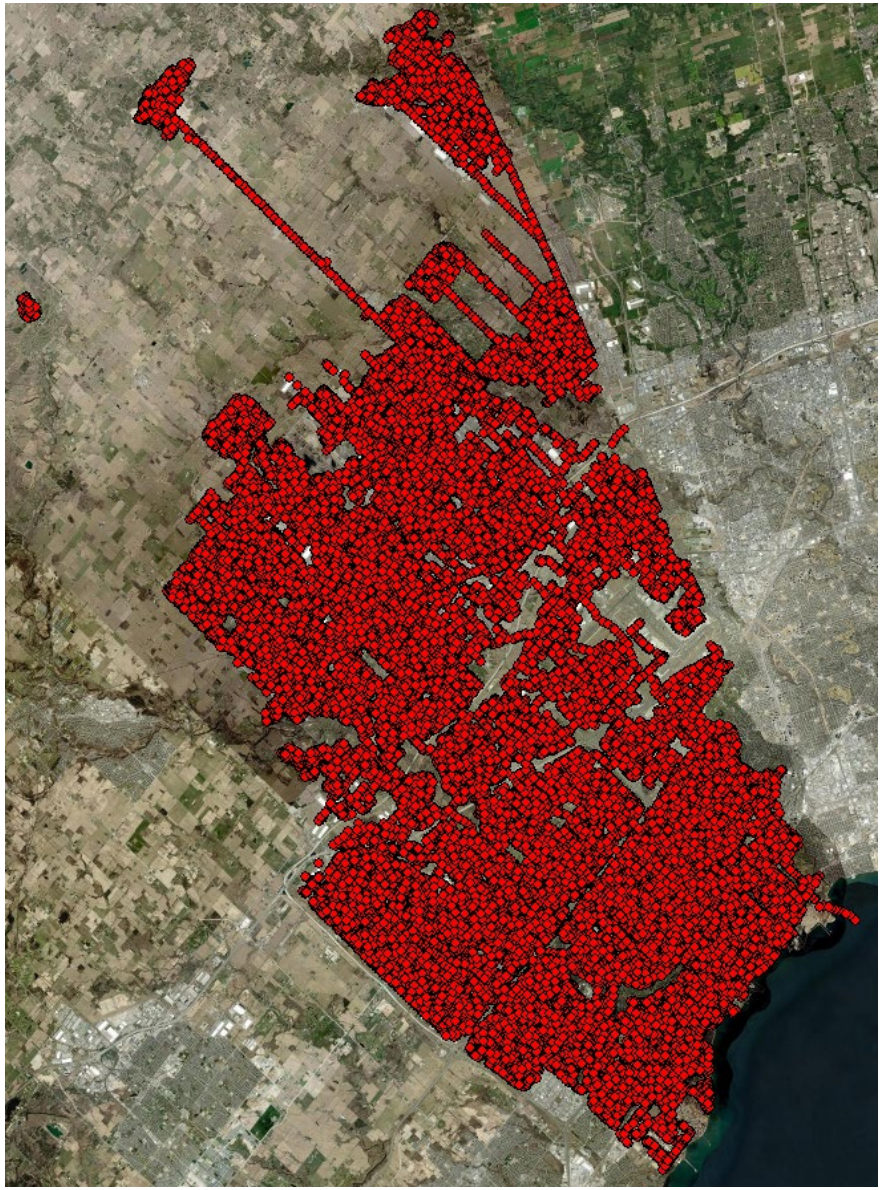
Risk	No. of Maintenance Holes	% of Dataset
Low	138	36%
Medium	177	47%
High	66	17%

Next Steps and Summary

NEXT STEPS

Site assessments to 66 high-risk sites (confirm mitigation approach)

Region expanded erosion hazard review to all MHs (~56,000) within the region



KEY TAKEAWAYS

- Lots of potential for interaction between the built environment and watercourses
- **Understanding geomorphological processes** allows asset managers to **prioritize resources**
- **Reach-scale erosion rate mapping is an effective** tool for **triaging** infrastructure based on relative lateral erosion hazards
- **Geomorphology** can be leveraged **throughout the entire asset management lifecycle** from planning to implementation

Questions?

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