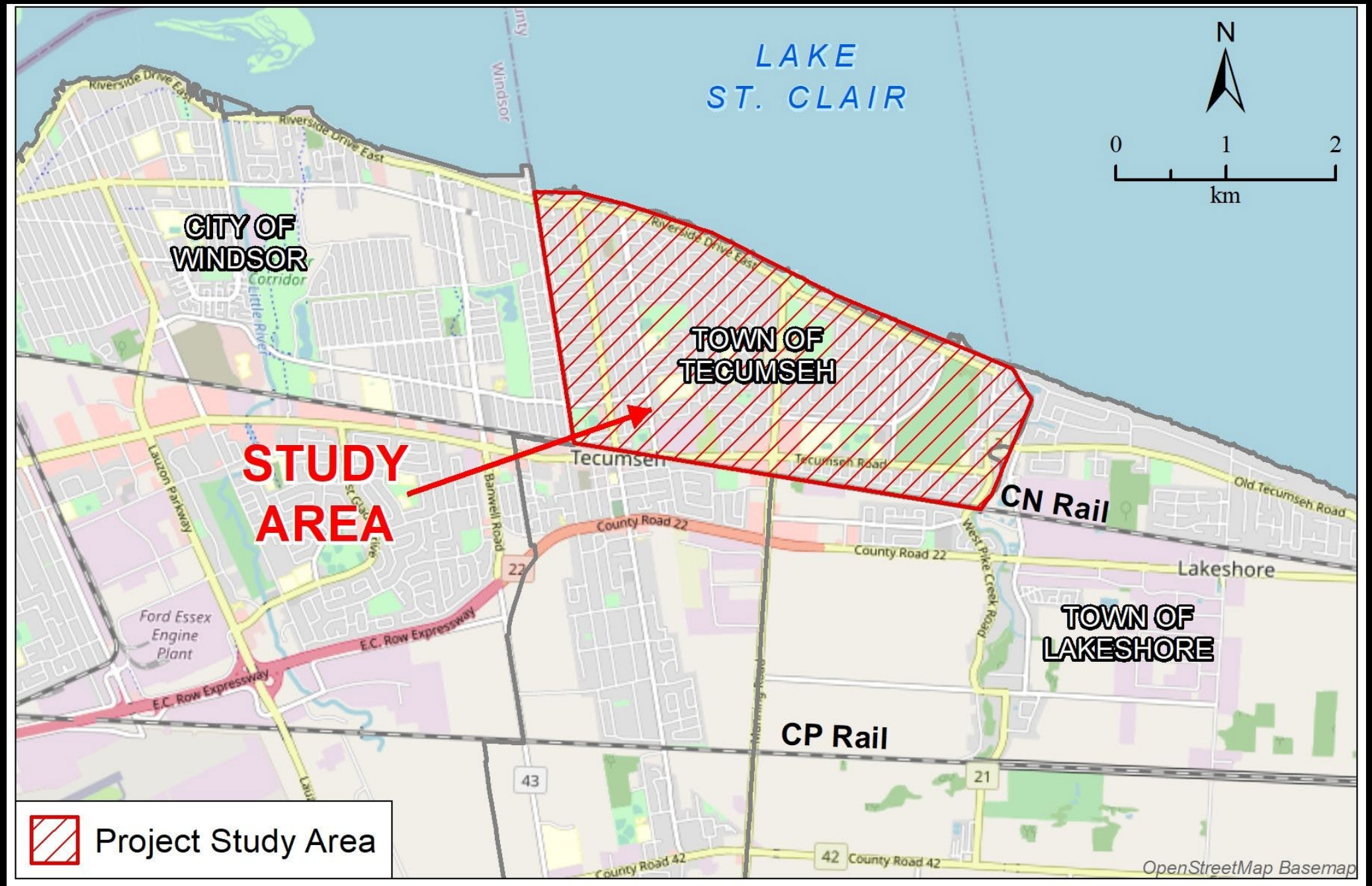
Town of Tecumseh
Coastal Flood Risk Assessment

Council Presentation

February 2023

Study Area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CITY OF
WINDSOR
TOWN OF
TECUMSEH
STUDY
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CP Rail
TOWN OF
LAKESHORE
Lakeshore
Tecumseh
Riverside Drive East
Windsor
Corridor
Little River
Lauzon Parkway
Ford Essex
Engine
Plant
E.C. Row Expressway
Tecumseh Road
County Road 22
Old Tecumseh Road
West Pike Creek Road
Barnwell Road
County Road 42
22
43
21
42
Project Study Area
OpenStreetMap Basemap

PRESENTATION OVERVIEW

- Field Data Collection
- Coastal Hazard Analysis
- Flood Risk Assessment
- Adaptation Options
- Next Steps
- Questions

FIELD DATA COLLECTION

Sample of Oblique Photos


Pike Creek Jetties


West Project Boundary

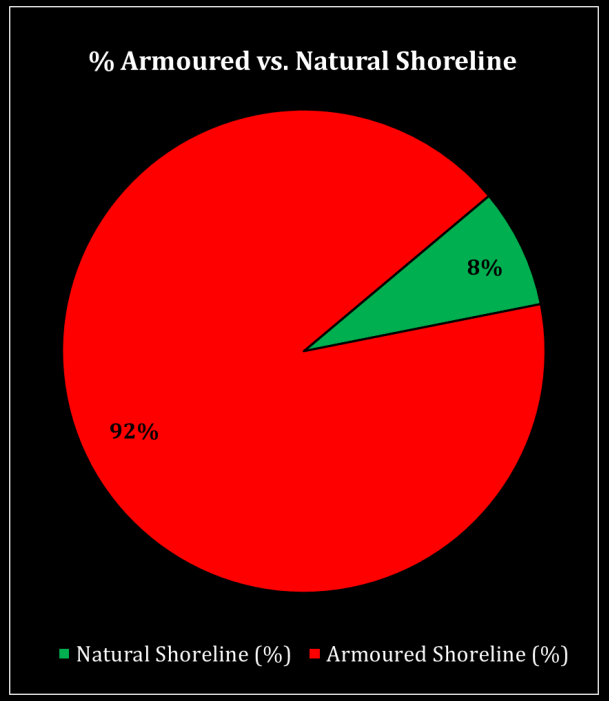

Lakewood Park

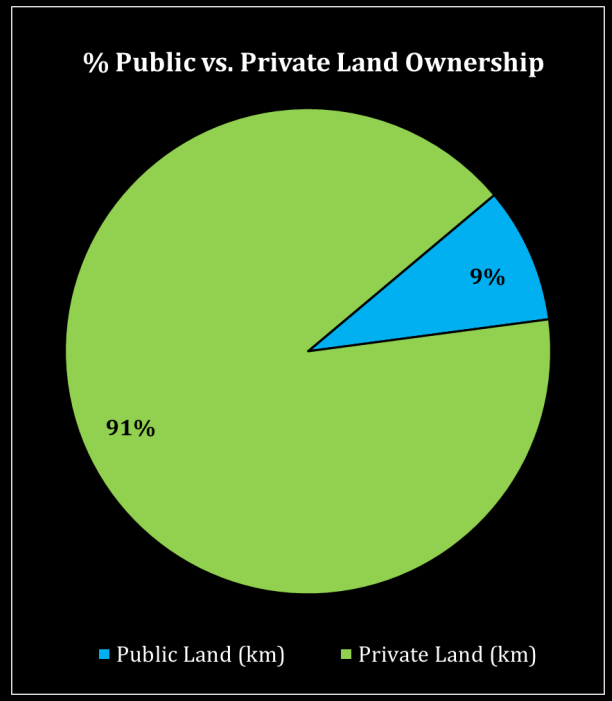

Chippewa Park

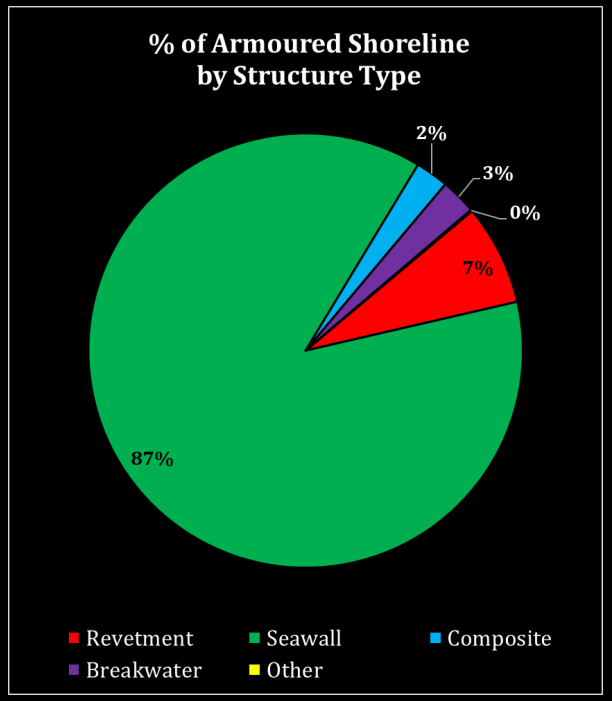
Shore Protection Database

- Shoreline protection database was assembled for the entire study shoreline from oblique photos
- Summary statistics:
  - Armoured vs. natural shoreline
  - Public versus private
  - Structure type
  - Structure condition

Sample Statistics:

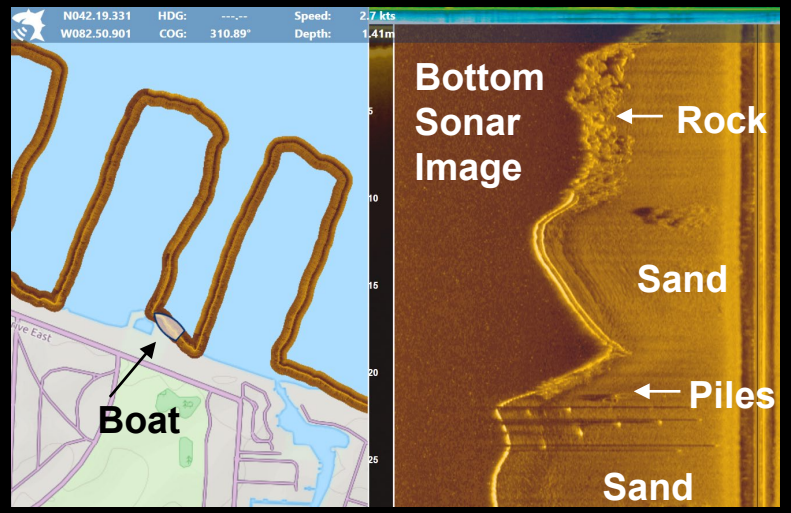


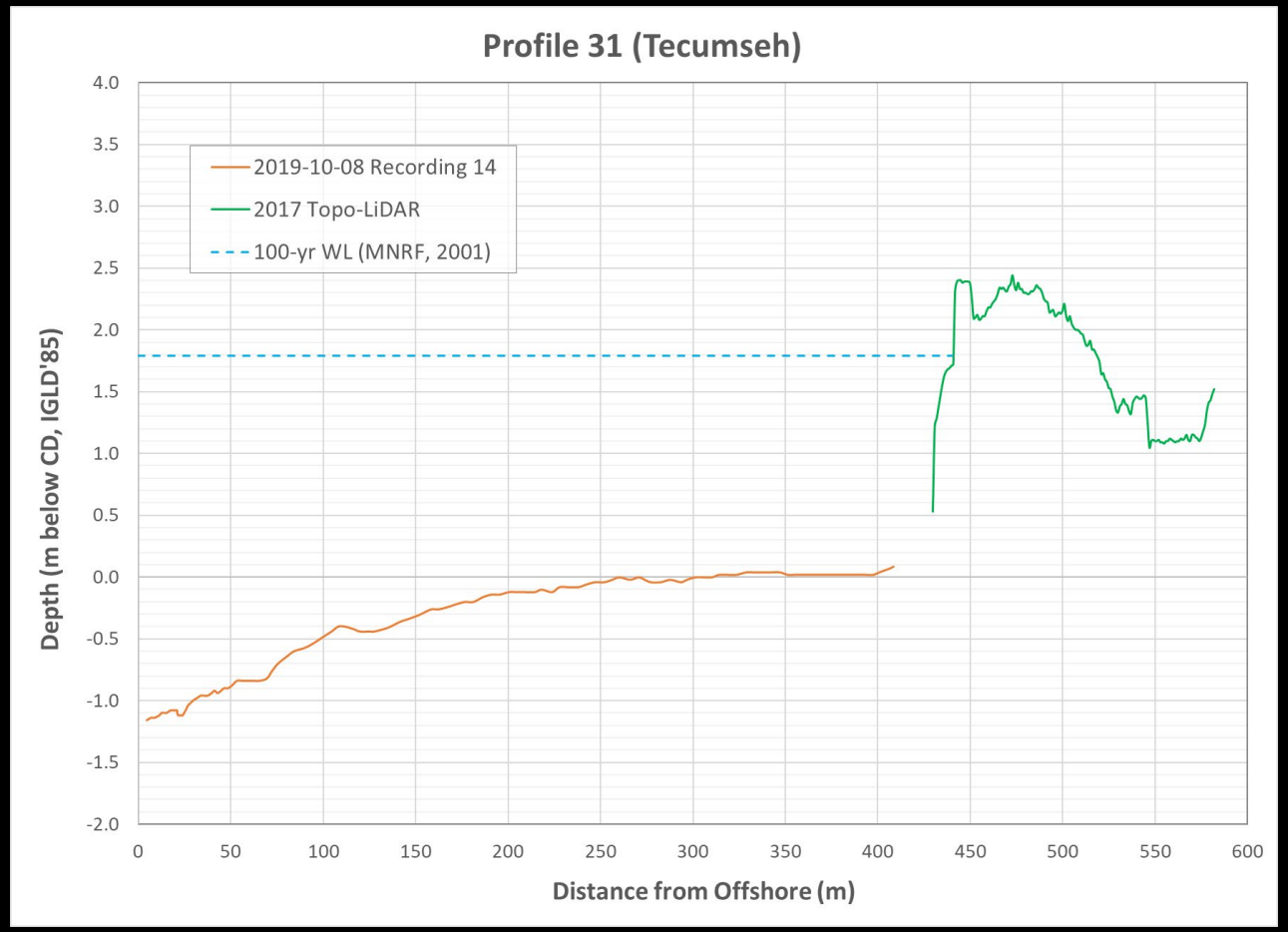




Bathymetric Survey

- Lakebed depths and substrate logged using SOLIX™ 2D Sonar instrument





Detailed Topographic Shoreline Survey

by JD Barnes

Zuzek inc.
ONE WORLD
www.zuzekinc.com

Aug. 2020 Topographic Survey By JD Barnes

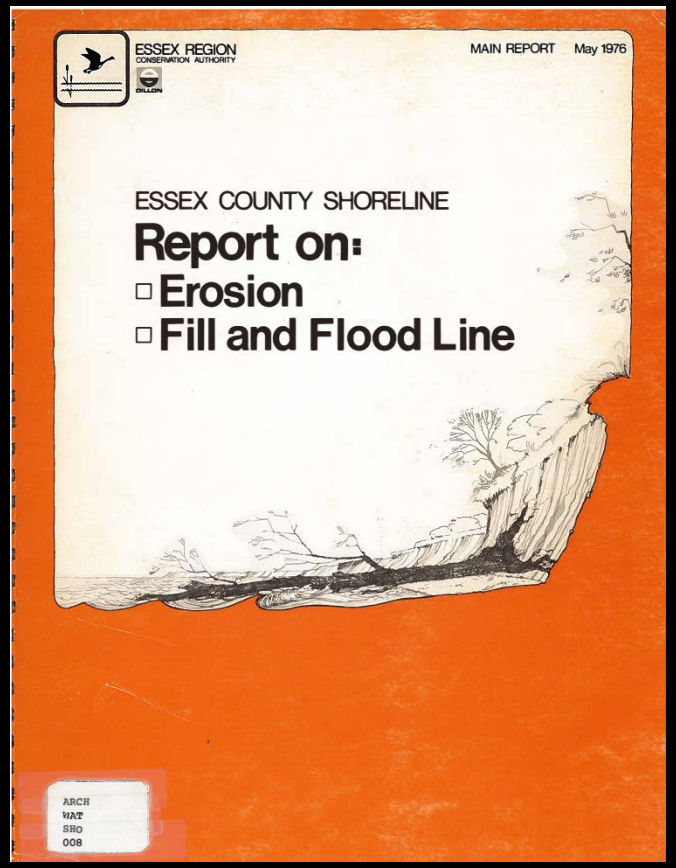
Town of Tecumseh

Data Sources:
1) 2019 ortho provided by the County of Essex.

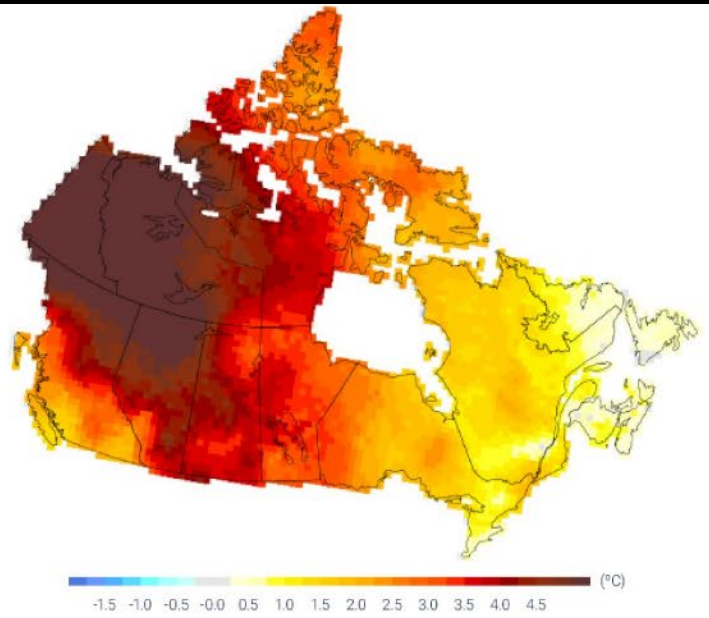
N E S W

0 500 m

COASTAL HAZARD ANALYSIS

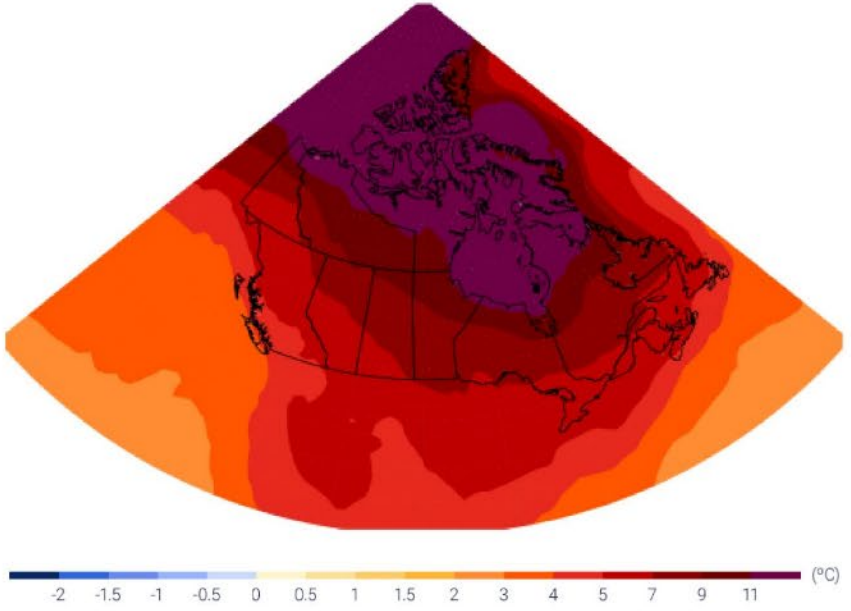


1948 to 2016 Winter Air Temperature Increase



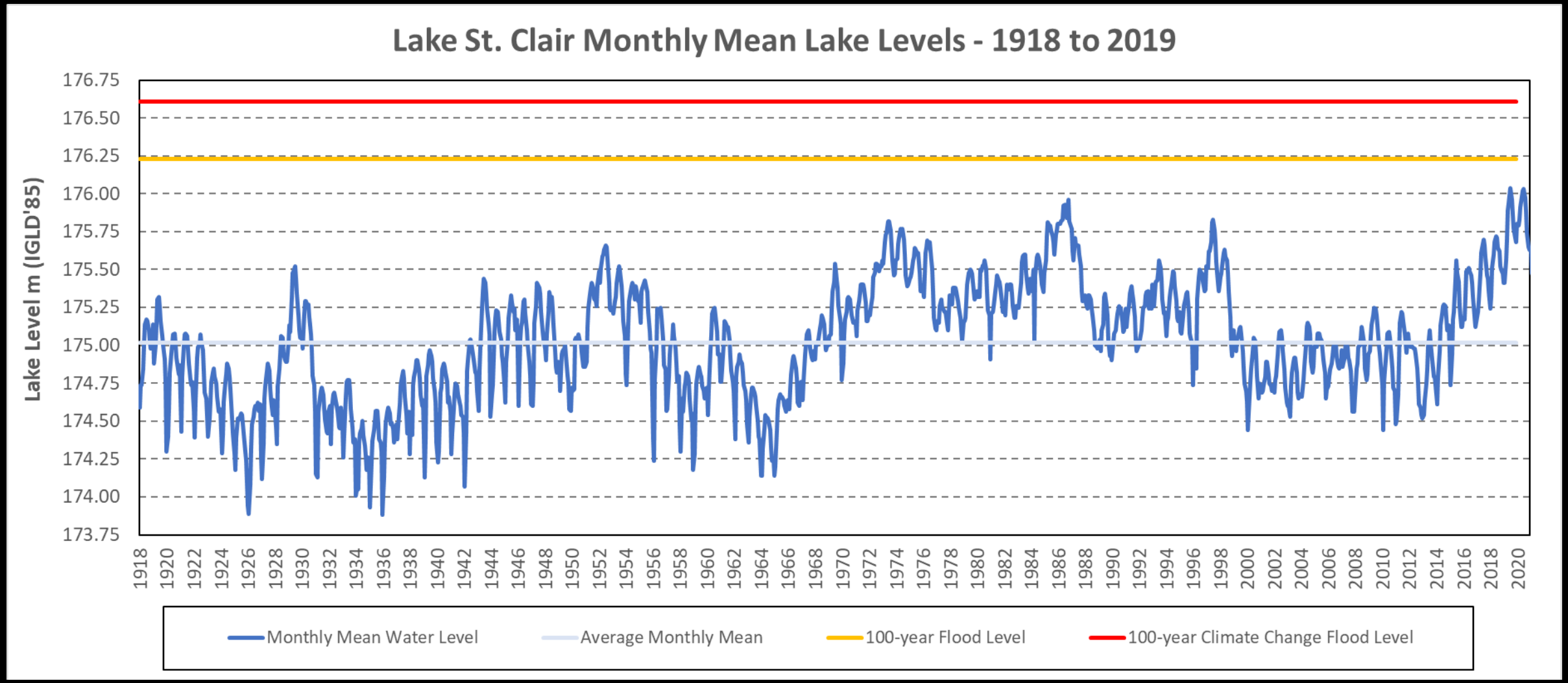
Source: Vincent et al. 2015. In 'Zhang, X., Flato, G., Kirchmeier-Young, M., Vincent, L., Wan, H., Wang, X., Rong, R., Fyfe, J., Li, G., Kharin, V.V. (2019): Changes in Temperature and Precipitation Across Canada; Chapter 4 in Bush, E. and Lemmen, D.S. (Eds.) Canada's Changing Climate Report. Government of Canada, Ottawa, Ontario, pp 112-193'.

2081-2100 Winter Warming Projection for RCP8.5



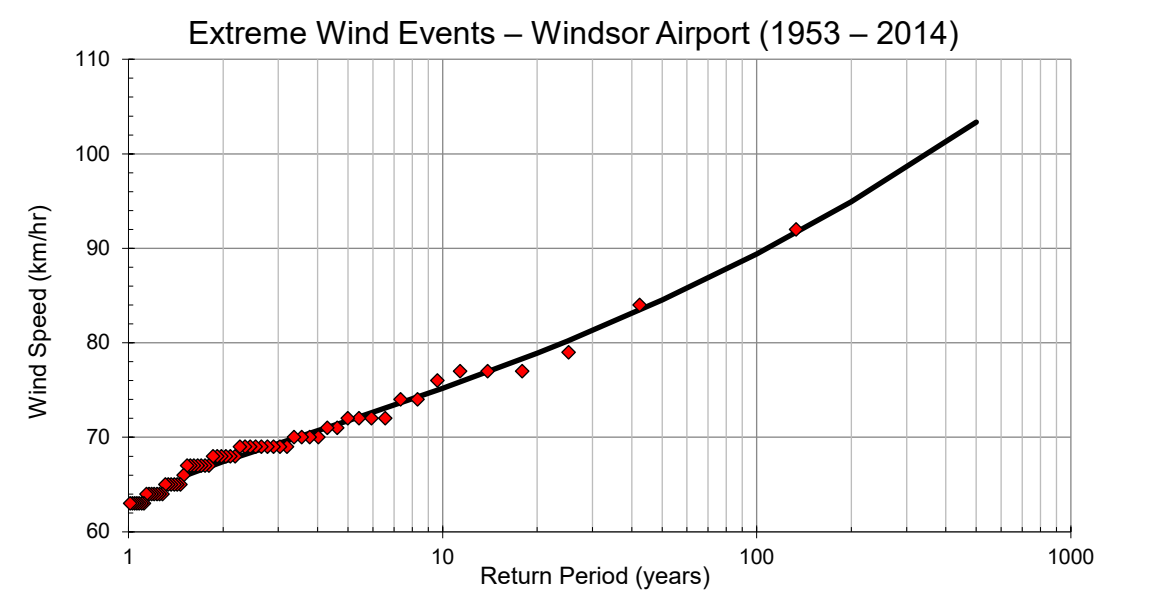
Source: Climate Research Division, Environment and Climate Change Canada. In 'Zhang, X., Flato, G., Kirchmeier-Young, M., Vincent, L., Wan, H., Wang, X., Rong, R., Fyfe, J., Li, G., Kharin, V.V. (2019): Changes in Temperature and Precipitation Across Canada; Chapter 4 in Bush, E. and Lemmen, D.S. (Eds.) Canada's Changing Climate Report. Government of Canada, Ottawa, Ontario, pp 112-193'.

Historical Water Levels, 100-year Flood Level, and 100-year Climate Change Flood Level



Analysis of Storm Waves

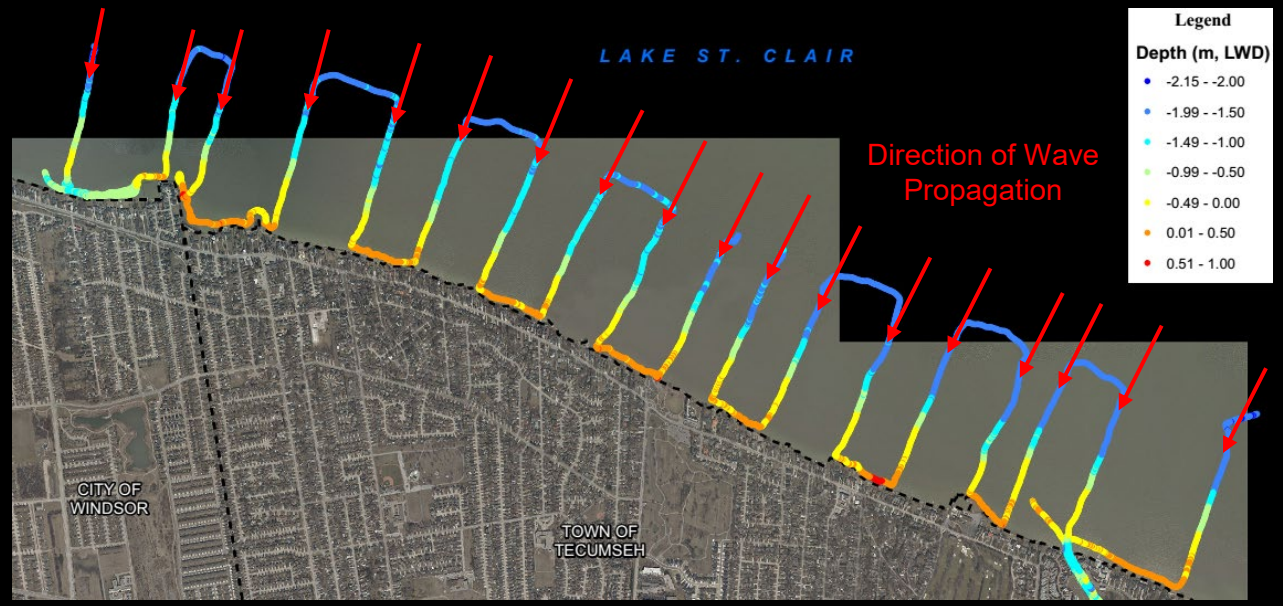
- Wave hindcast performed to predict wave generation over Lake St. Clair during extreme wind events (i.e., 100-year, etc.) from Windsor Airport
  - Validated against available wave buoy data (2000 – 2019, intermittent)



RP (years)	Wind Speed (km/hr)	1977 SPM – Shallow Water	
		Wave Height (m)	Wave Period (s)
1.5	66.07	1.30	4.7
2	67.53	1.32	4.7
5	71.82	1.37	4.8
10	75.33	1.42	4.9
20	79.31	1.46	5.0
25	80.72	1.48	5.0
50	85.54	1.53	5.2
100	91.18	1.59	5.3
200	97.78	1.65	5.4
500	108.30	1.75	5.7

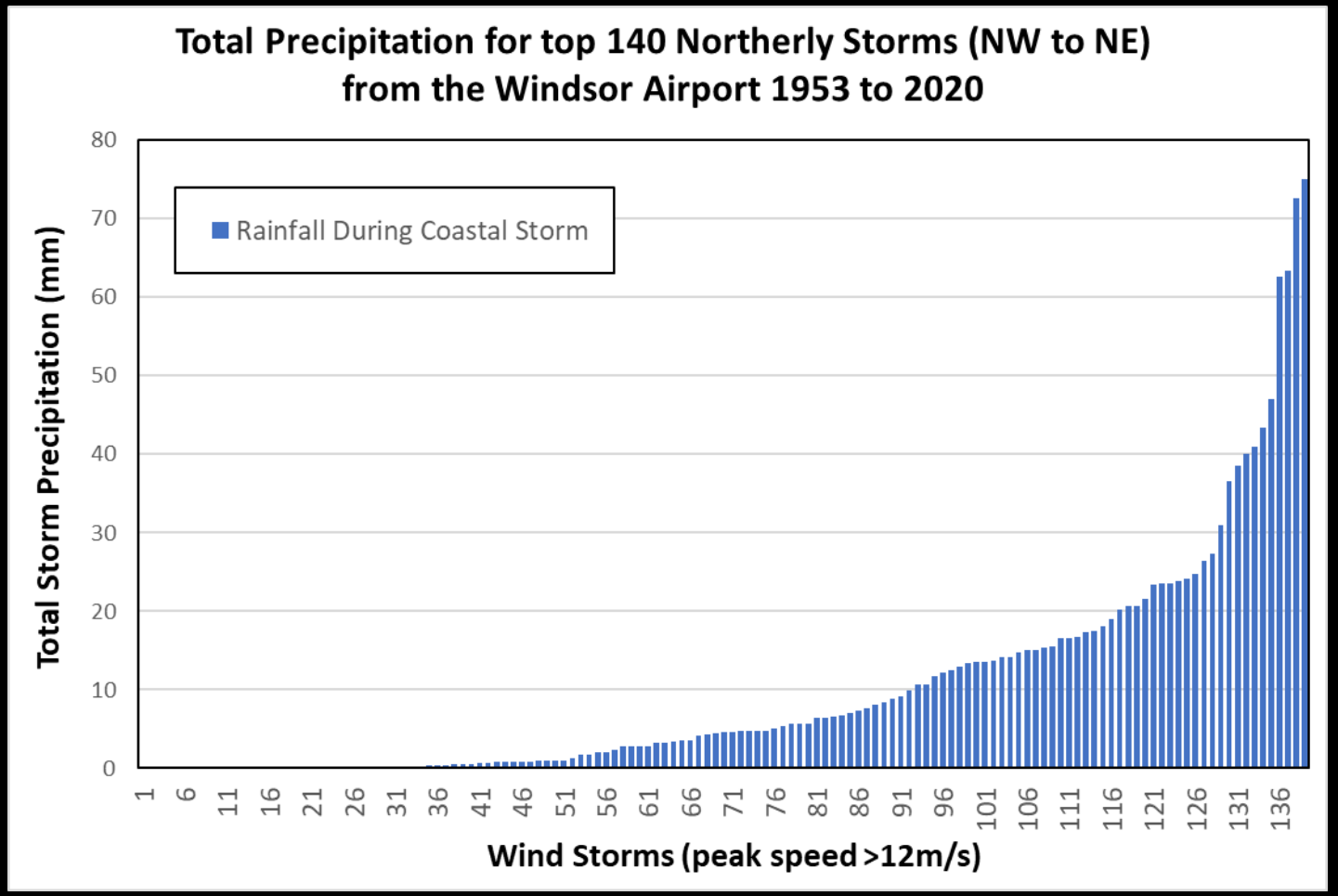
Analysis of Storm Waves

- Offshore waves transformed to Tecumseh shoreline at each bathymetric profile
  - Includes effects of shoaling, refraction and wave breaking
- 100-year wave conditions output at toe of shoreline protection & beaches
  - Used in wave runup and overtopping calculations to inform flood mapping
  - Used in development of risk mitigation concepts, including recommendations for shoreline protection structures



Combined Rainfall and Coastal Flooding Events (wave overtopping)

- Leverage results from Dillon (2019) for rainfall flood risk
- Roughly 70% of the historical coastal storm events featured some rainfall
- Storms with coastal flooding and rainfall will be evaluated



FLOOD RISK ASSESSMENT

“4 feet of water on Riverside Drive”

Windsor Star

Historical Context: Saint Patrick's Day Storm of 1973

- Major coastal storm on March 17, 1973
- Peak water level at Belle River reached +176.19 m IGLD85'
  - 4 cm below predicted 100-year flood level
  - Mean Lake Level = +175.83 (50-year for March)
  - Storm Surge = 0.36 m (25-year)
  - Significant wave height event


St. Clair Beach Police Station


Riverside Drive


Tecumseh Road


Arlington Blvd.

PROPERTY PARCEL DATABASE

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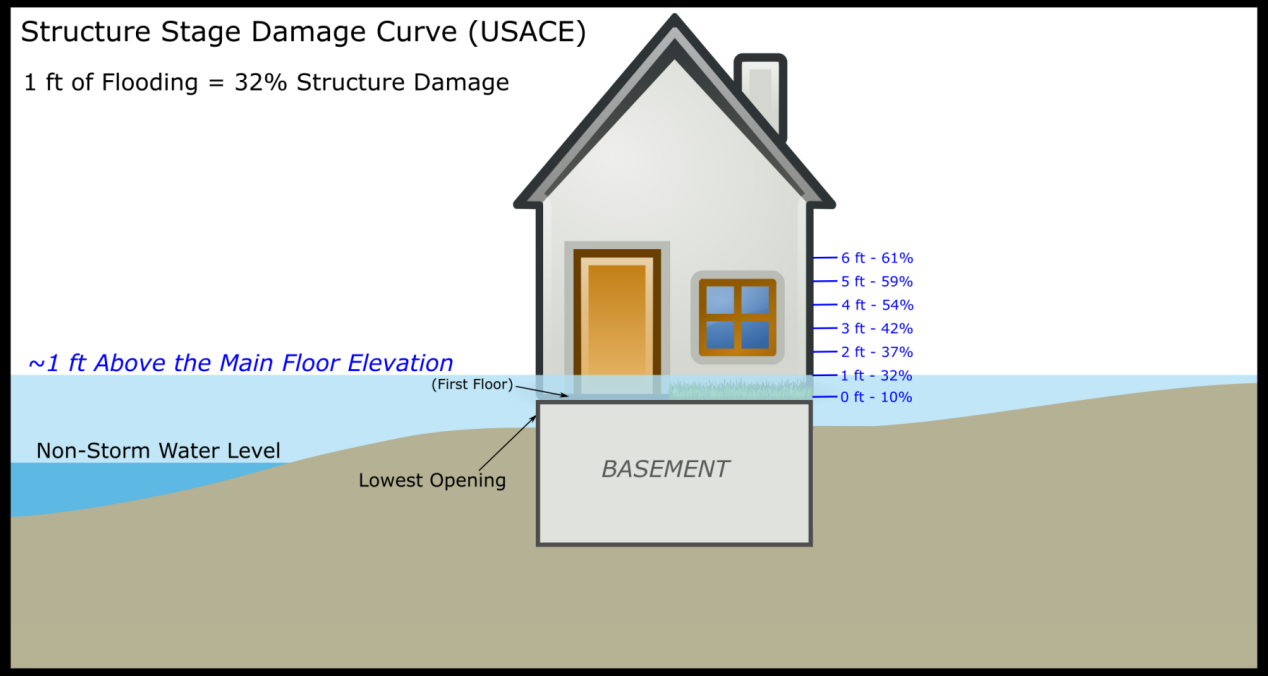
Parcel Database
Collection of Estimated First Floor Elevations

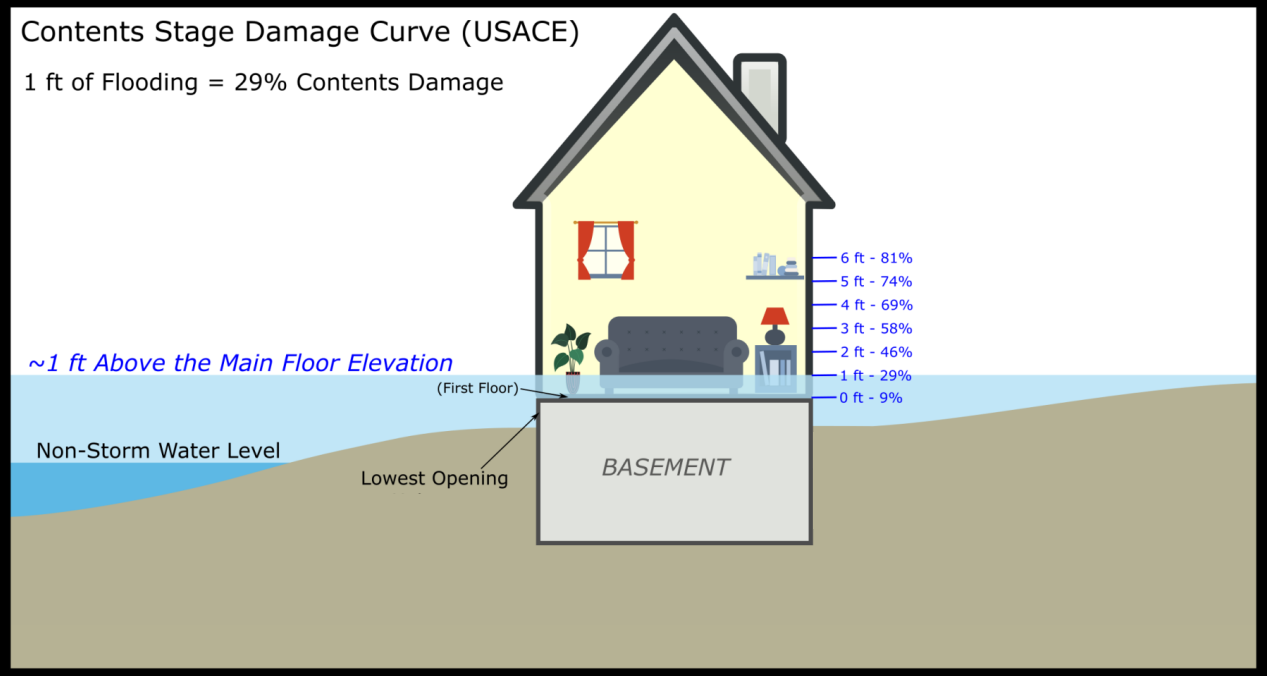
Town of Tecumseh

Data Sources:
1) 2019 ortho provided by the Cou
Essex.

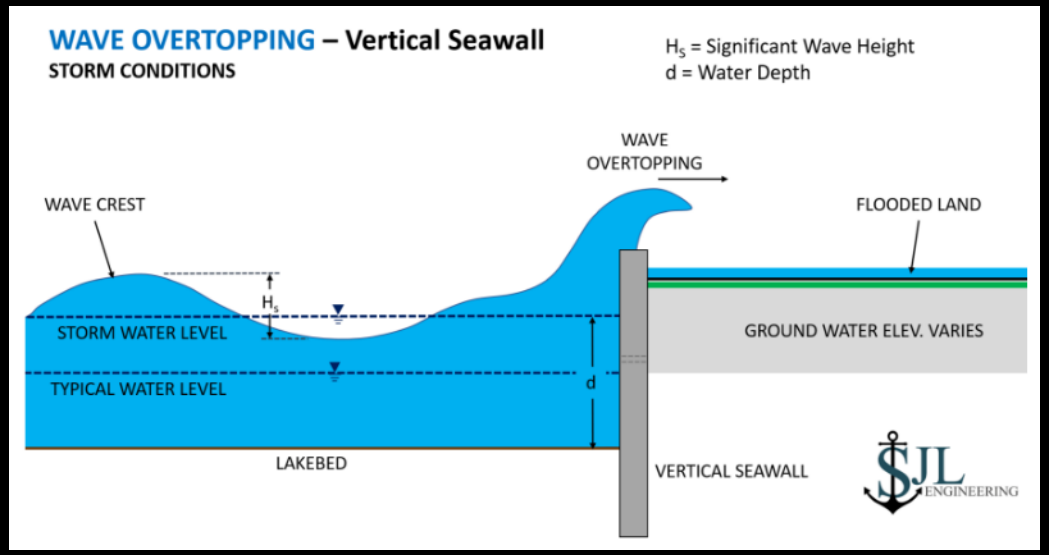
Flood Damage Methodology

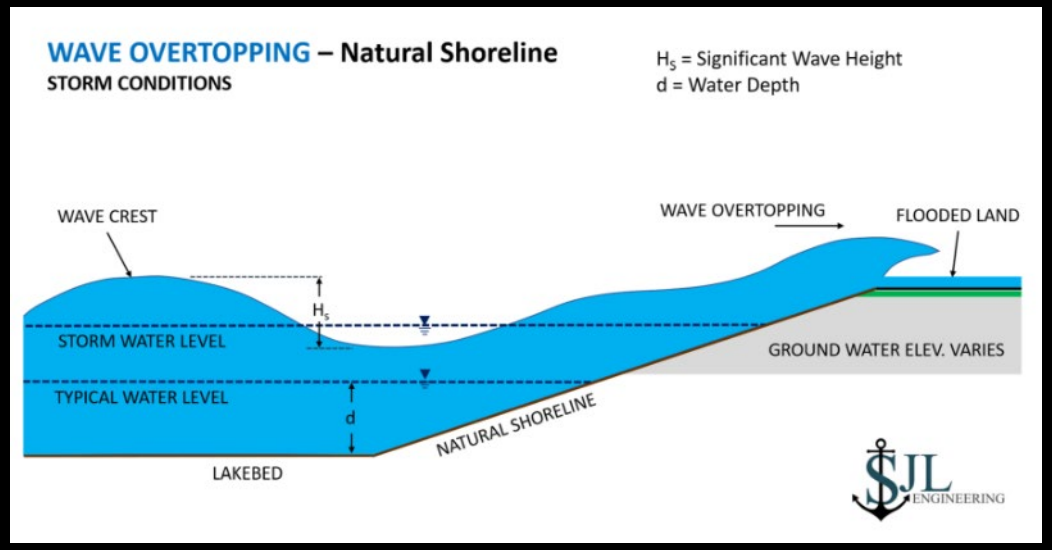
- Property value based on current assessment value (not market value)
- Building and content damages increase with the depth of flooding above the first floor (USACE methodology in graphics below)



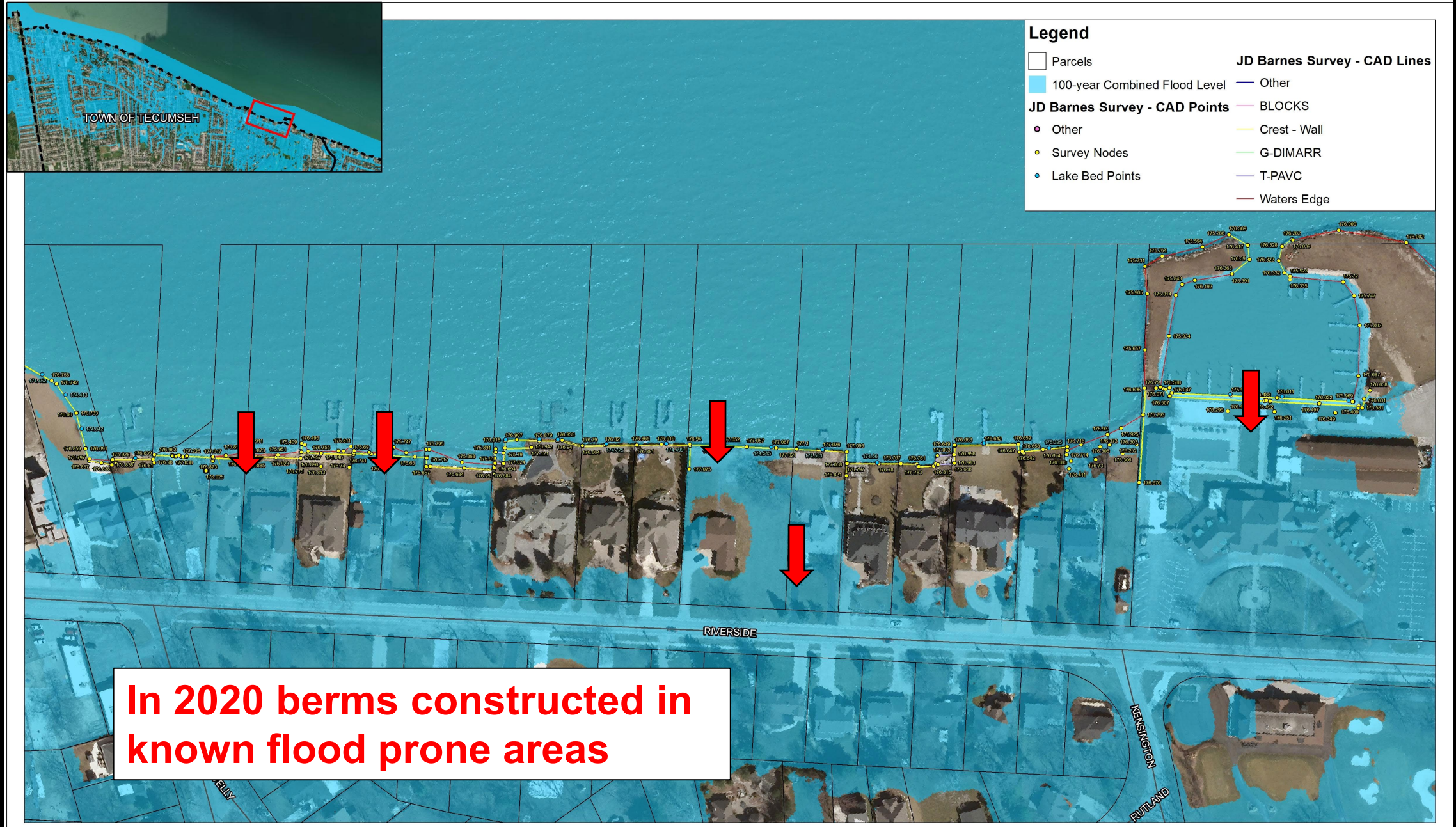


Wave Overtopping Pushes Water over the Shore Protection and onto Riverside Drive





FLOOD PATHWAYS



TOWN OF TECUMSEH
FLOOD RISK STUDY

Flood Pathway for 100-year Combined Flood Level

Notes:
JD Barnes survey elevations in CGVD'28, m.
For Tecumseh, IGLD'85 - CGVD'28 = ~0 m.

0 50
m

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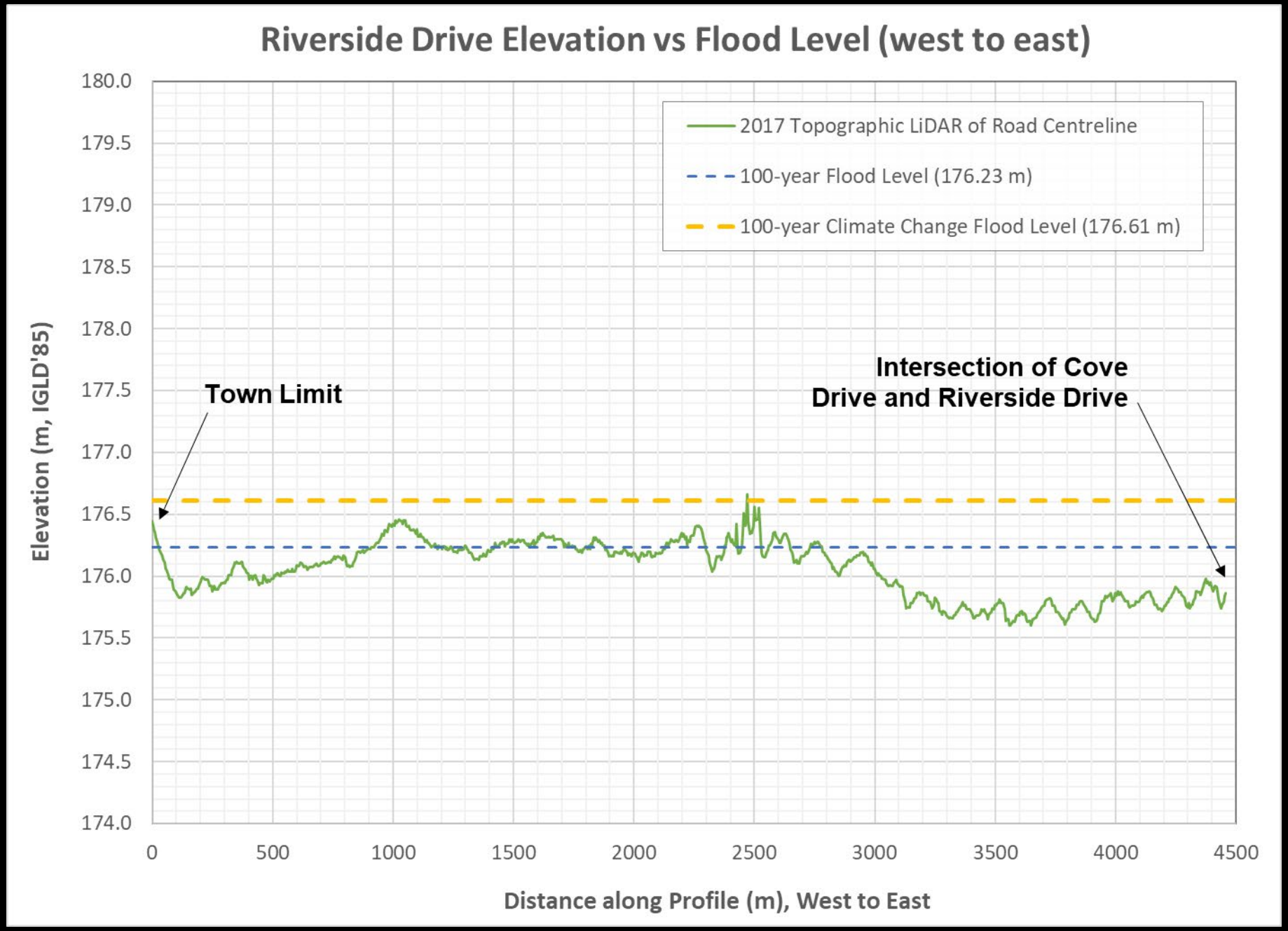
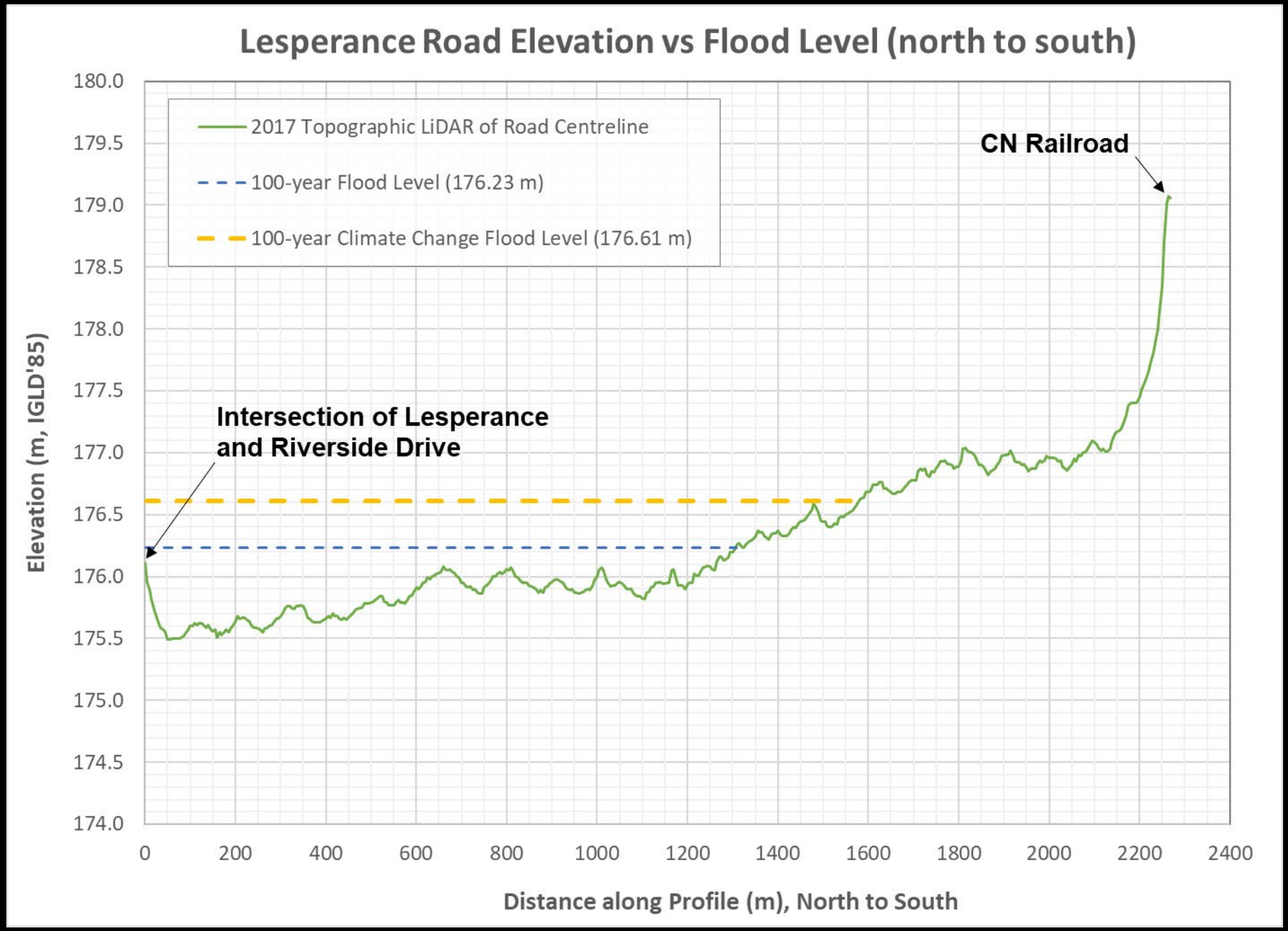
ONE WORLD

Road Elevation versus Flood Elevation



Road Elevation versus Flood Elevation



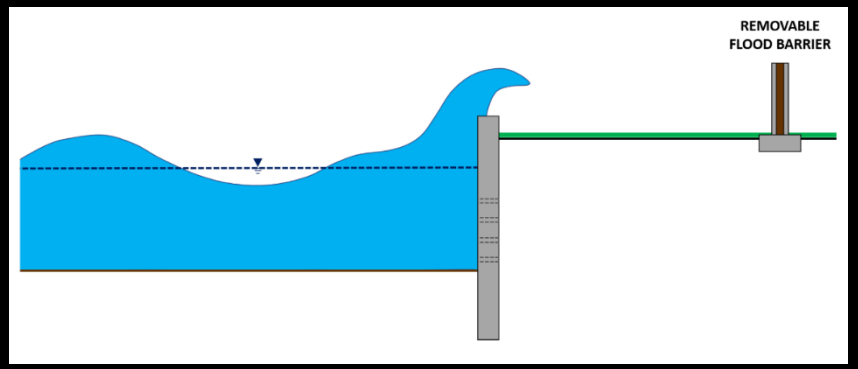
SCENARIO A FLOOD ANIMATION (30 hours)

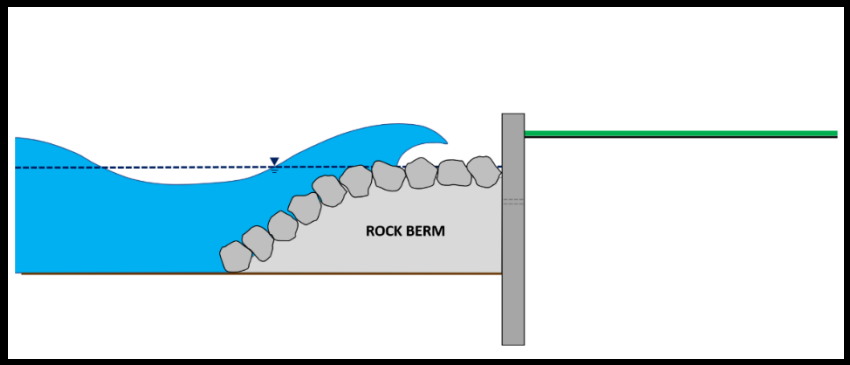
110 Buildings with first floor flooding, $24-$37 million

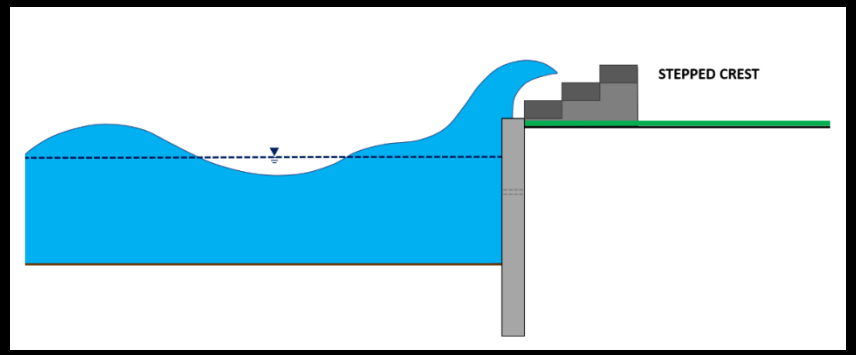
SCENARIO C FLOOD ANIMATION (30 hours)

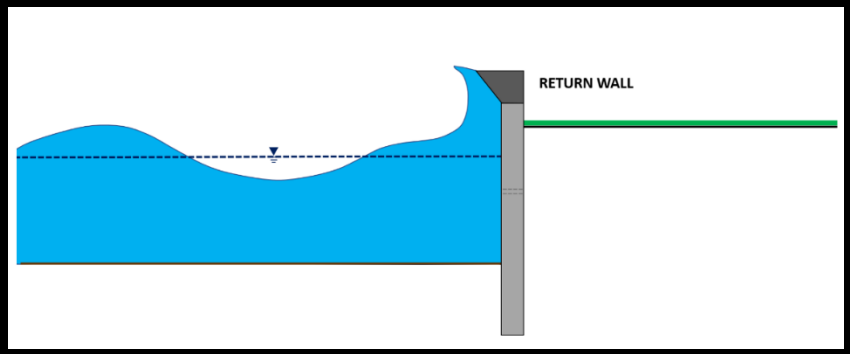
730 Buildings with first floor flooding, $124-$188 million

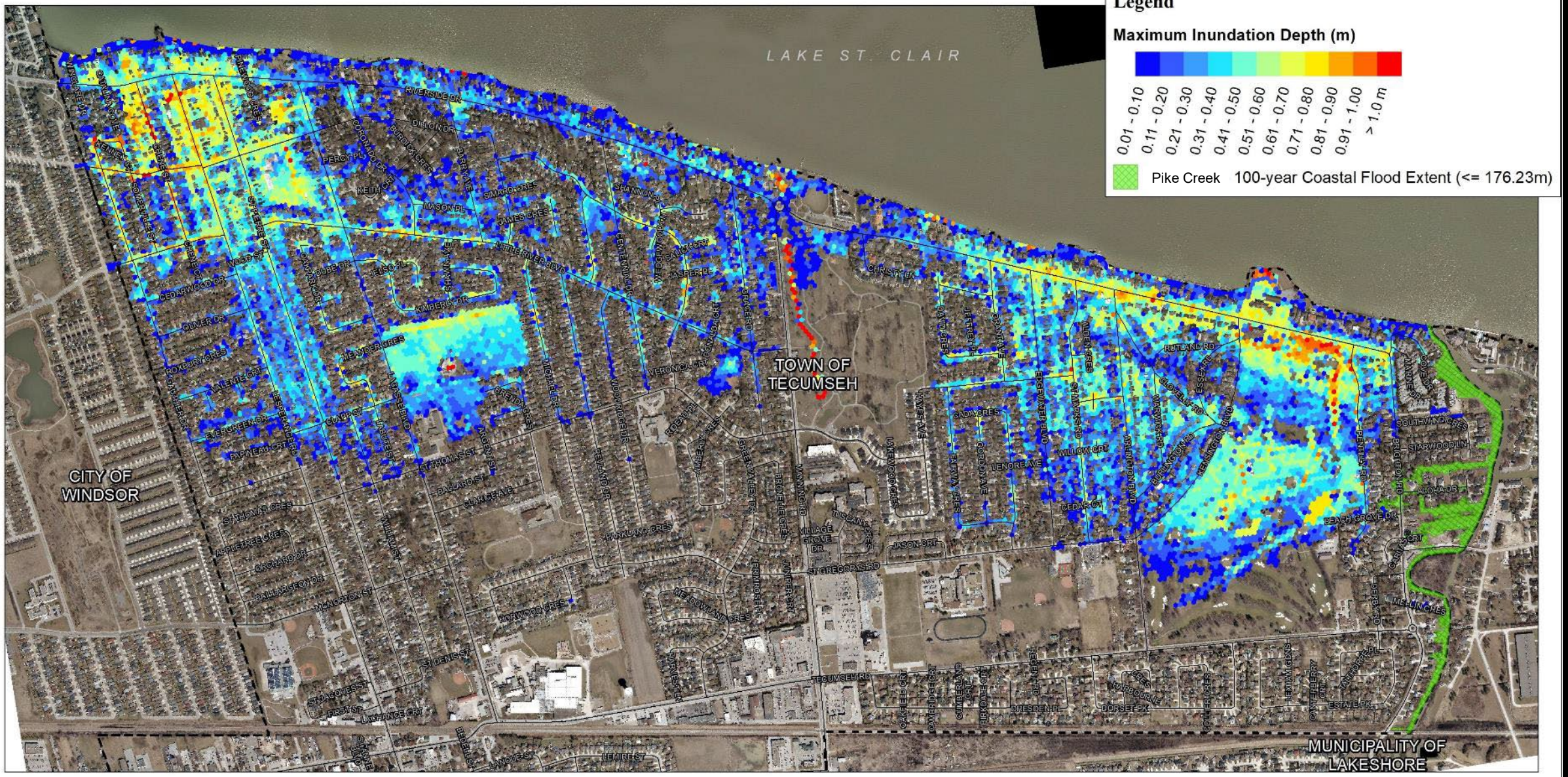
ADAPTATION OPTIONS TO REDUCE FLOOD RISK AND FUTURE DAMAGES











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Scenario A
100-year Coastal Flood with No Rain

Town of Tecumseh

Notes:
1) Wave overtopping calculations by SJL Engineering
2) Pike River flood analysis by Zuzek Inc.
3) Interior flood modelling by Dillon Consulting
4) 2019 aerial provided by the County of Essex

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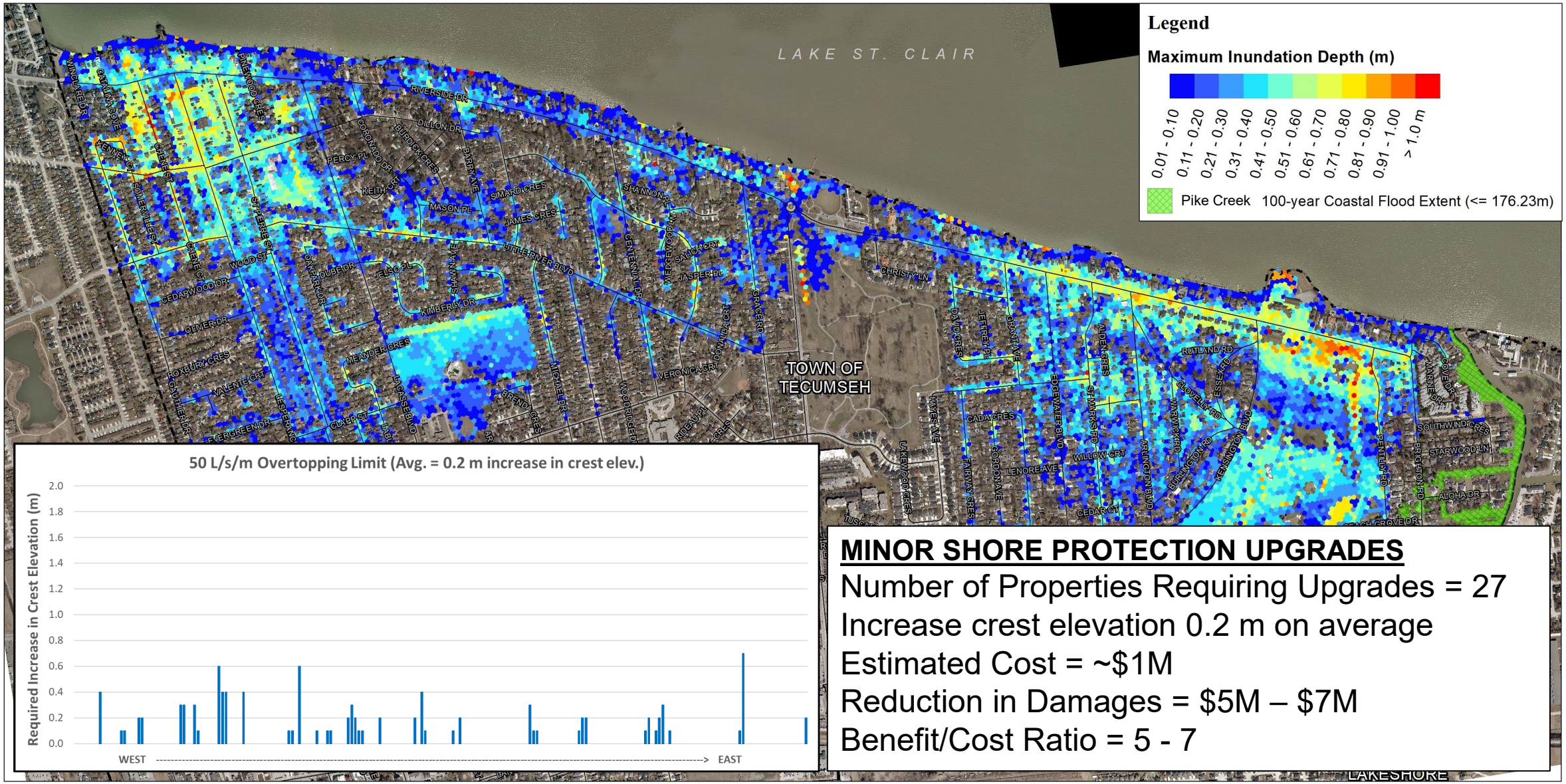

MINOR SHORE PROTECTION UPGRADES

Number of Properties Requiring Upgrades = 27
Increase crest elevation 0.2 m on average
Estimated Cost = ~$1M
Reduction in Damages = $5M – $7M
Benefit/Cost Ratio = 5 - 7

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Scenario H
100-year Coastal Flood with No Rain
Shore Protection Upgraded to Limit Overtopping to 50 L/s/m
Town of Tecumseh

Notes:
1) Wave overtopping calculations by SJL Engineering
2) Pike River flood analysis by Zuzek Inc.
3) Interior flood modelling by Dillon Consulting
4) 2019 aerial provided by the County of Essex

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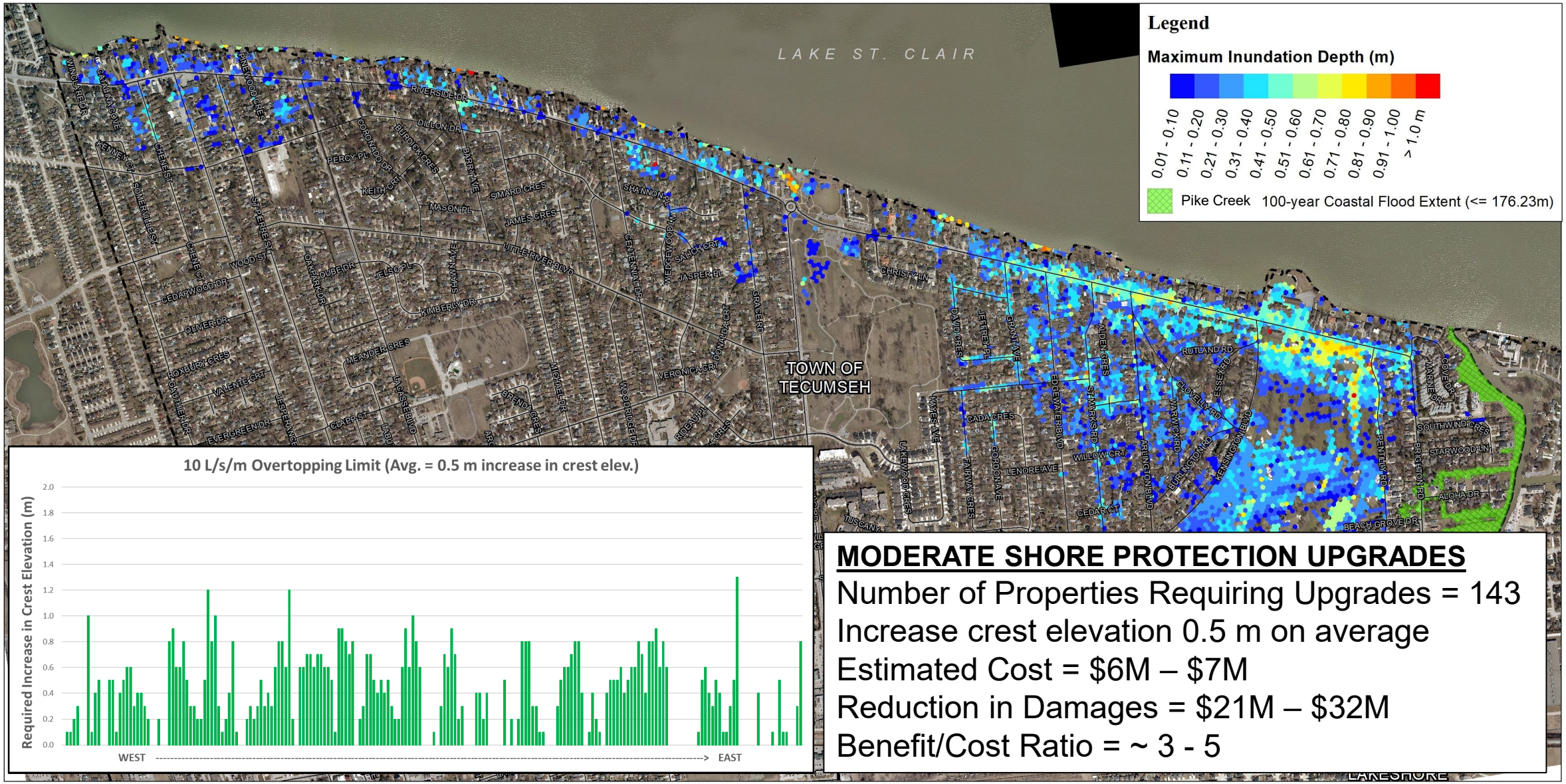

MODERATE SHORE PROTECTION UPGRADES

Number of Properties Requiring Upgrades = 143
Increase crest elevation 0.5 m on average
Estimated Cost = $6M – $7M
Reduction in Damages = $21M – $32M
Benefit/Cost Ratio = ~ 3 - 5

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Scenario G
100-year Coastal Flood with No Rain
Shore Protection Upgraded to Limit Overtopping to 10 L/s/m
Town of Tecumseh

Notes:
1) Wave overtopping calculations by SJL Engineering
2) Pike River flood analysis by Zuzek Inc.
3) Interior flood modelling by Dillon Consulting
4) 2019 aerial provided by the County of Essex

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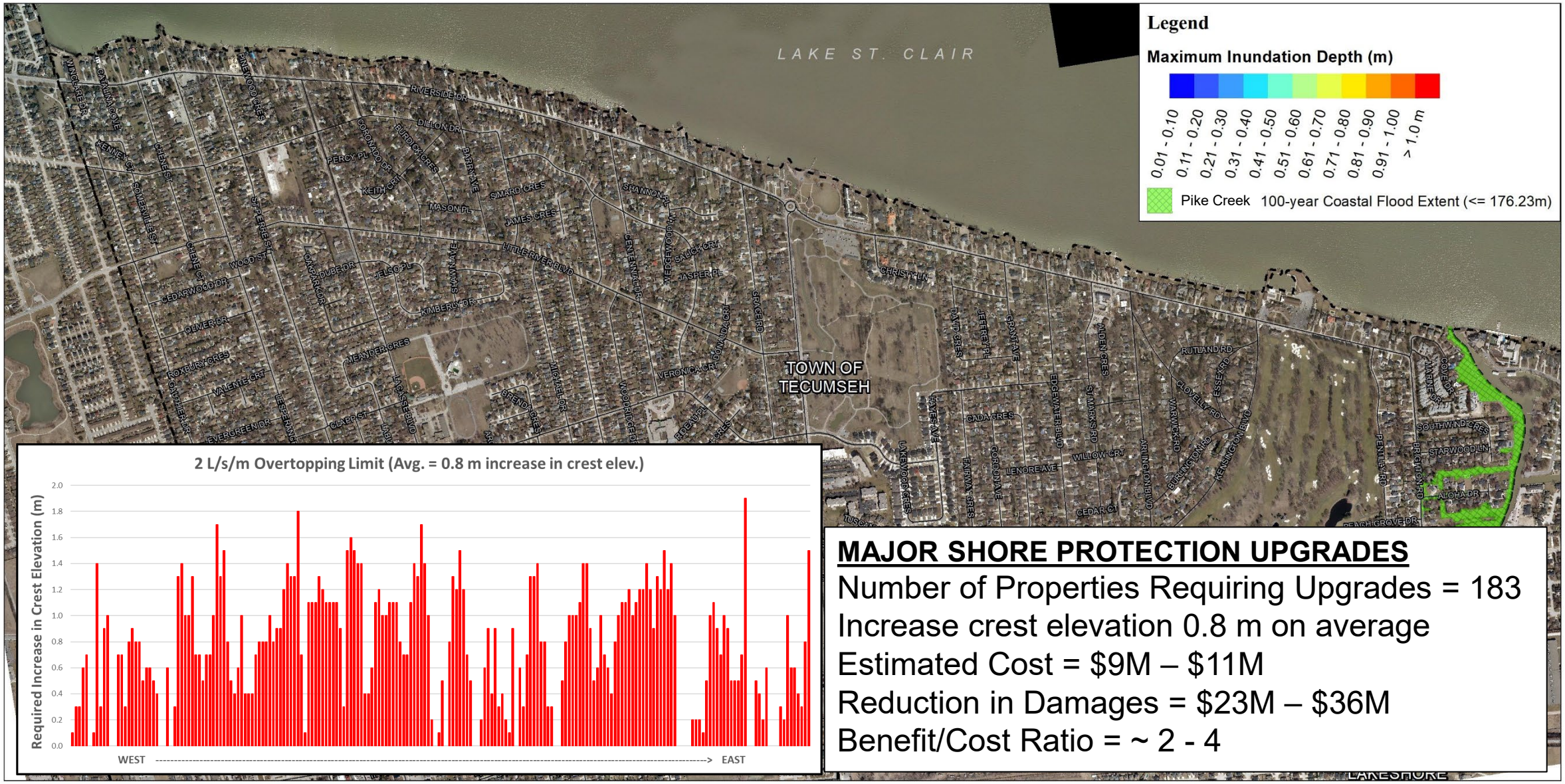

MAJOR SHORE PROTECTION UPGRADES

Number of Properties Requiring Upgrades = 183
Increase crest elevation 0.8 m on average
Estimated Cost = $9M – $11M
Reduction in Damages = $23M – $36M
Benefit/Cost Ratio = ~ 2 - 4

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Scenario F
100-year Coastal Flood
Shore Protection Upgraded to Limit Overtopping to 2 L/s/m
Town of Tecumseh

Notes:
1) Wave overtopping calculations by SJL Engineering
2) Pike River flood analysis by Zuzek Inc.
3) Interior flood modelling by Dillon Consulting
4) 2019 aerial provided by the County of Essex

N W E S
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FLOOD BARRIER FOR RIVERSIDE DRIVE AND A SMALL PORTION OF BRIGHTON ROAD

Continuous barrier along Riverside Drive and a portion of Brighton Road

Estimated Cost = not calculated

Reduction in Damages = $15M – $24M

Benefit/Cost Ratio = no calculated

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Scenario L
100-year Coastal Flood with No Rain
Hypothetical Riverside Drive Flood Barrier
Town of Tecumseh

Notes:
1) Wave overtopping calculations by SJL Engineering
2) Pike River flood analysis by Zuzek Inc.
3) Interior flood modelling by Dillon Consulting
4) 2019 aerial provided by the County of Essex

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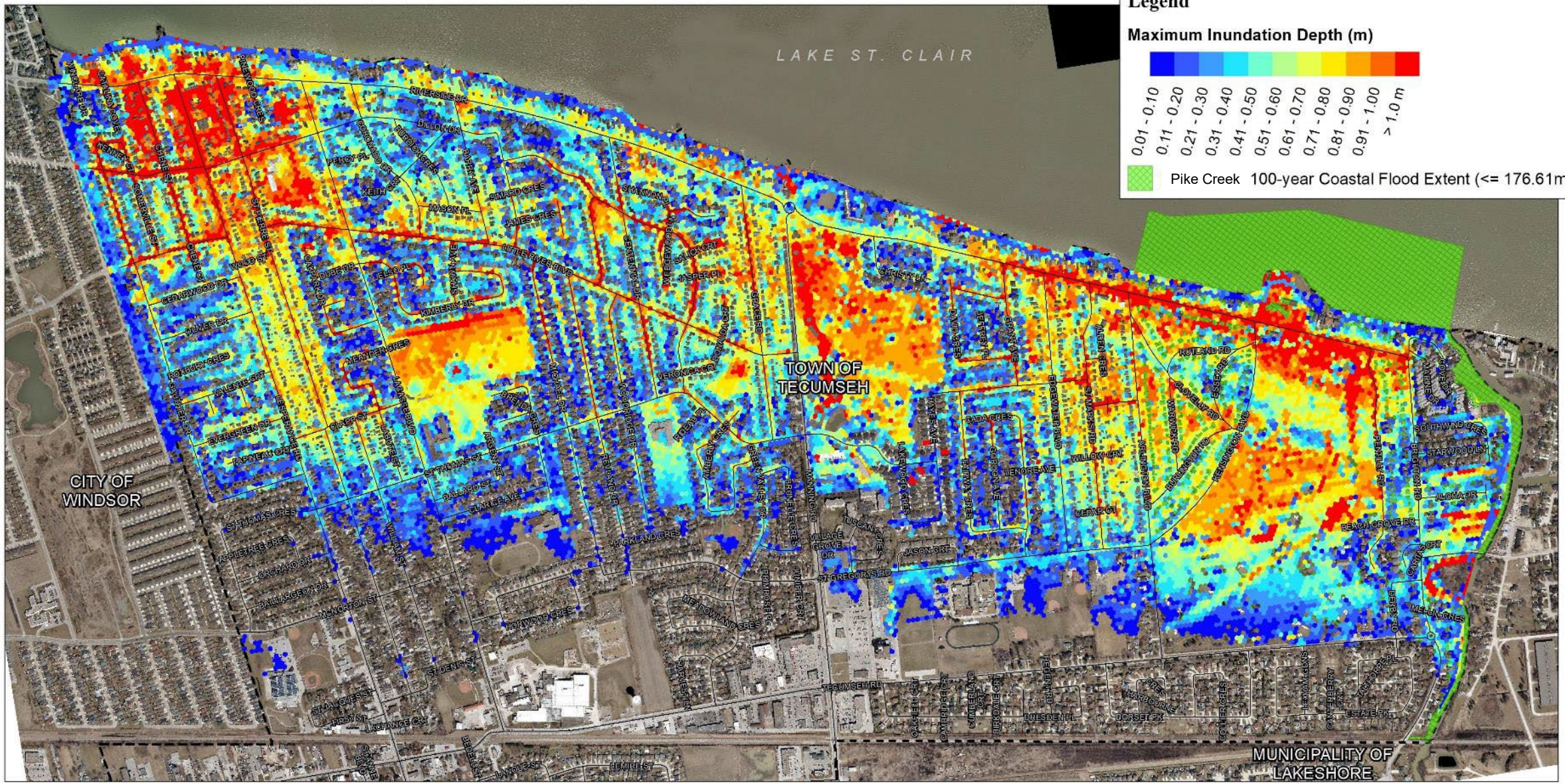

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Scenario C
100-year Climate Change Coastal Flood with No Rain

Town of Tecumseh

Notes:
1) Wave overtopping calculations by SJL Engineering
2) Pike River flood analysis by Zuzek Inc.
3) Interior flood modelling by Dillon Consulting
4) 2019 aerial provided by the County of Essex

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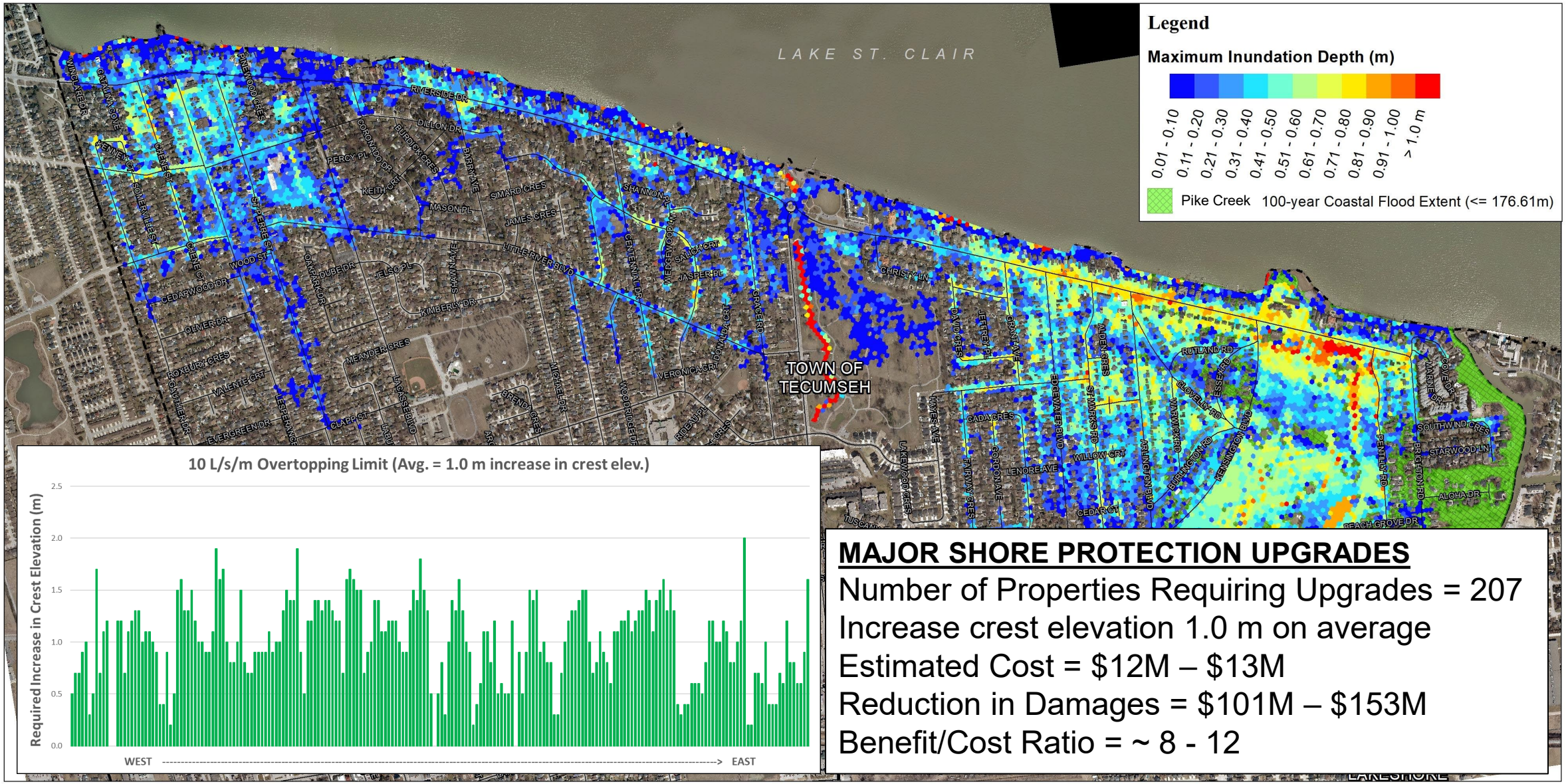

MAJOR SHORE PROTECTION UPGRADES

Number of Properties Requiring Upgrades = 207
Increase crest elevation 1.0 m on average
Estimated Cost = $12M – $13M
Reduction in Damages = $101M – $153M
Benefit/Cost Ratio = ~ 8 - 12

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Scenario J
100-year Climate Change Coastal Flood with No Rain
Shore Protection Upgraded to Limit Overtopping to 10 L/s/m
Town of Tecumseh

Notes:
1) Wave overtopping calculations by SJL Engineering
2) Pike River flood analysis by Zuzek Inc.
3) Interior flood modelling by Dillon Consulting
4) 2019 aerial provided by the County of Essex

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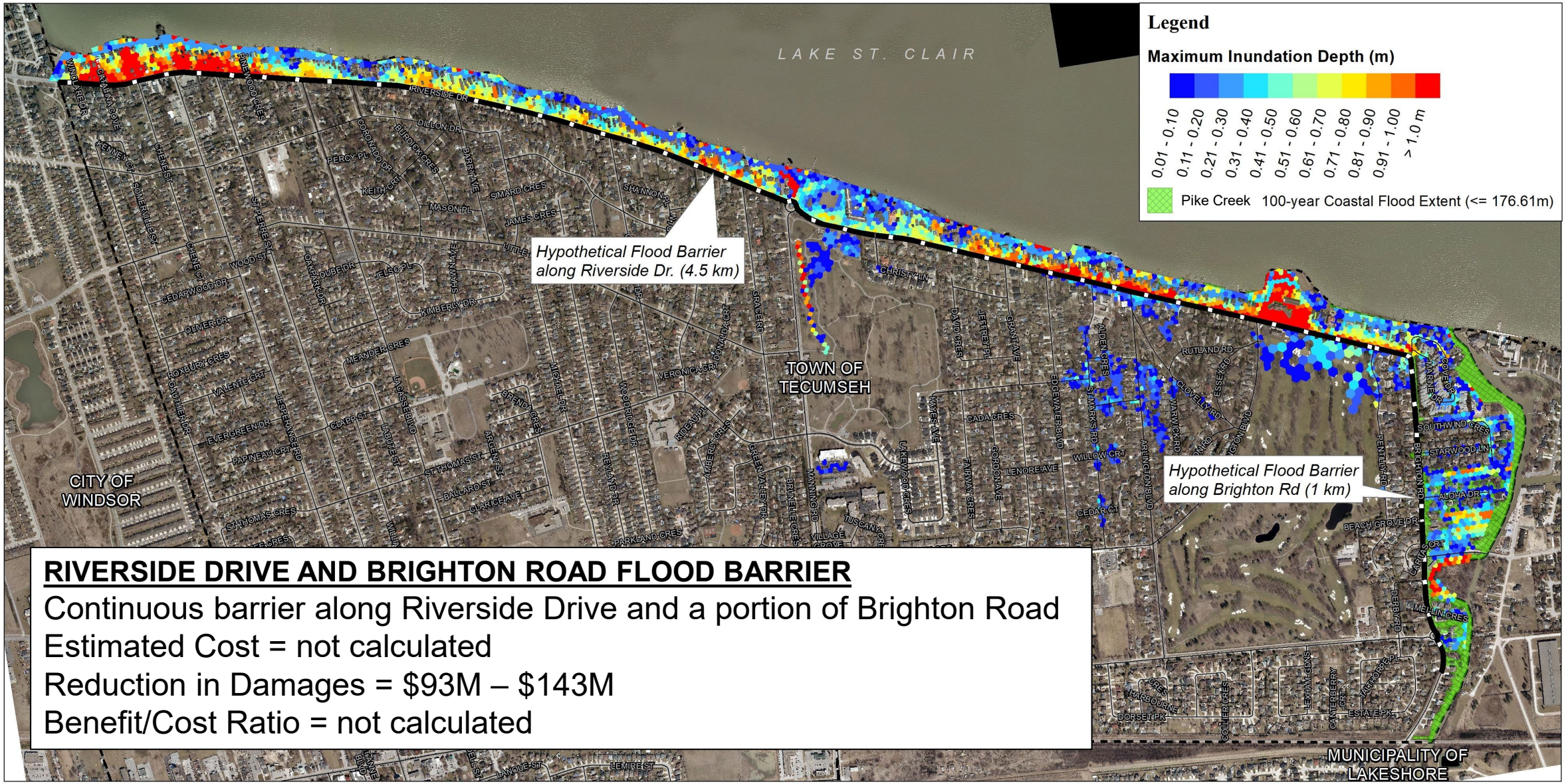

RIVERSIDE DRIVE AND BRIGHTON ROAD FLOOD BARRIER

Continuous barrier along Riverside Drive and a portion of Brighton Road
Estimated Cost = not calculated
Reduction in Damages = $93M – $143M
Benefit/Cost Ratio = not calculated

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Scenario M
100-year Climate Change Coastal Flood with No Rain
Hypothetical Riverside Drive Flood Barrier
Town of Tecumseh

Notes:
1) Wave overtopping calculations by SJL Engineering
2) Pike River flood analysis by Zuzek Inc.
3) Interior flood modelling by Dillon Consulting
4) 2019 aerial provided by the County of Essex

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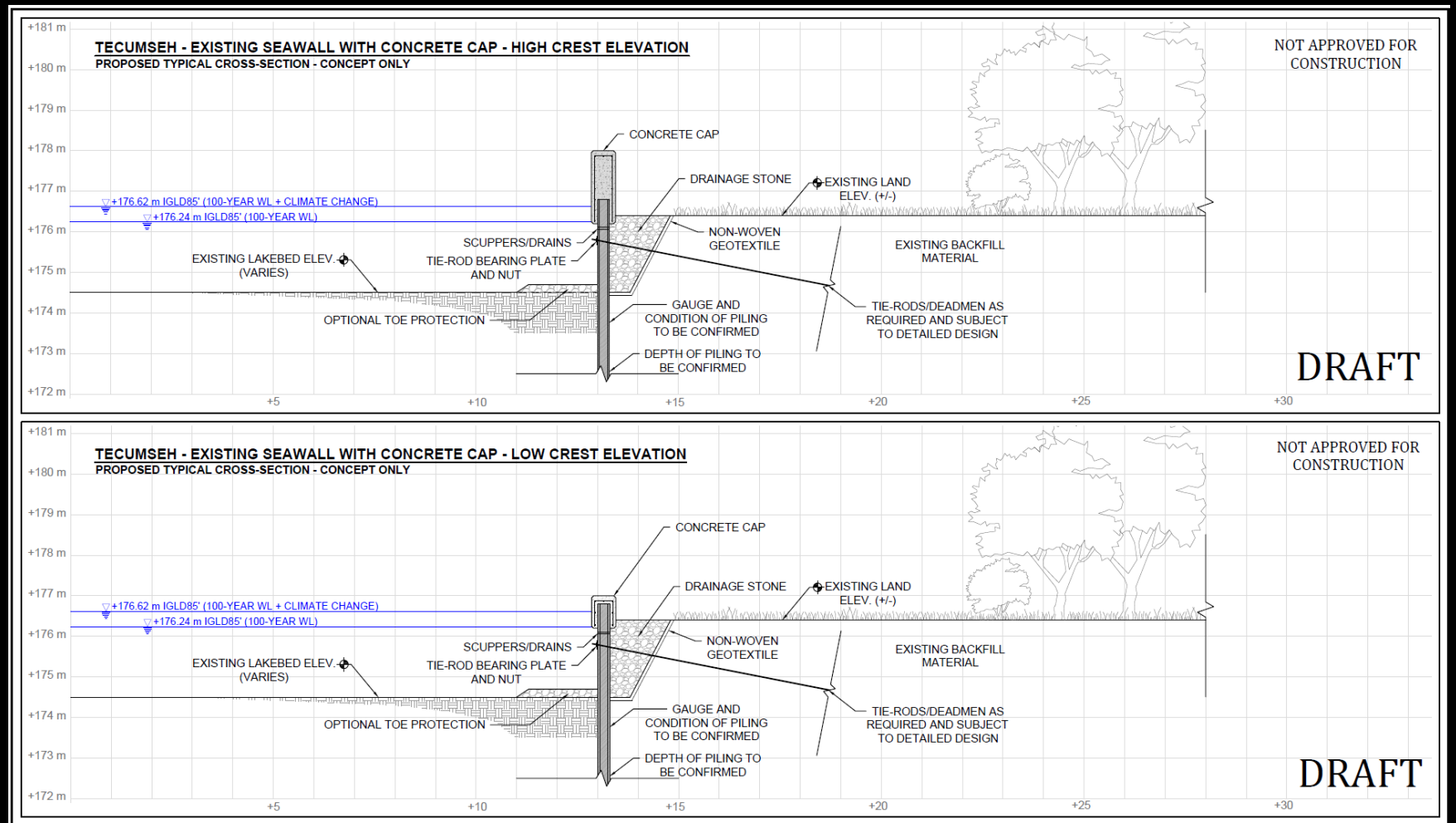
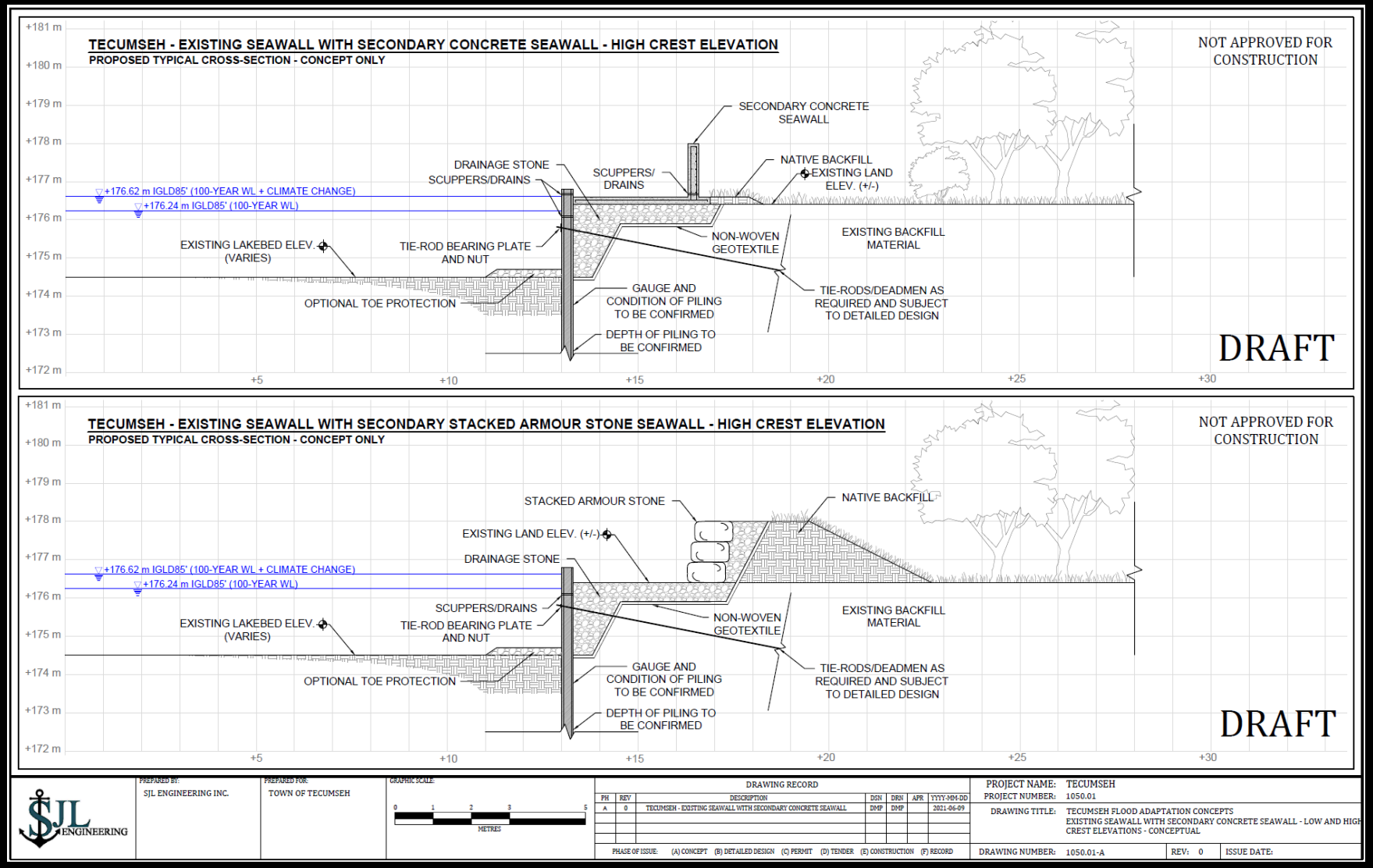
PROTECTION STRATEGIES ASSUMED IN COSTING

Increase crest elevation of vertical wall:



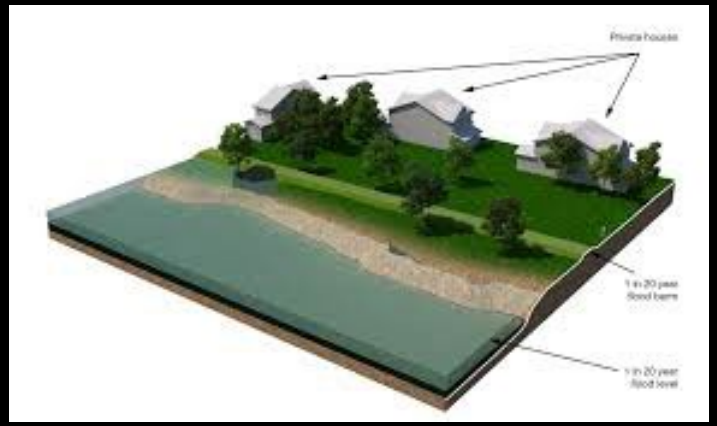
PROTECTION STRATEGIES ASSUMED IN COSTING

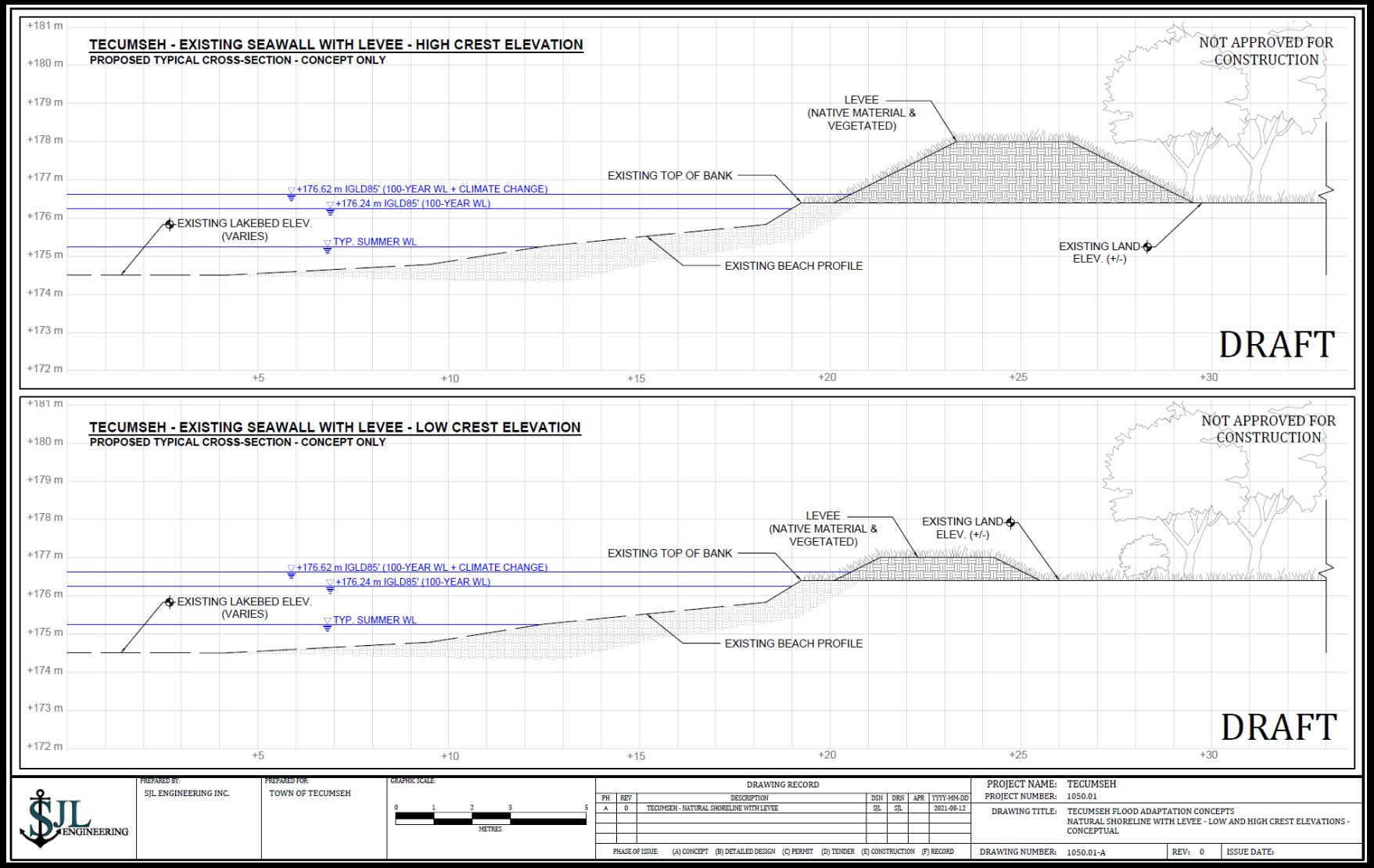
Add a secondary wall:



PROTECTION STRATEGIES ASSUMED IN COSTING

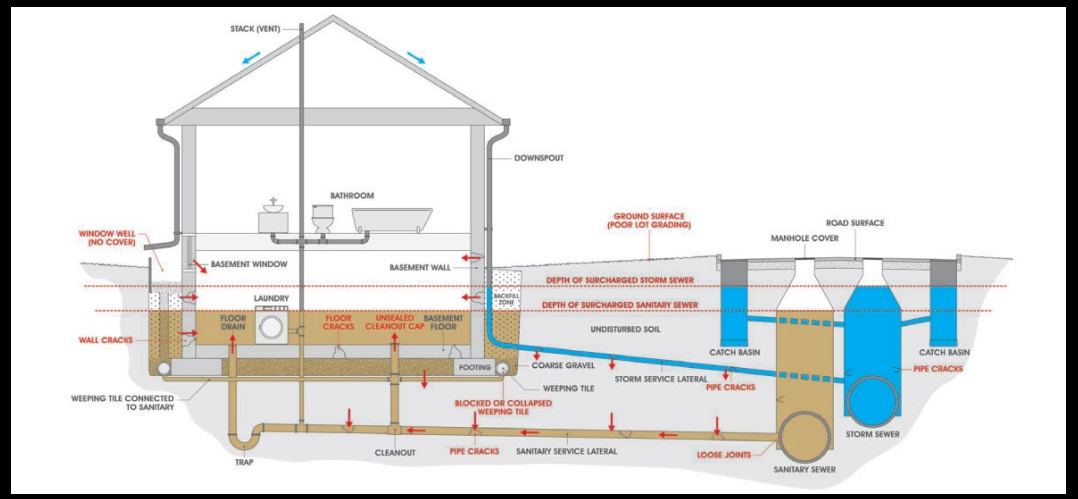
Increase crest elevation of natural shoreline:





Basement Flooding During a Coastal Flood from Sanitary Sewer Surcharging and Lowest Opening

- During a coastal flood, the Hydraulic Grade Line (HGL) elevations (water levels) in some sanitary sewers may be above the basement floor level, which could lead to backflow and basement flooding north of County Road 22



- Basement windows and doors are potential pathways for building flooding
- Water shields and solid block windows

NEXT STEPS

Existing Activities and New Initiatives

- Continue with design work and construction plans to upgrade storm sewers infrastructure and pumping stations
- Continue with multi-facetted approach to reduce basement flooding from sanitary sewer backups
- New activities:
  - Work with emergency responders to evaluate depth of flooding and update the Flood Response Plan as required
  - Develop guidance for landowners to reduce basement flooding threats from a coastal flooding event
  - Complete further engagement with the landowners on a community scale shoreline protection upgrade program

QUESTIONS