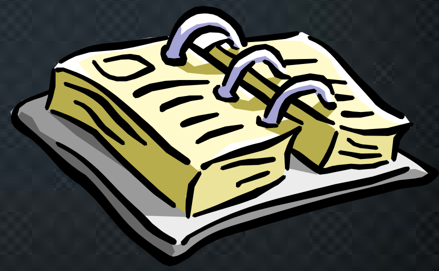
Several Images from Google Earth were utilized

Nature Based Shoreline Decision Making: Overview of Geology, Driving Forces and Coastal Processes

Peter J. Zuzek, MES, CFM, P.Geo.

Presentation Overview

- I – Geology
- II – Driving Forces
- III – Littoral Cells
- IV – Case Studies
- V – Questions



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Natural

Baird

Developed

Baird

Natural

Developed

Baird

Natural

Baird

Developed

Baird

Moveable Structures

Baird

Fixed Foundations

Baird

Questions to Consider

- “Manage Erosion” or “Manage Development?”

- “Stabilize Shorelines” or “Restore Dynamic Shoreline Processes?”

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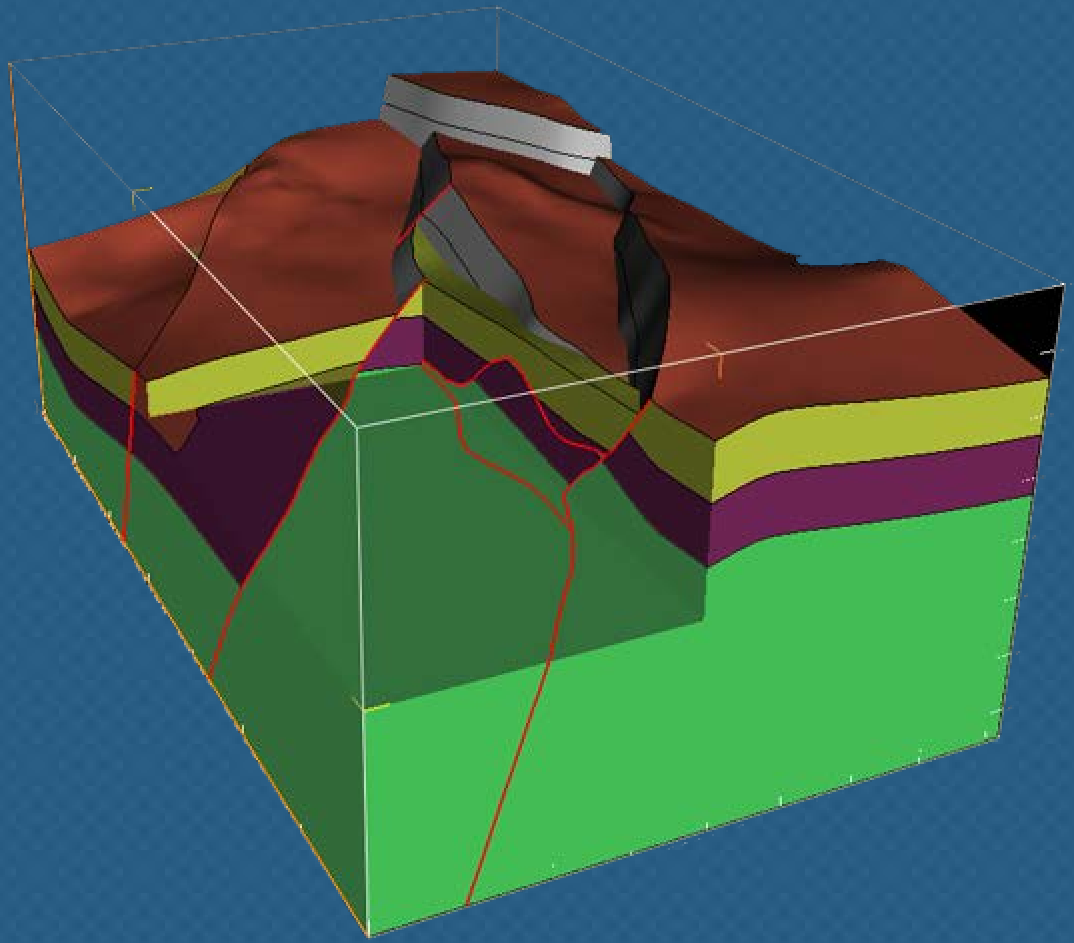
I – Geology Matters



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St. Lawrence River Bedrock

St. Lawrence River Cohesive River Banks

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Sedimentary Bedrock

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Know What is Below!

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This Leads to That …

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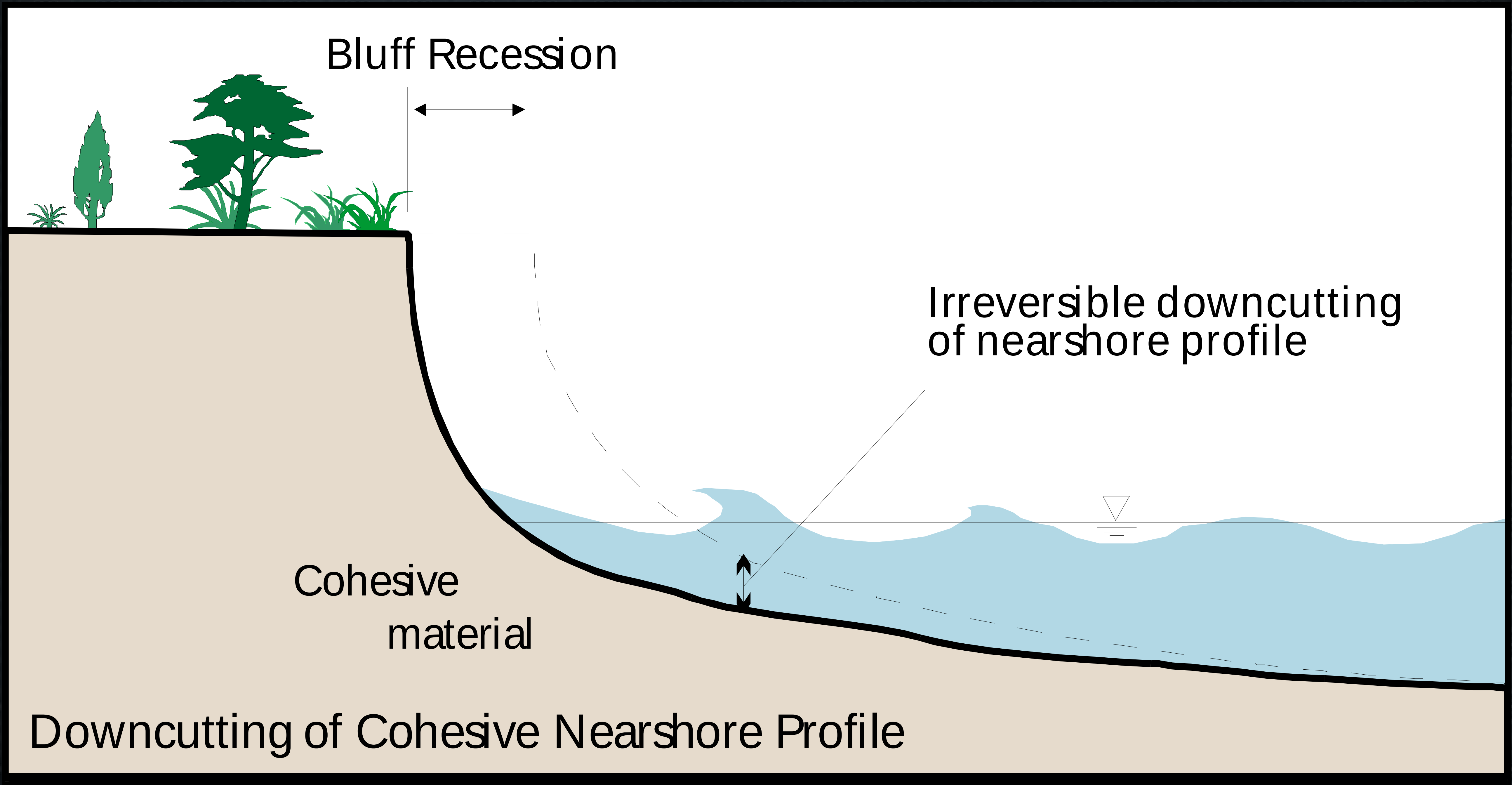
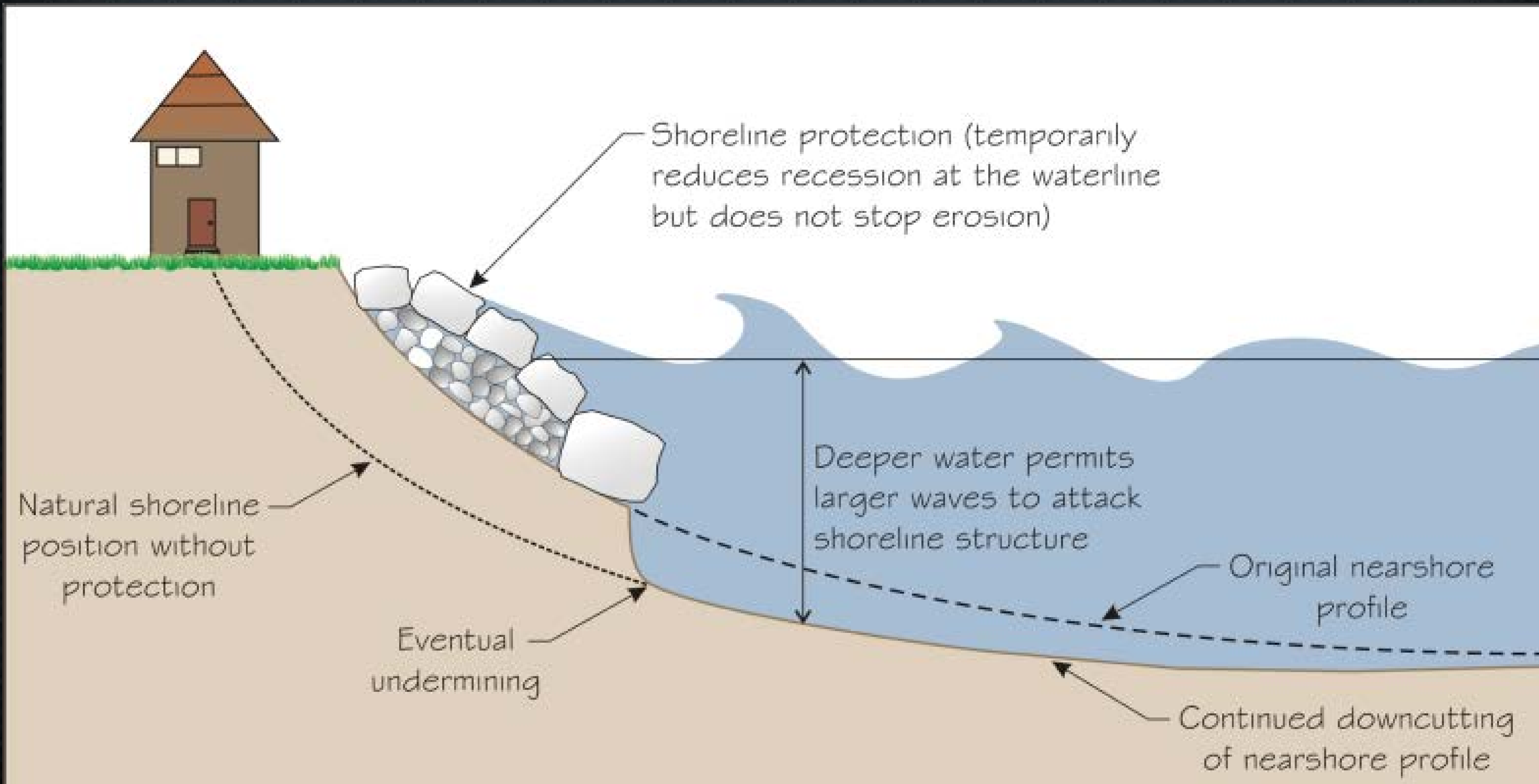
Lakebed Downcutting and Bluff Recession



Lakebed Downcutting and Bluff Recession (armouring fails)



Limited Options …

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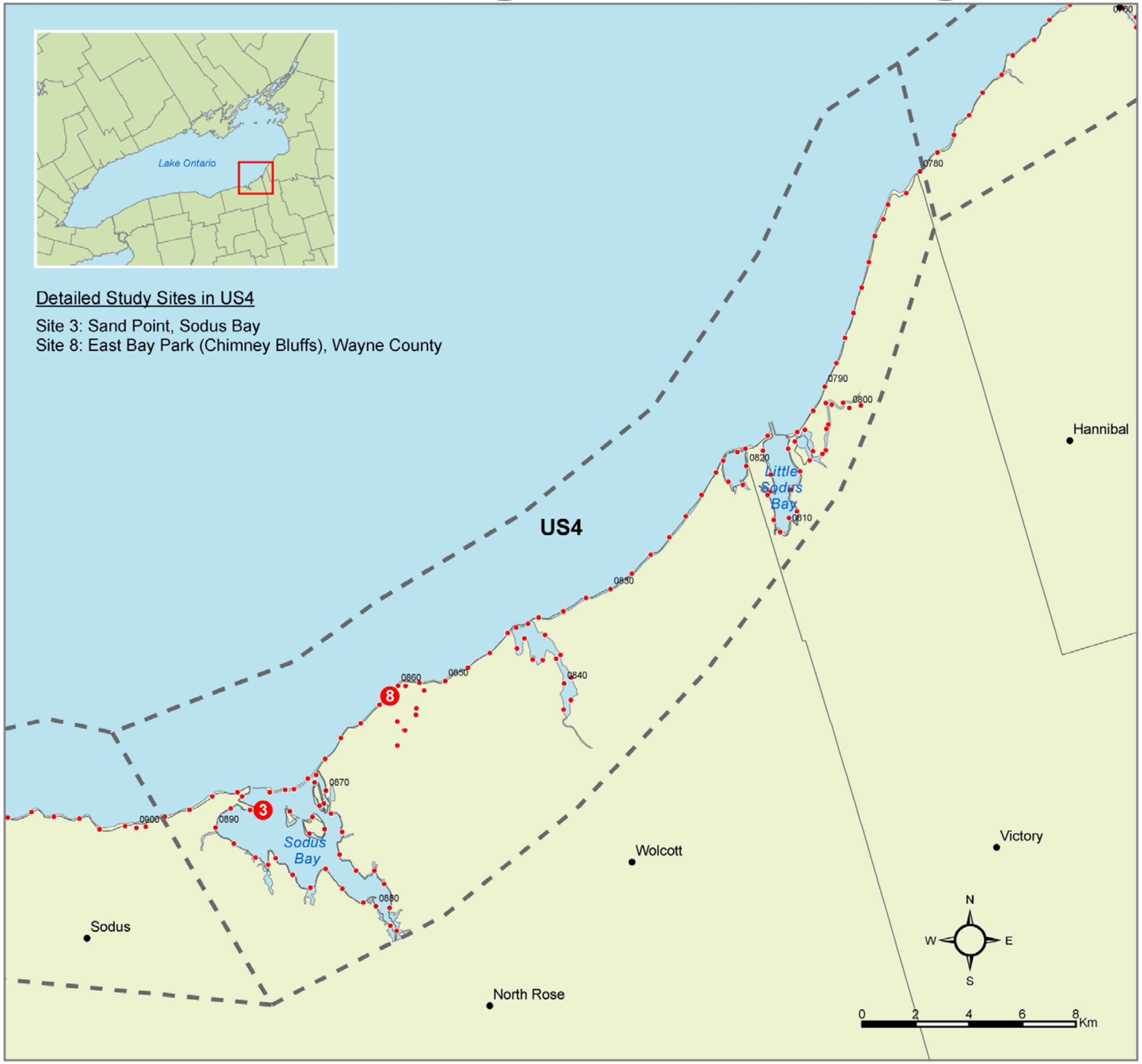
Geotech

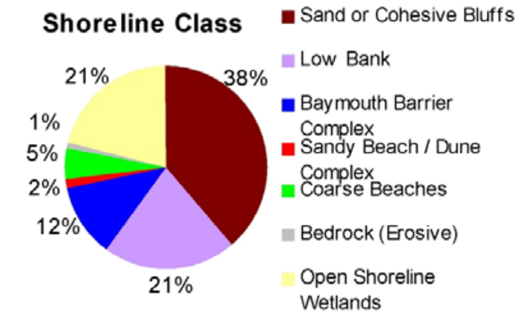
UAV Video

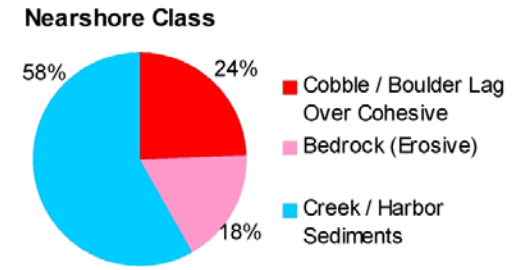
Little Sodus Bay to Sodus Bay

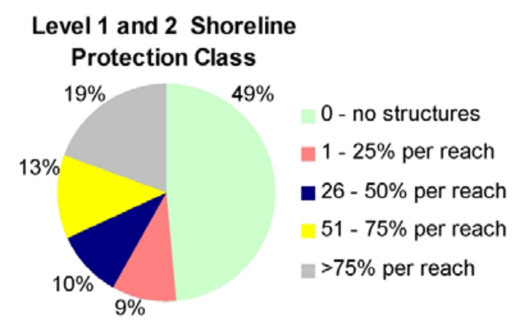


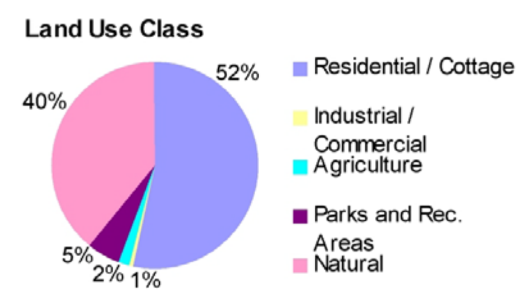
Shore Unit US4:

reach: 780 to 898
length: 119Km









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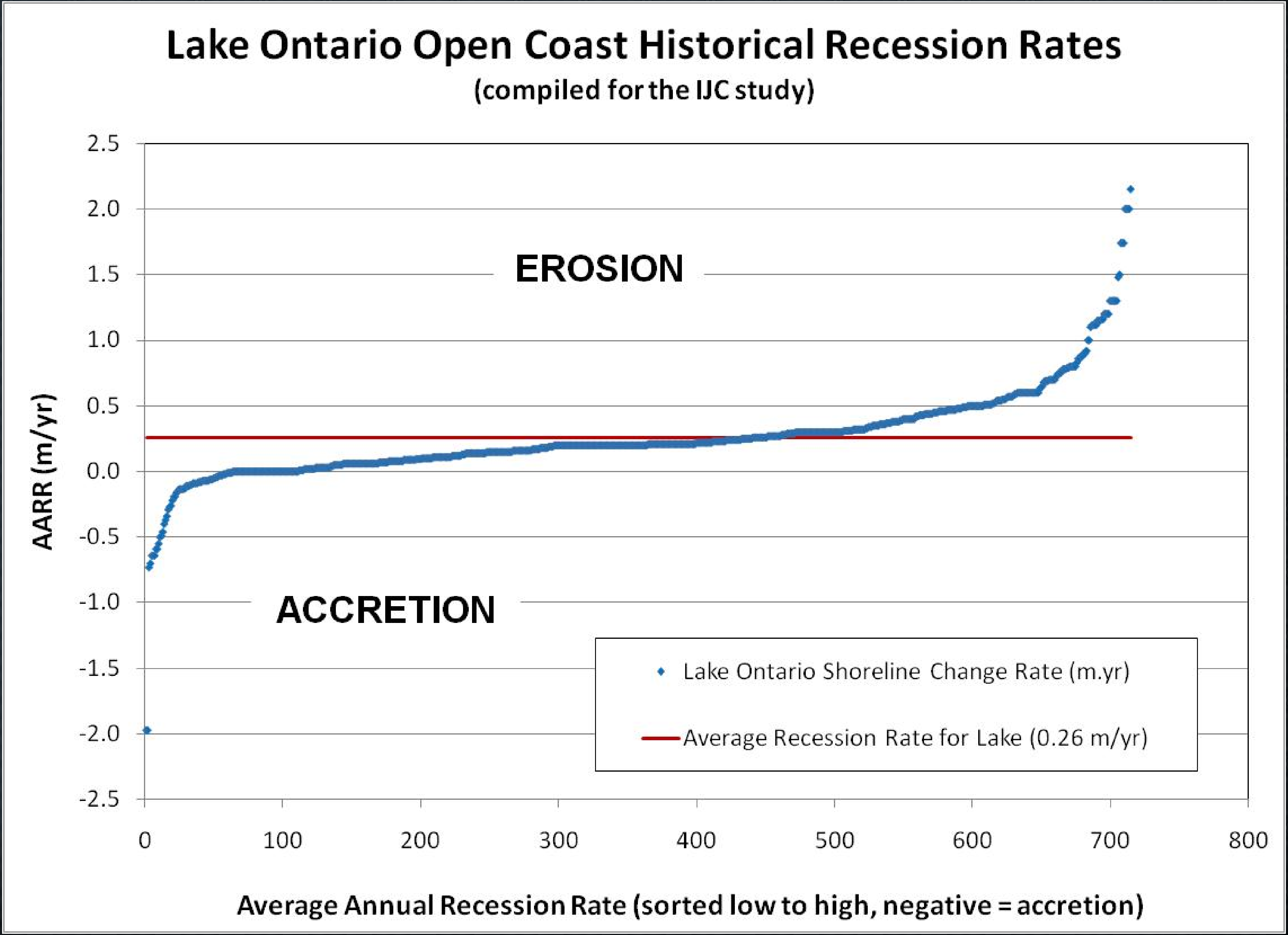
Historical Erosion Rate



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II – Driving Forces

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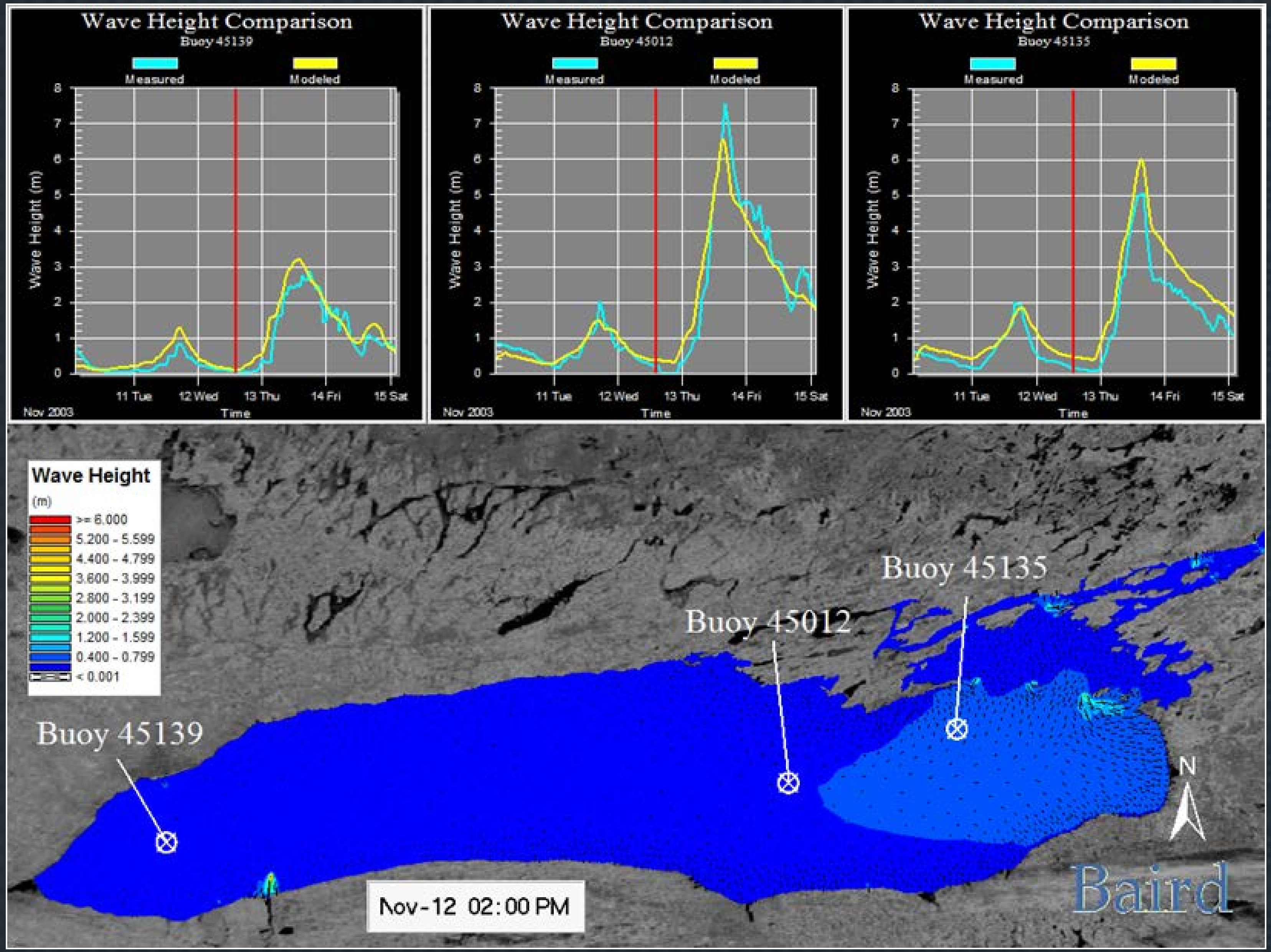
Time Series Results for Nov. 13, 2003



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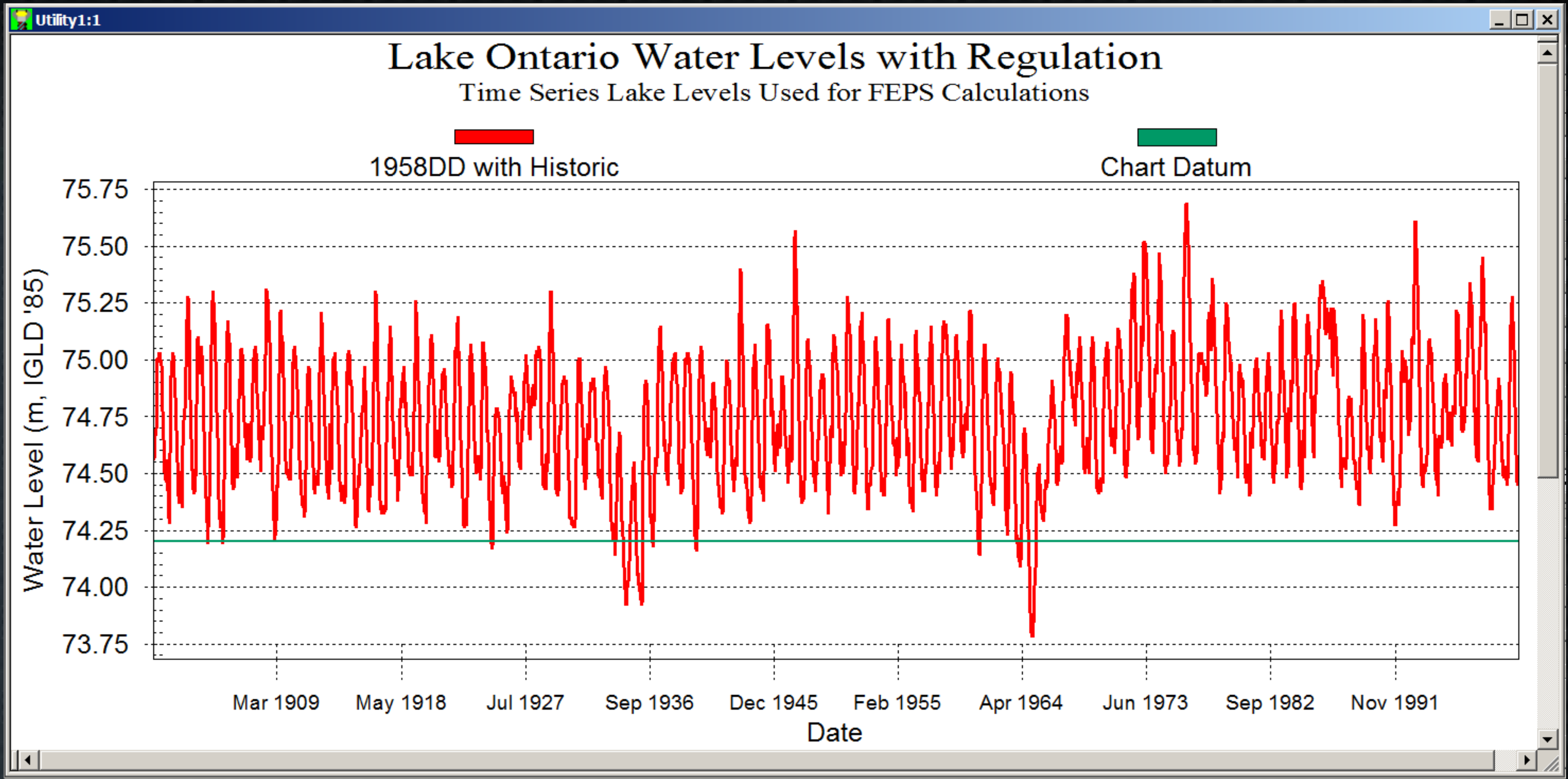
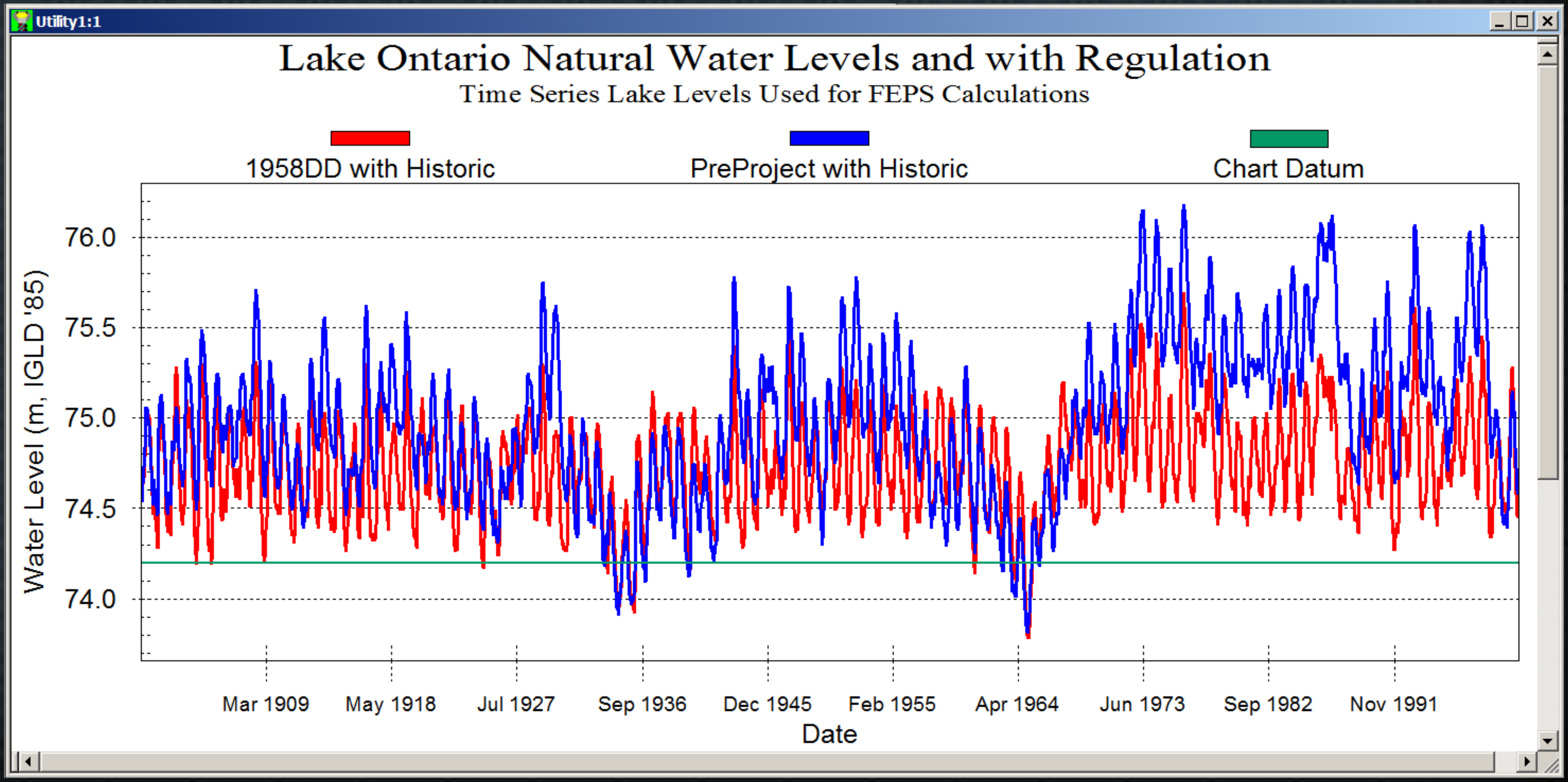
Lake Levels with and without the Dam





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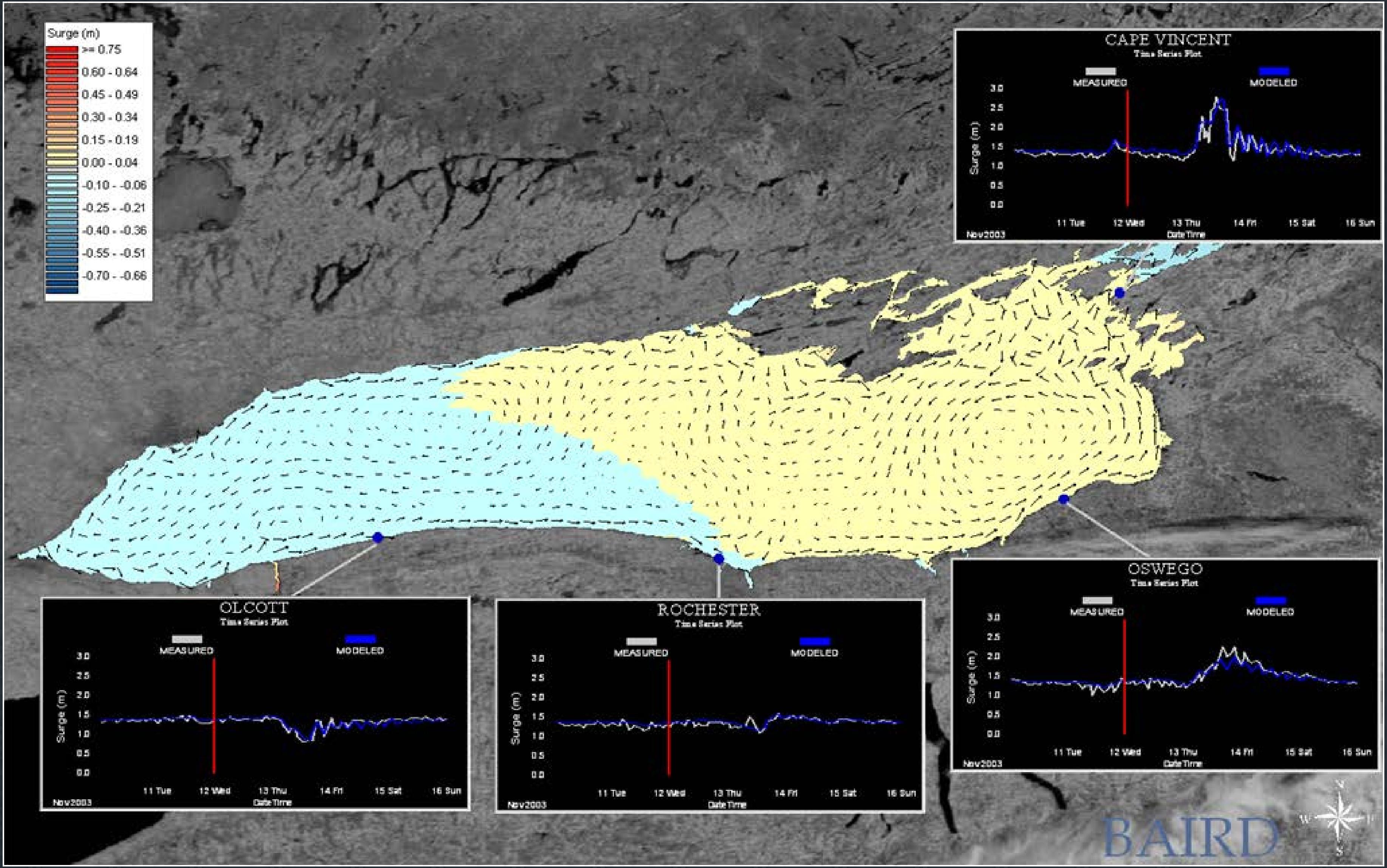
November 2003



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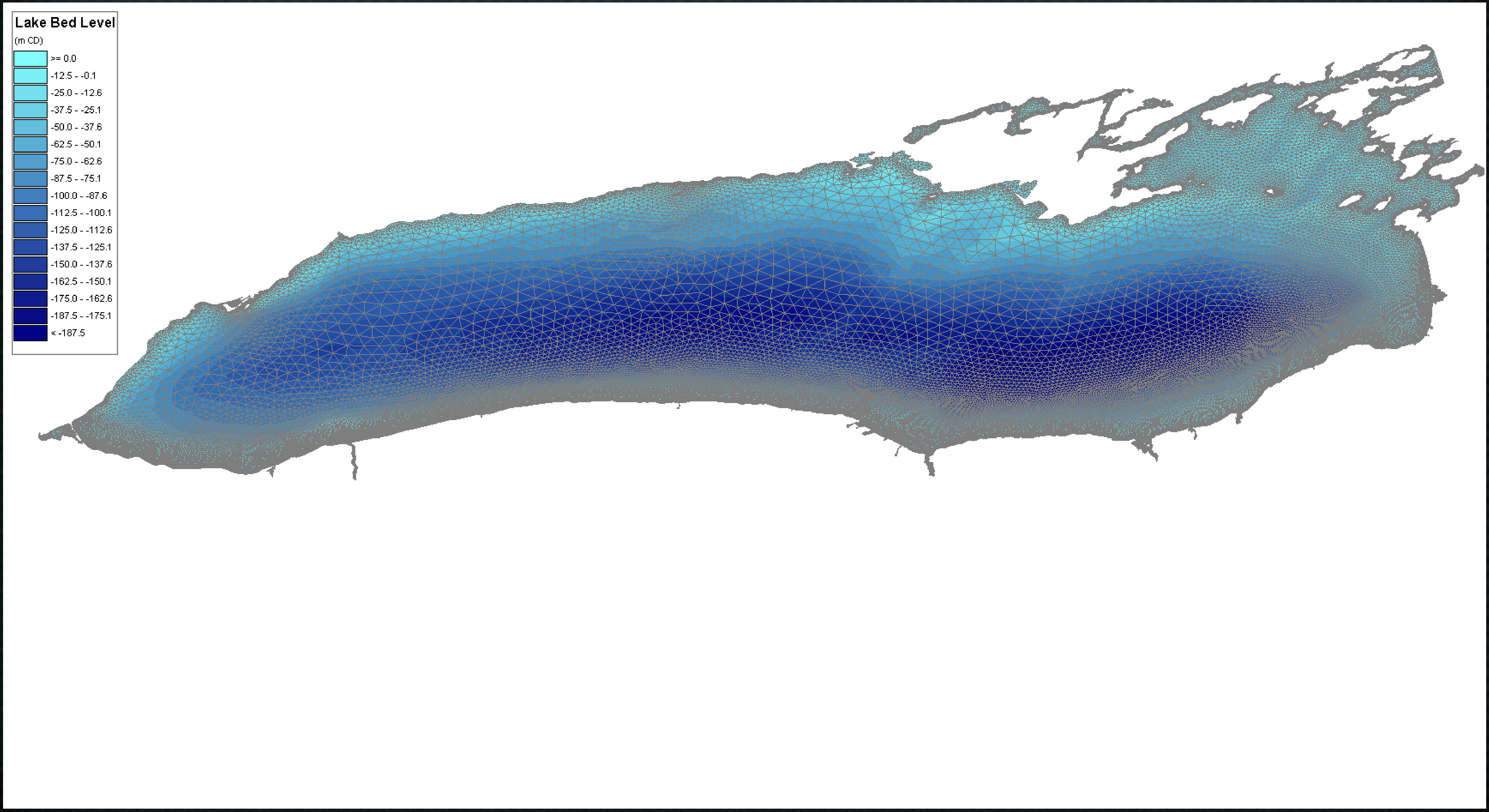
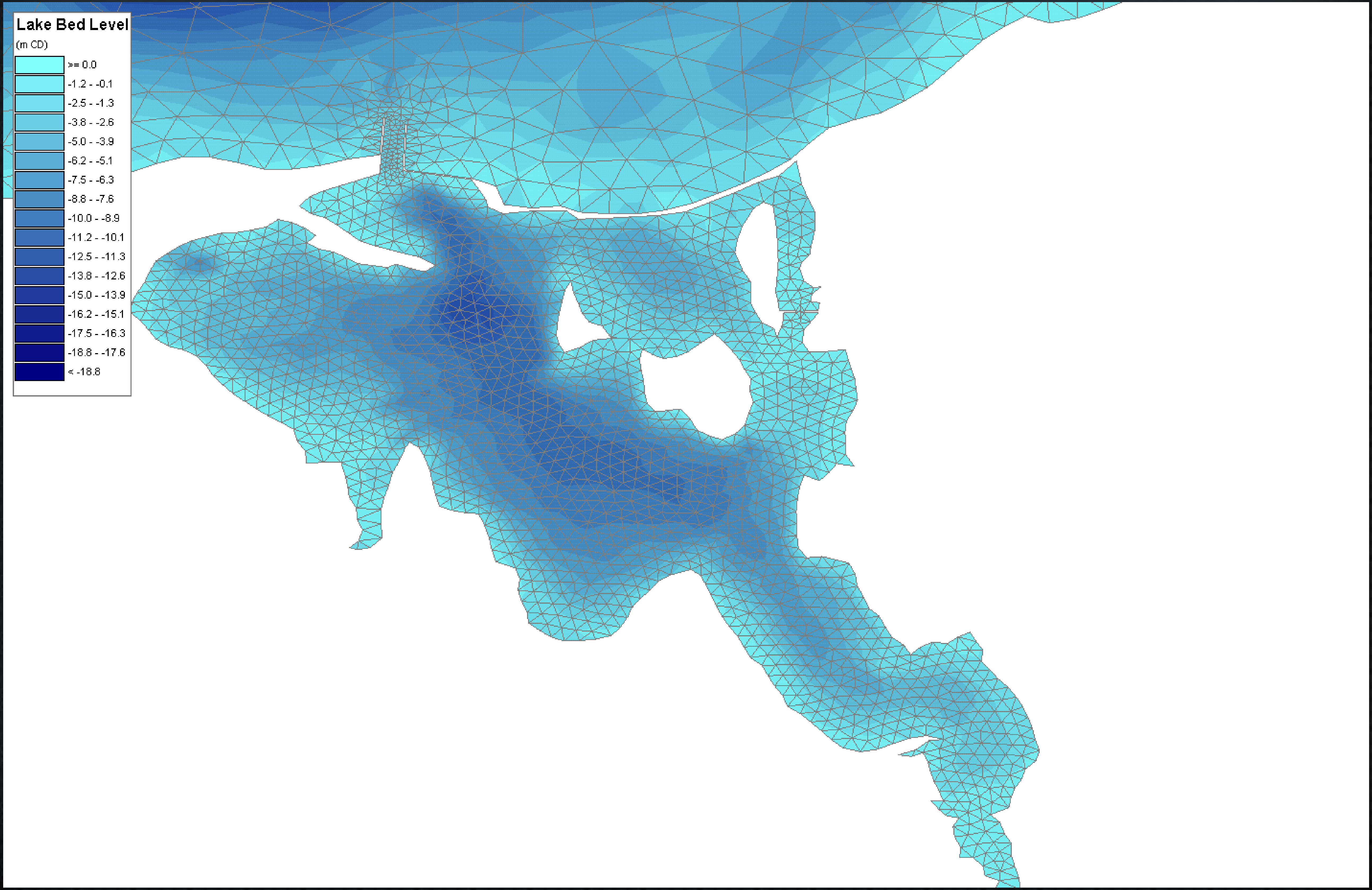
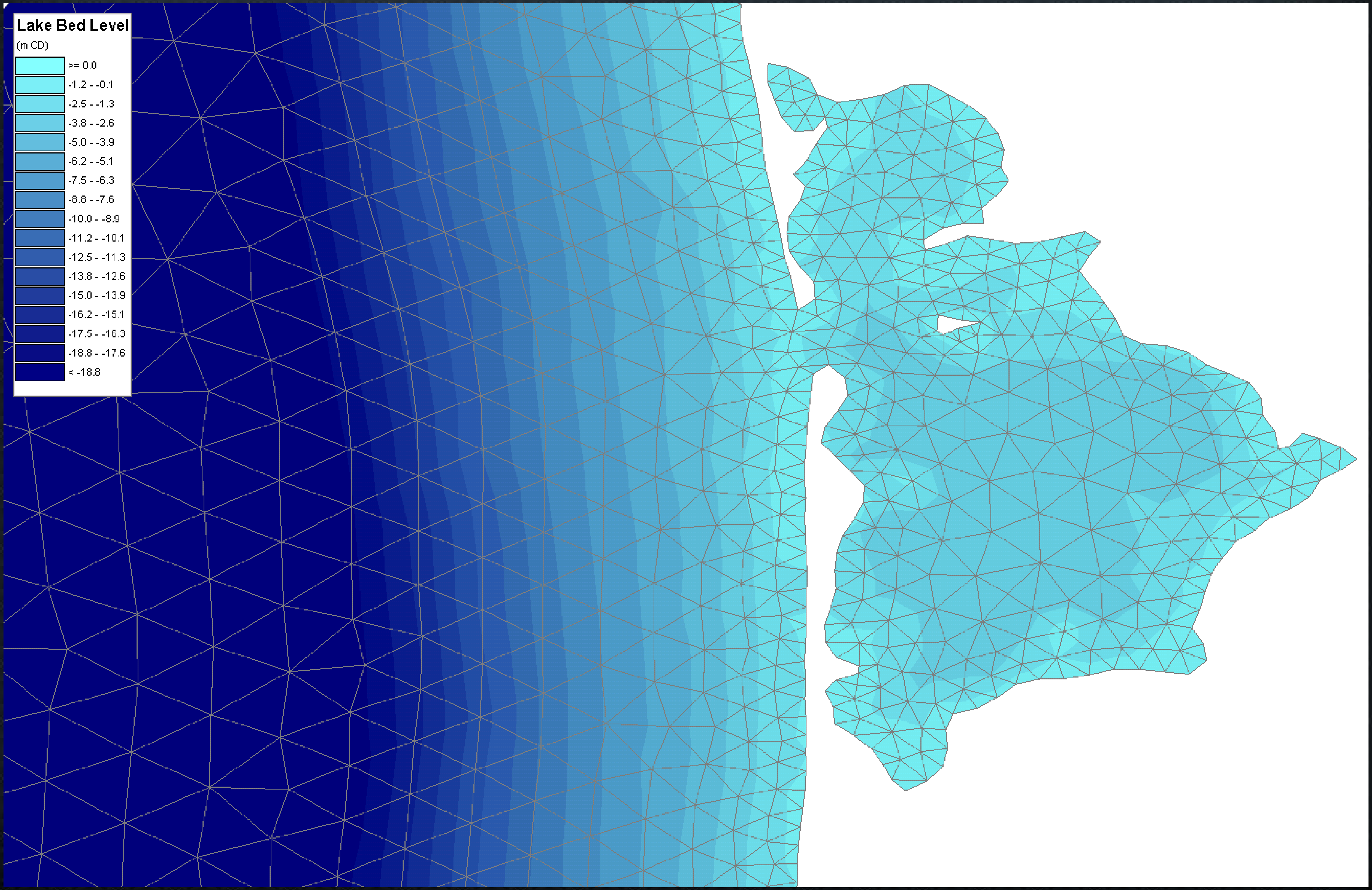
Lake Ontario Mesh



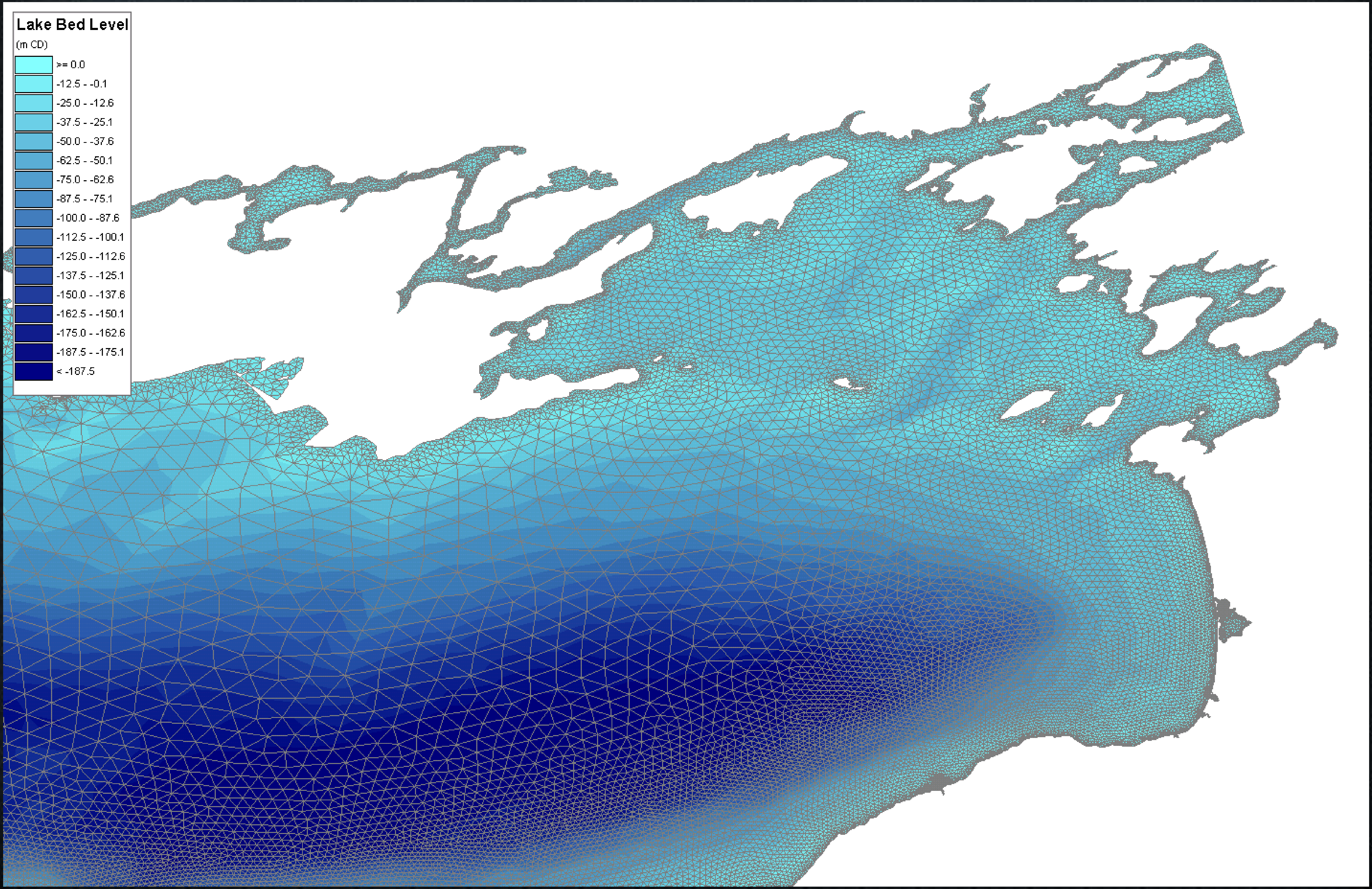
Sodus Bay


Lake Bed Level
(m CD)
>= 0.0
-1.2 - -0.1
-2.5 - -1.3
-3.8 - -2.6
-5.0 - -3.9
-6.2 - -5.1
-7.5 - -6.3
-8.8 - -7.6
-10.0 - -8.9
-11.2 - -10.1
-12.5 - -11.3
-13.8 - -12.6
-15.0 - -13.9
-16.2 - -15.1
-17.5 - -16.3
-18.8 - -17.6
< -18.8

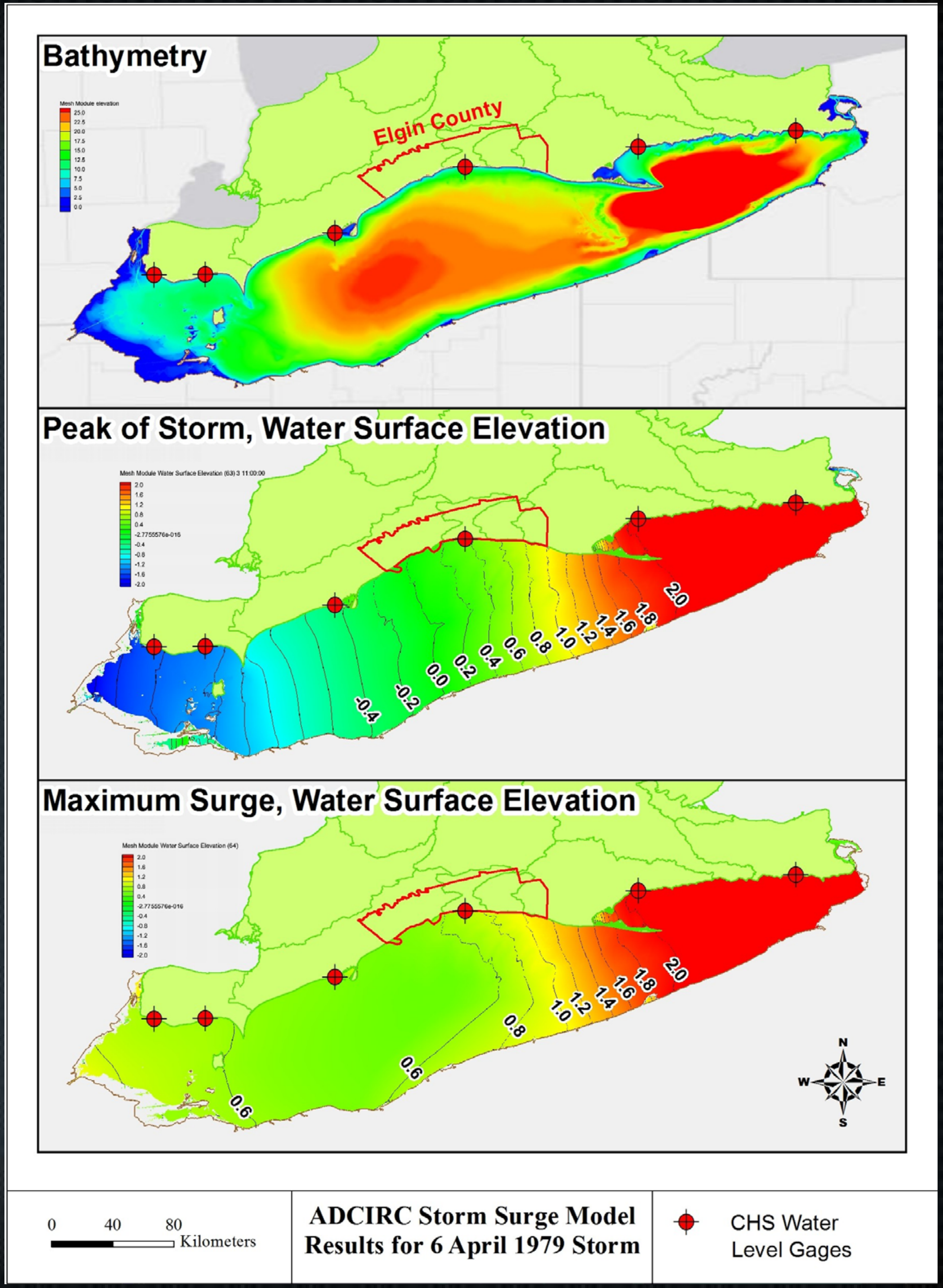
North Sandy Pond



Eastern Lake Ontario



Lake Erie Surge



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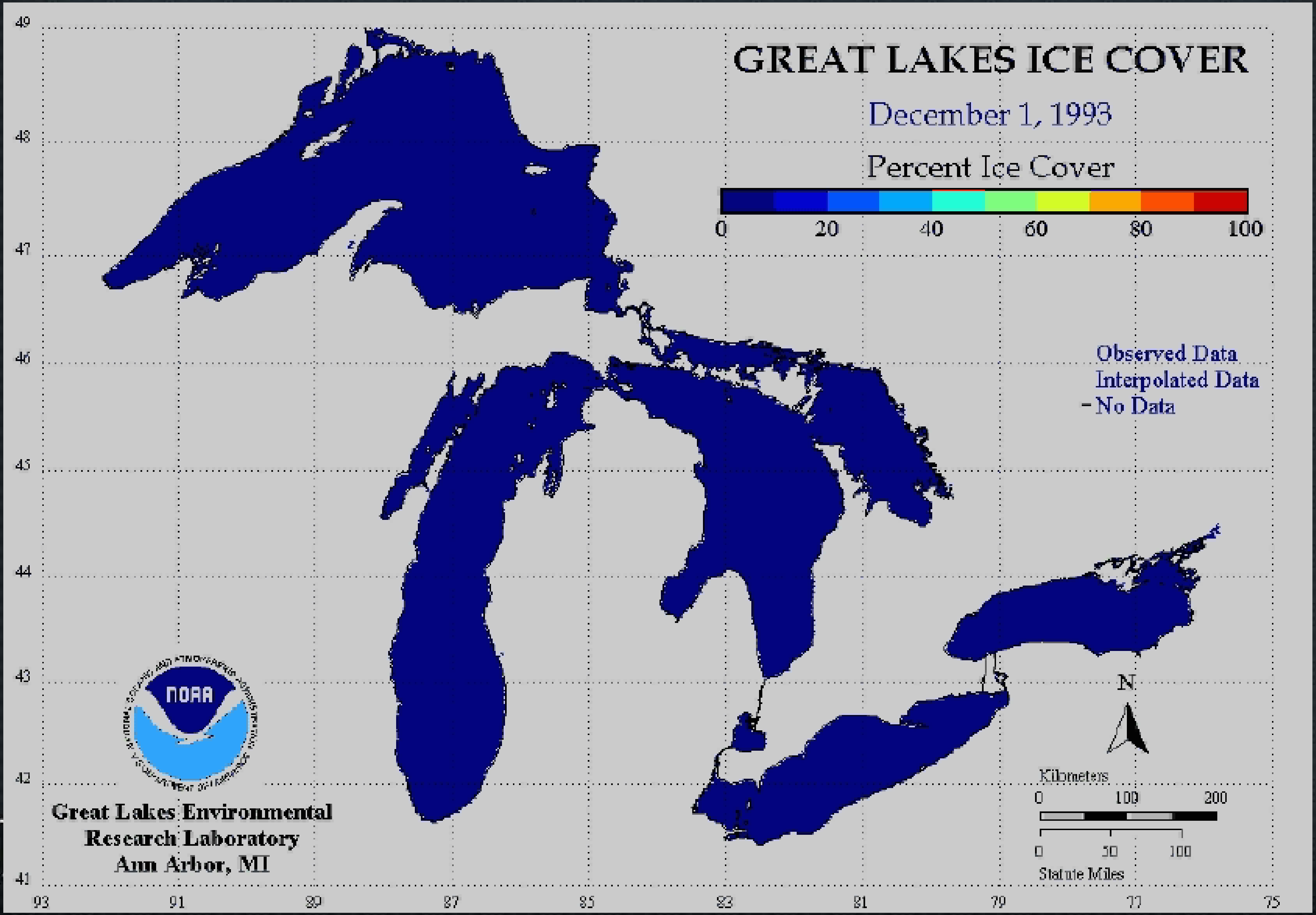
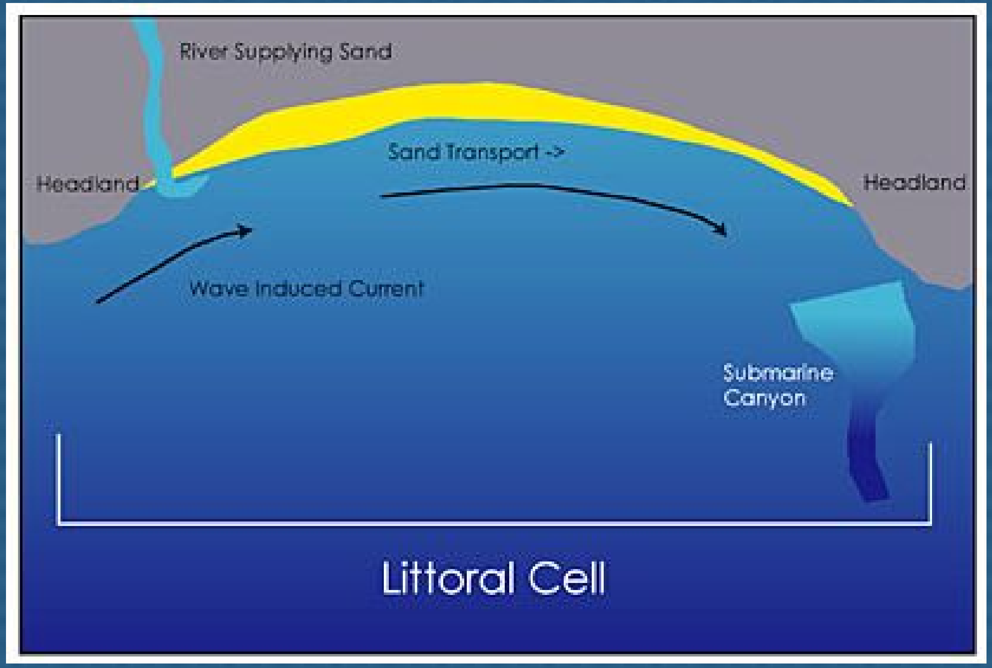
Ice Data (NOAA-GLERL)



III – Littoral Cells



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0 5 10 20 30 40 50 km

Scale 1:1,000,000

Lake Erie Littoral Cell Definition with Net LST Estimates (m^3/yr)

Reinders ,1988. Littoral Cell Definition and Sediment Budget for Ontario's Great Lakes.

Image: MODIS 2005
Spatial Reference: UTM 17N NAD 1983

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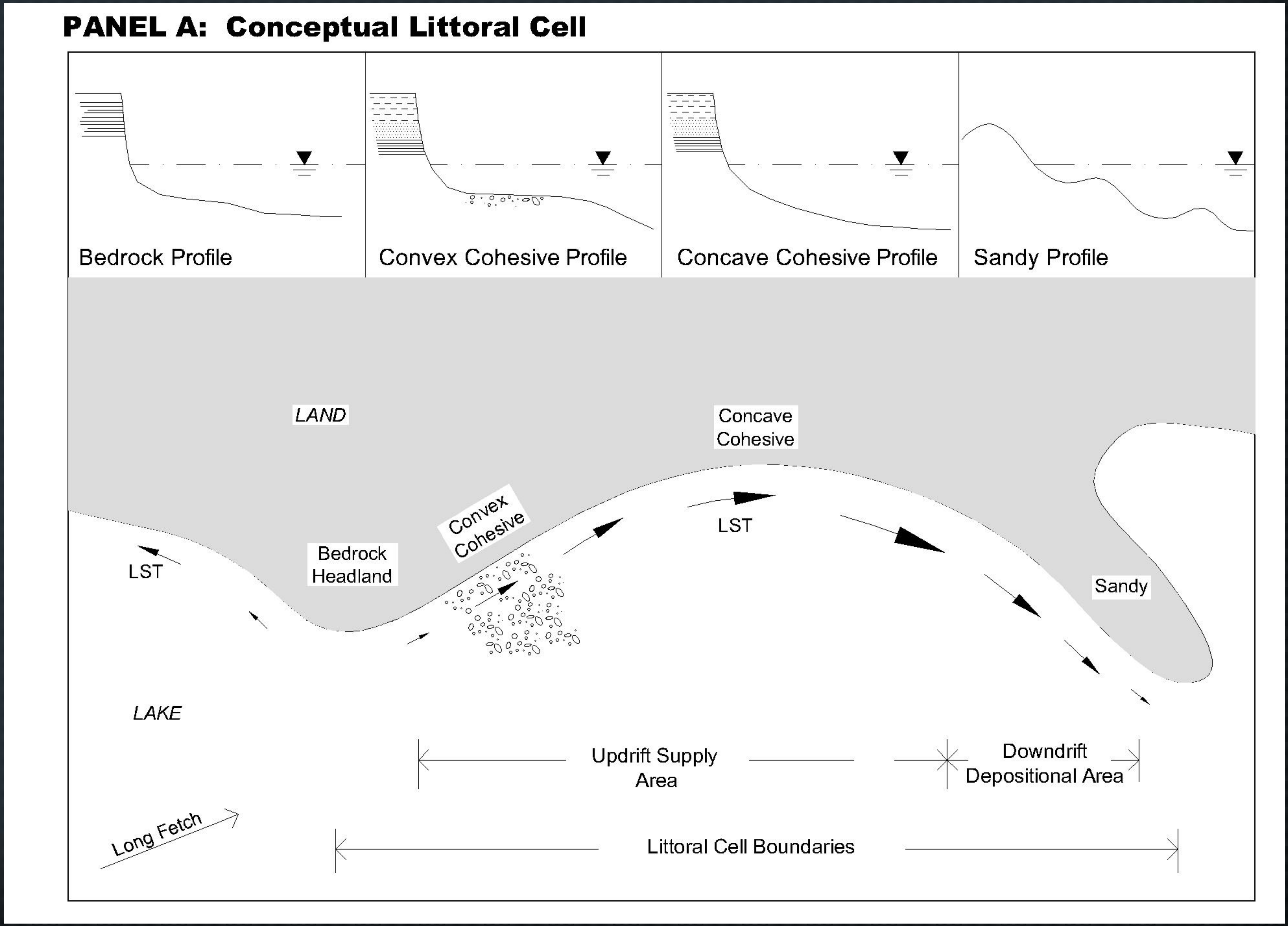
Littoral Cells



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Littoral Cells

Sediment Transport

Shoreline Trend

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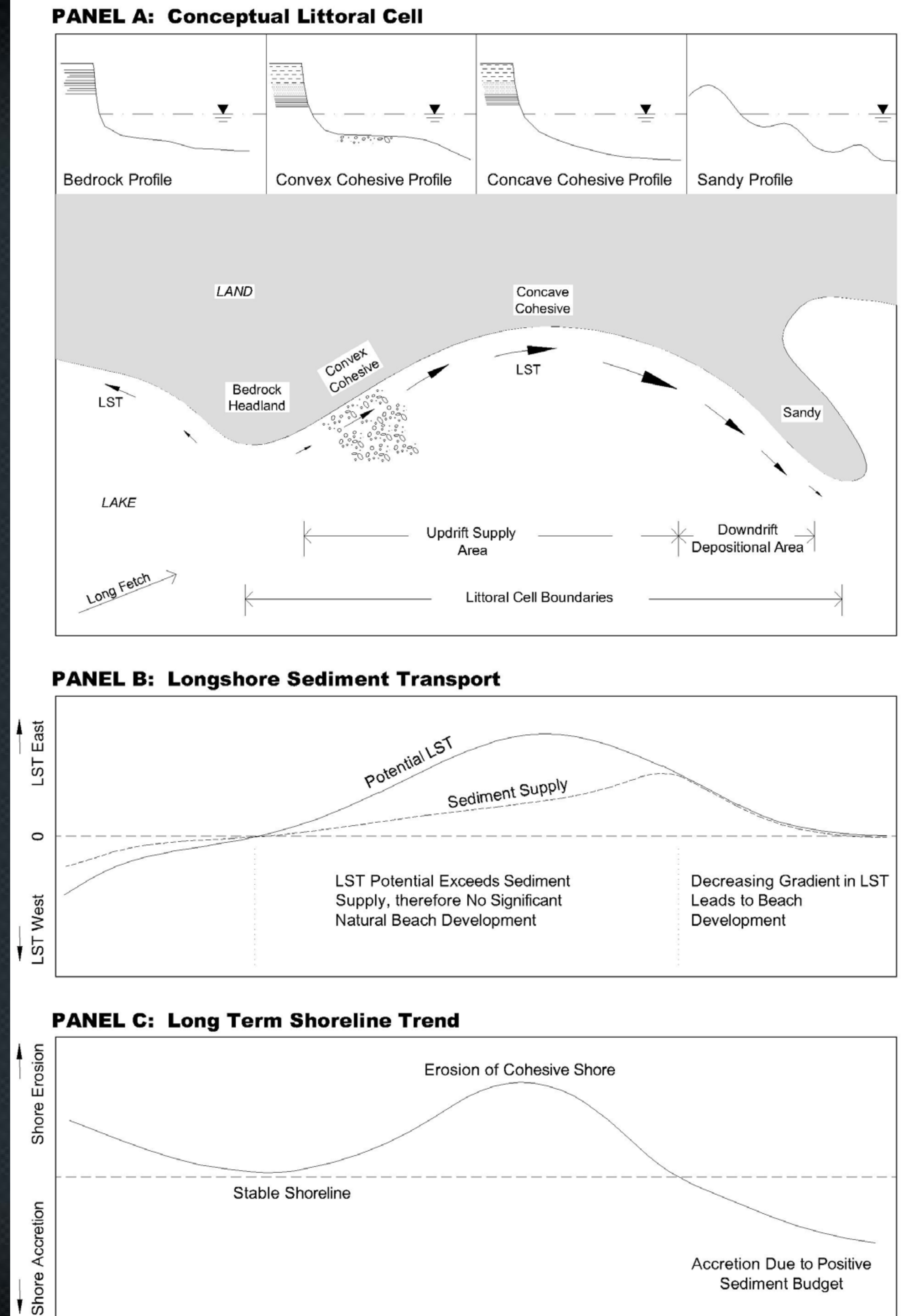
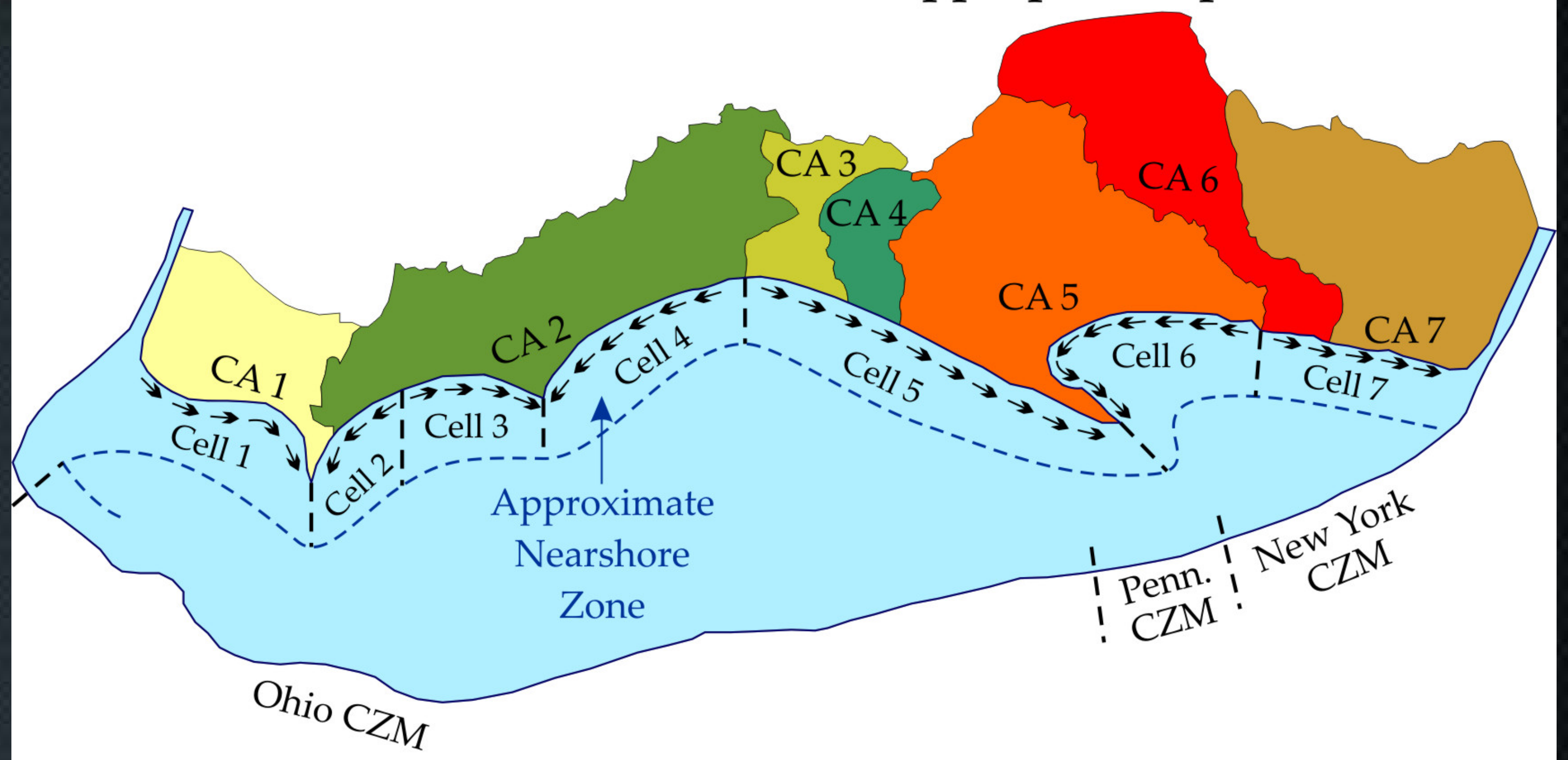


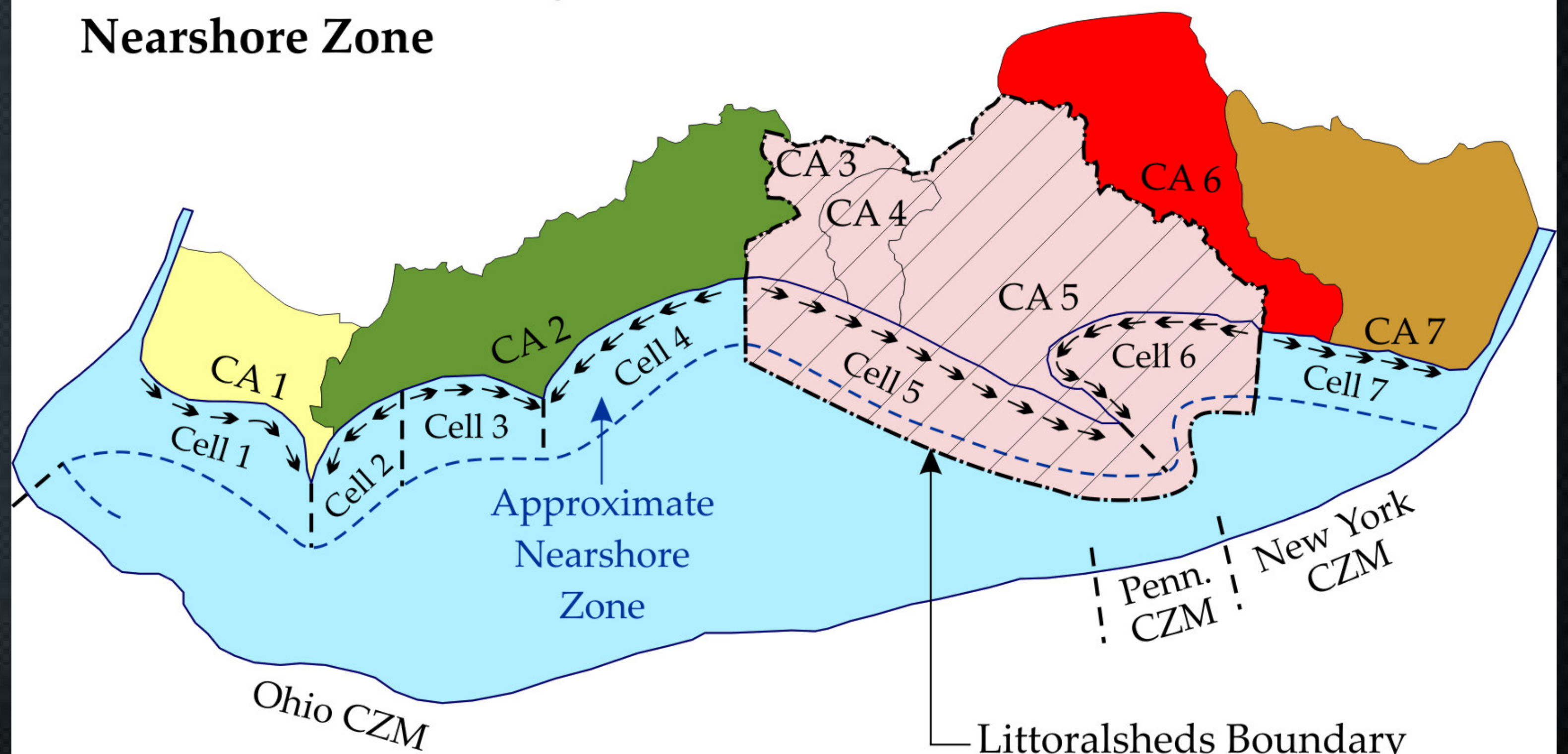
Adopted from Davidson-Arnott, 1990

Scale for Action Plans

2. New Coastal Zone Management Plans Should Link Watersheds, Shorelines and the Nearshore at the Appropriate Spatial Scales



3. Littoralshed Boundary Links Watersheds, Littoral Cells and the Nearshore Zone



Note: These are conceptual boundaries for illustration only.

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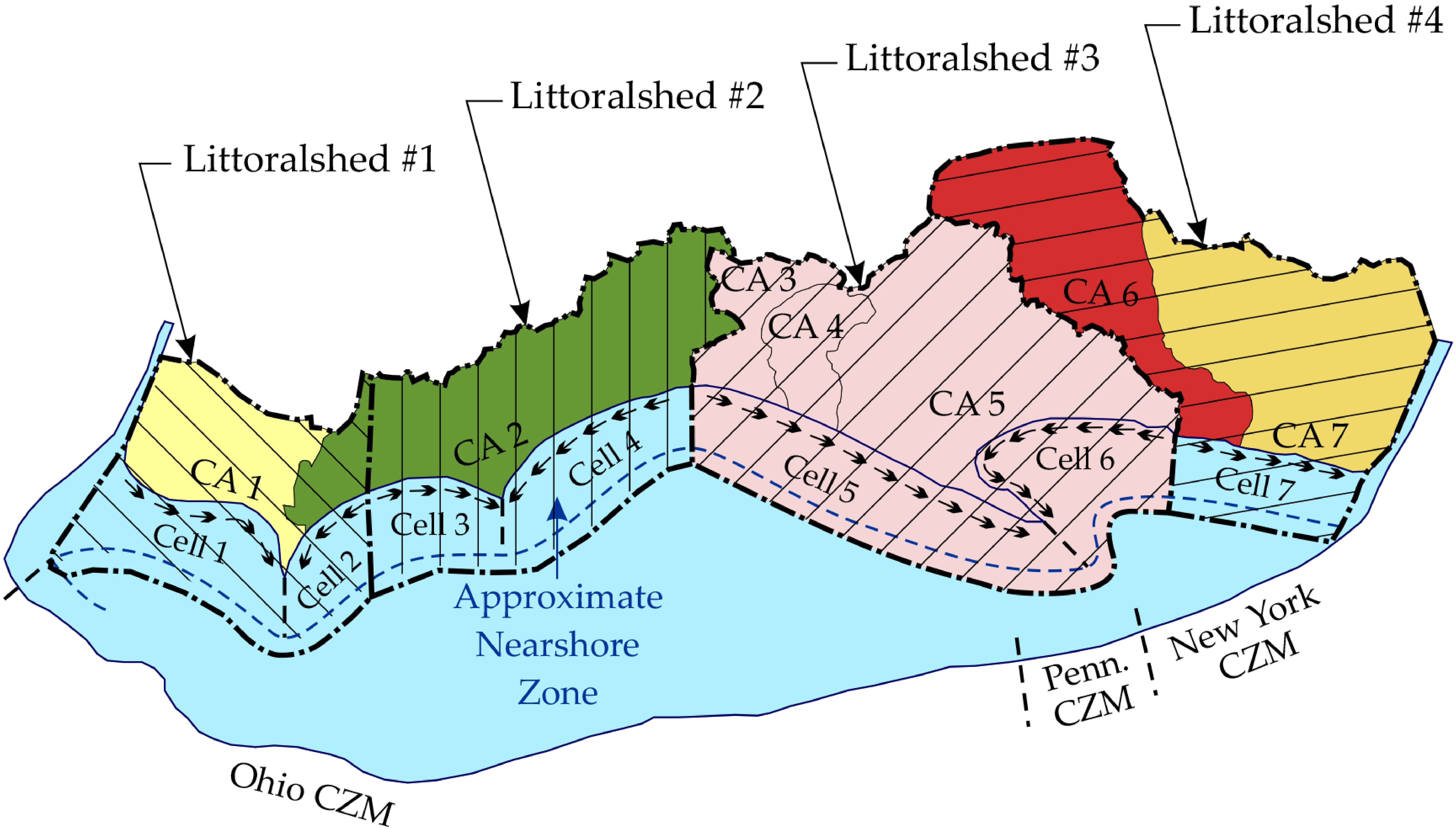
Individual Lakes are Sub-divided into Multiple Littoralsheds for Management/Action Plans



Note: These are conceptual boundaries for illustration only.

Case Study: Elgin County Shoreline Management Plan

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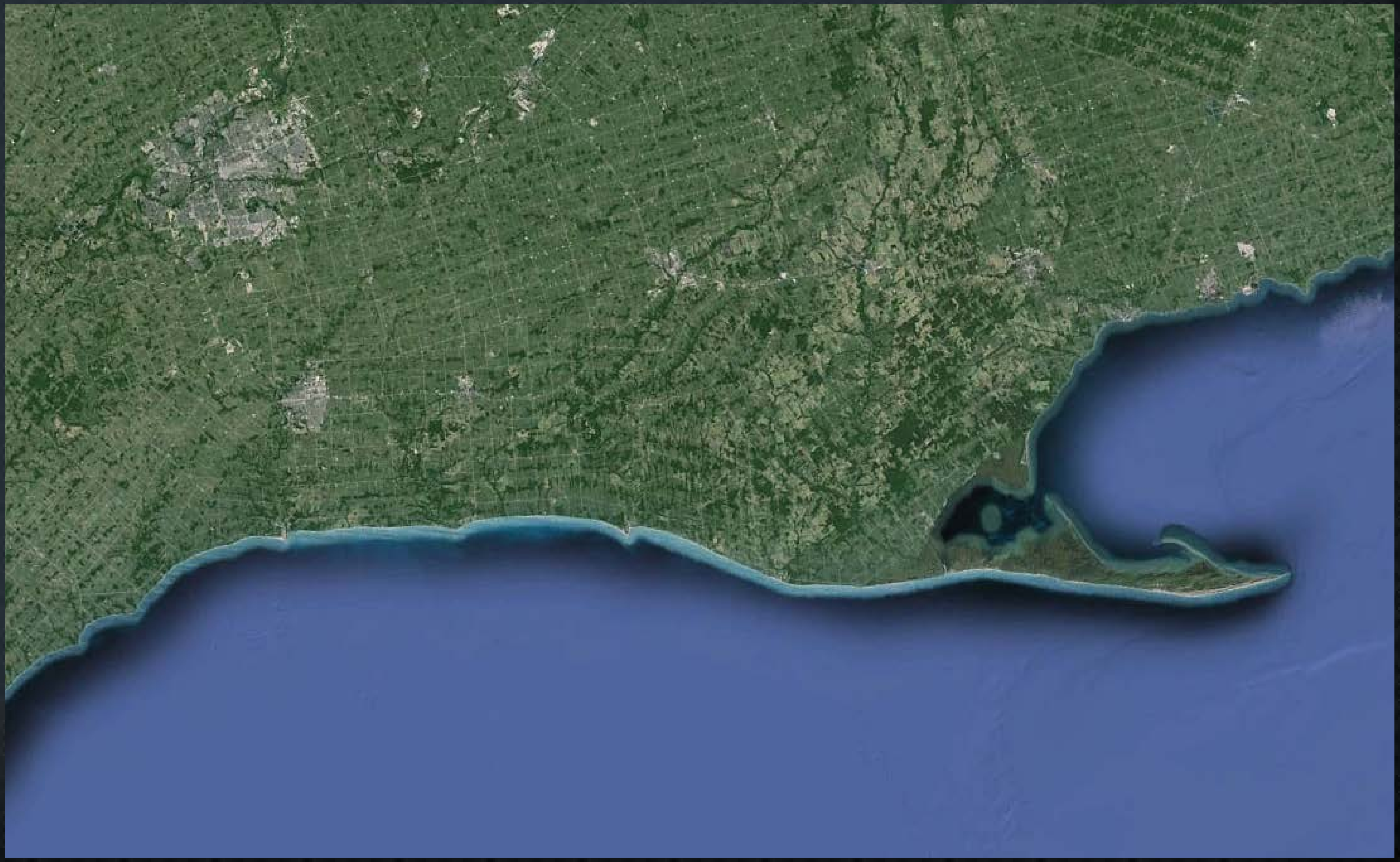
SMP for the North Shore of Lake Erie

- Principals: ICZM, EBM, Protect Aquatic and Terrestrial Ecosystems (no impacts)
- No Downdrift Impacts or Cumulative Impacts



0 30 60 90 120 m

0 100 200 300 400 ft

Site 48
1978 Imagery

Imagery: 1978
Grid Spacing: 50m
Spatial Reference: NAD 1983 UTM Zone 17N

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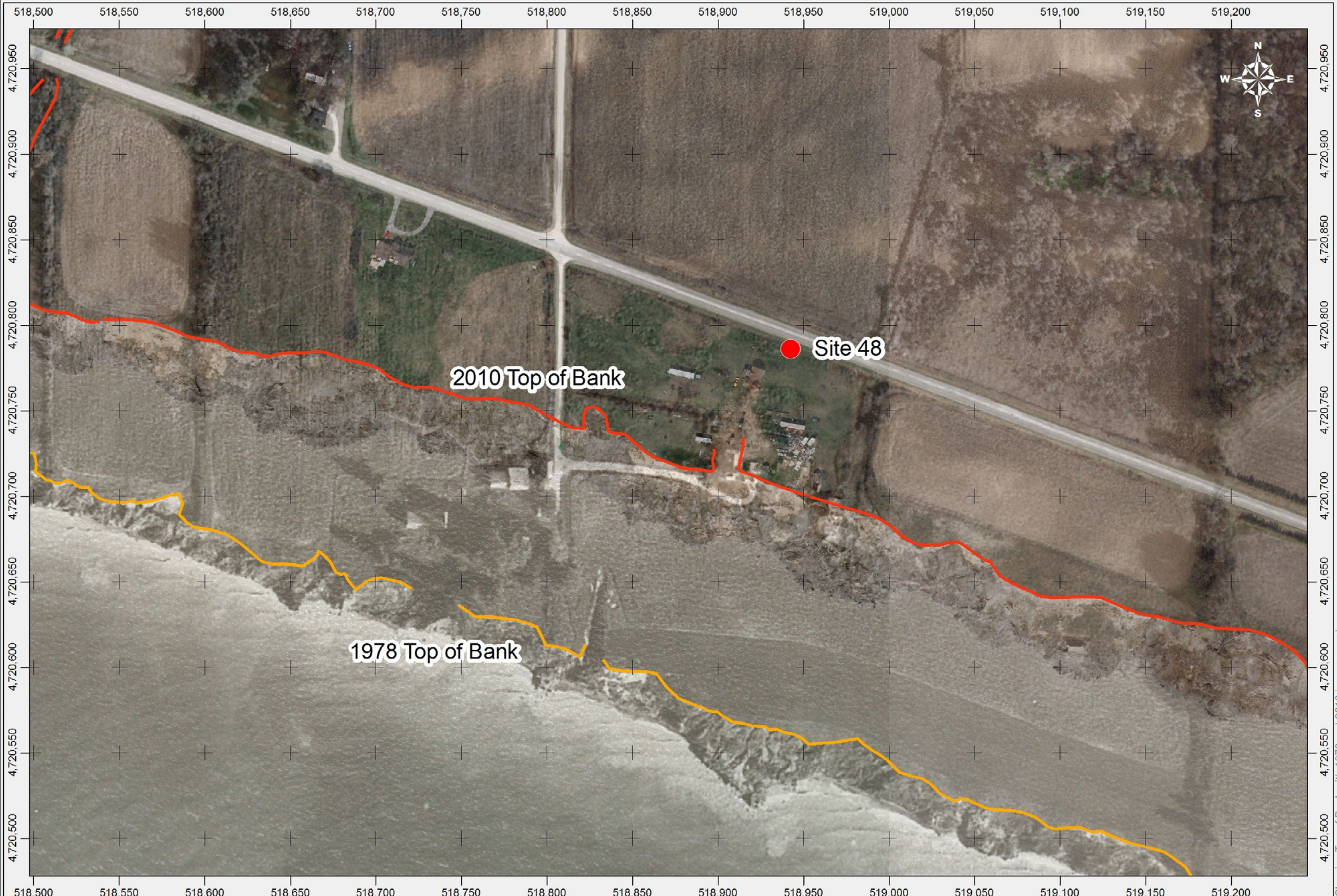
Site 48 - Local Map Showing Top of Bank with 1978 imagery.mxd

Map Published: 2014-08-06



0 30 60 90 120 m

0 100 200 300 400 ft

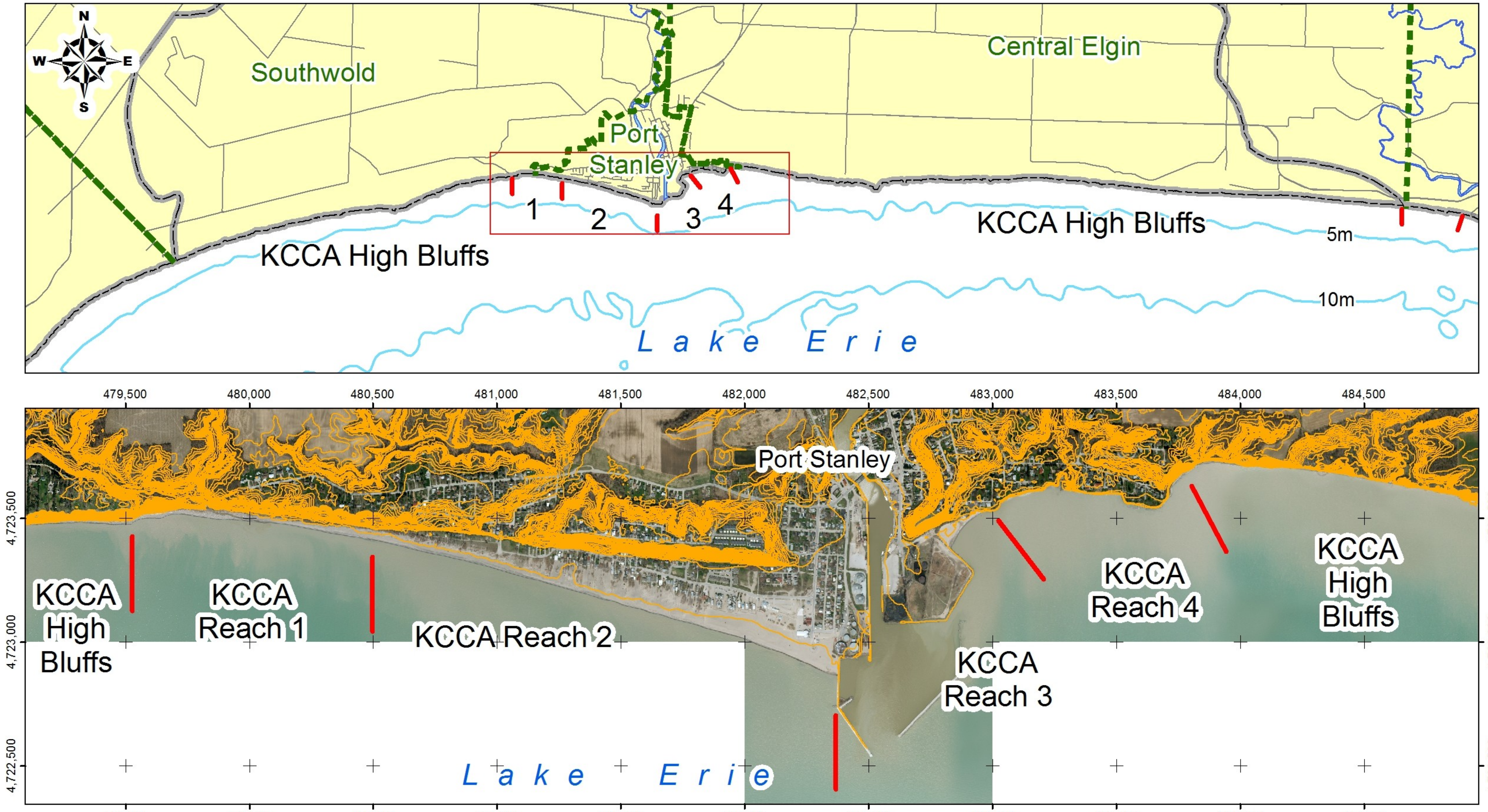
Site 48
1978 and 2010 Imagery

Imagery: 1978 and 2010 SWOOP
Grid Spacing: 50m
Spatial Reference: NAD 1983 UTM Zone 17N

Baird

Site 48 - Local Map Showing Top of Bank with 1978 and 2010 imagery.mxd

Map Published: 2014-08-06



Overview: 0 2.5 5 km

Detail: 0 500 1,000 m

Kettle Creek C.A.
Shoreline Reaches for S.M.P.

Aerial Imagery: SWOOP 2010.
Detailed Map Grid Spacing: 500 metres
Spatial Reference: NAD 1983 UTM Zone 17N

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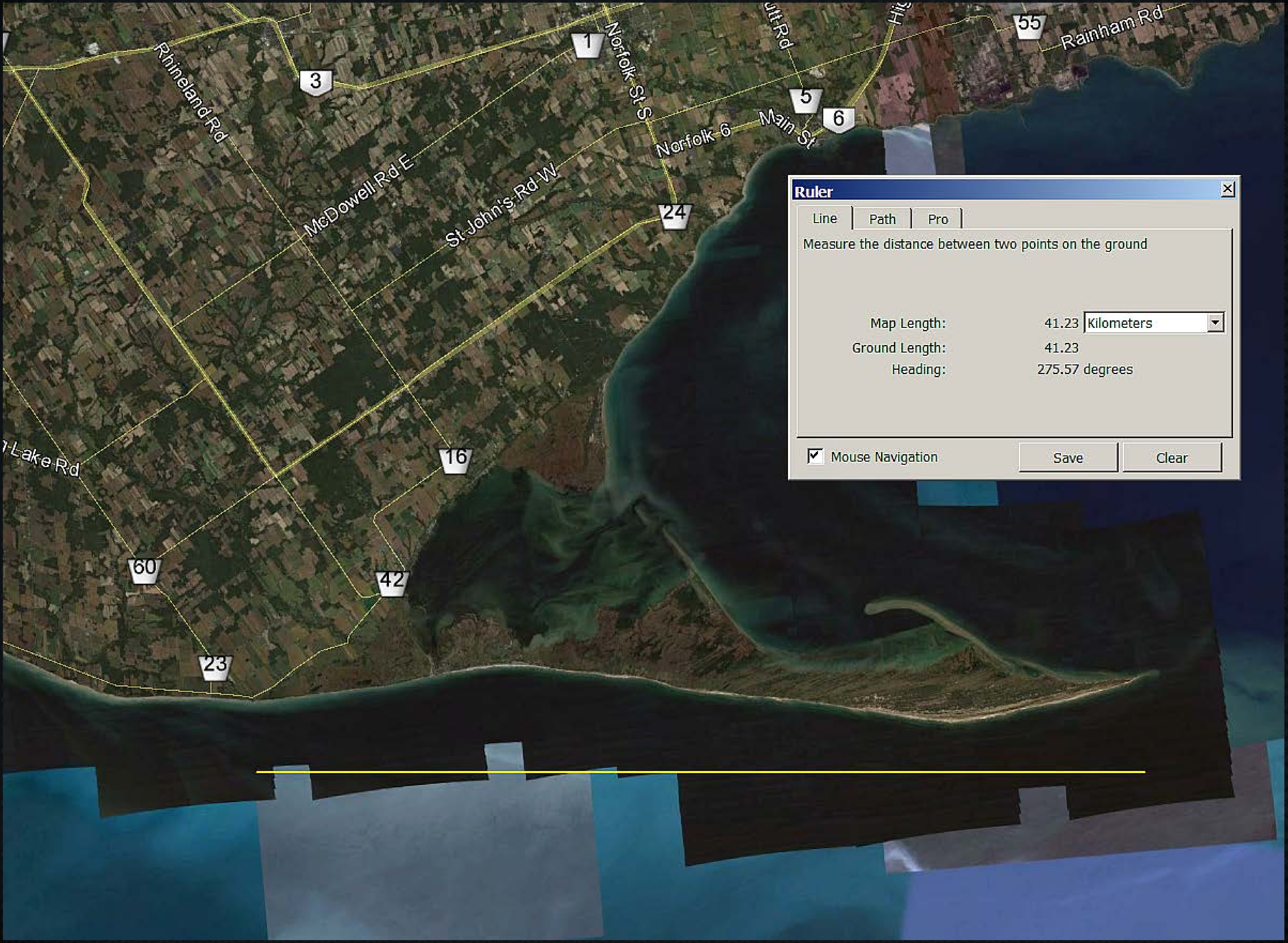
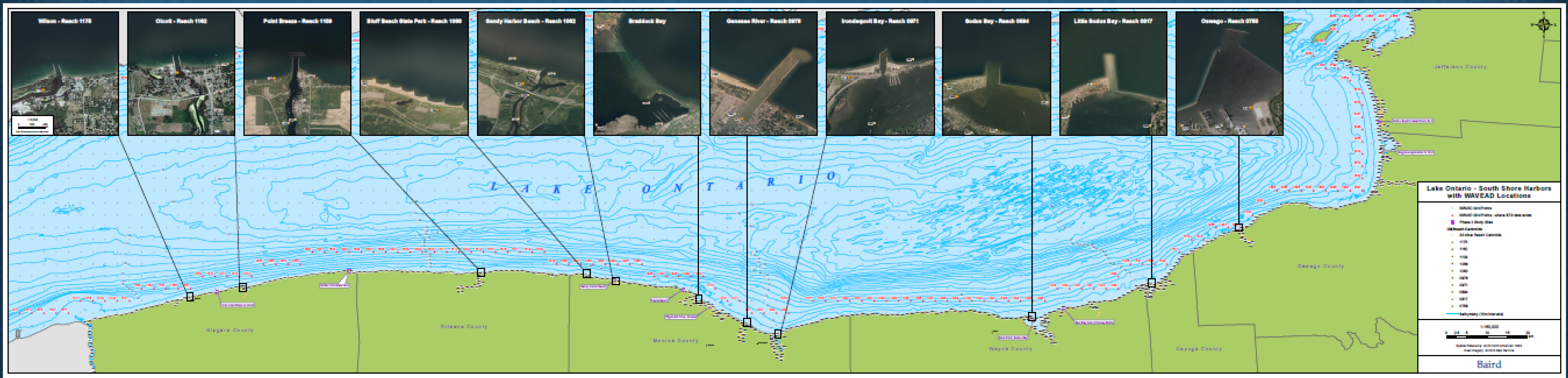

Ruler
Line
Path
Pro
Measure the distance between two points on the ground
Map Length: 41.23 Kilometers
Ground Length: 41.23
Heading: 275.57 degrees
Mouse Navigation
Save
Clear
Rhineland Rd
McDowell Rd E
St John's Rd W
Norfolk St S
Norfolk 6
Main St
Rainham Rd
Lake Rd
3
1
5
6
55
24
16
60
42
23

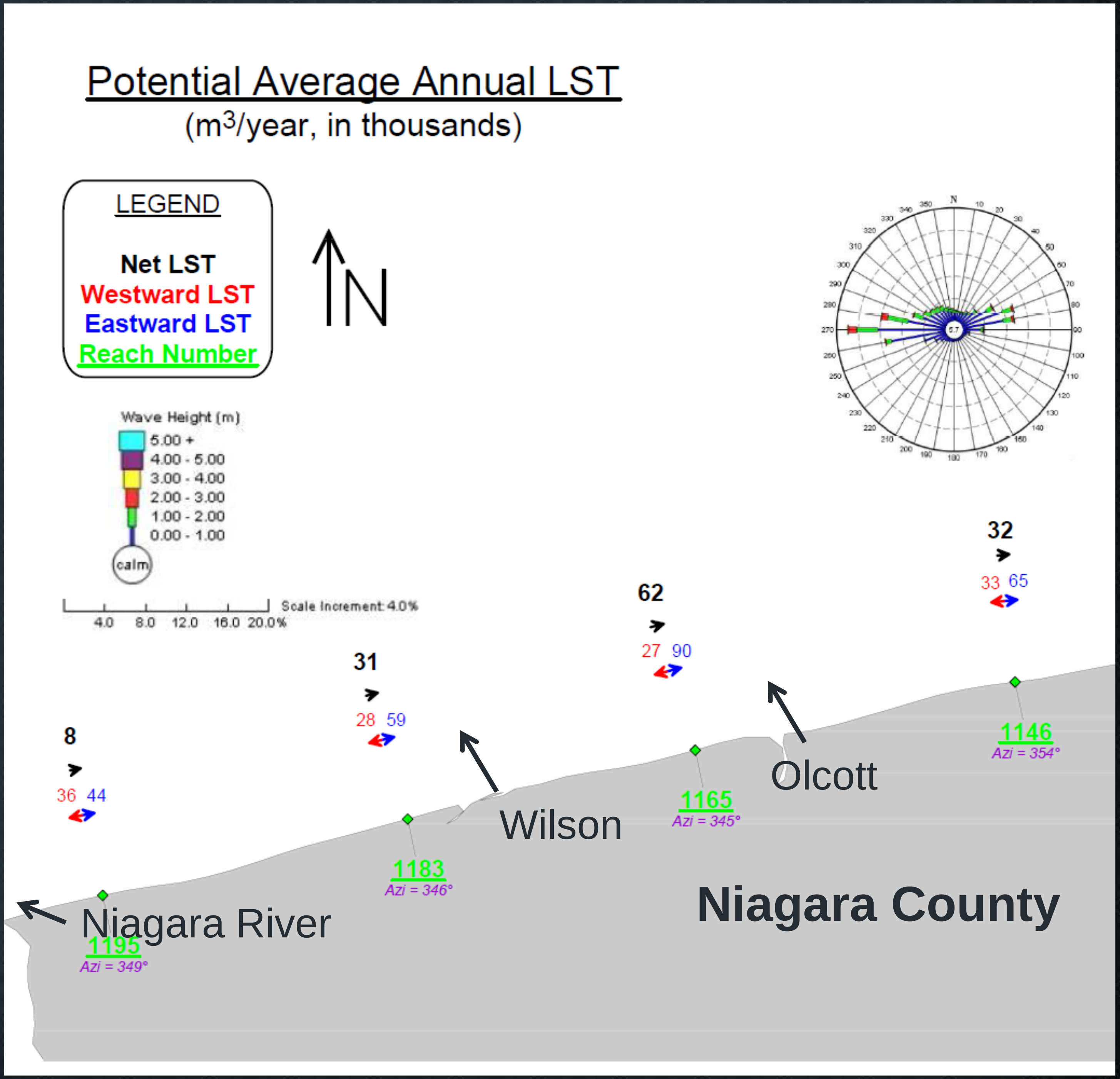
Case Study: South Shore Ecological Sediment Budget



Baird with E&E

Potential LST COSMOS Run

- Longshore Sediment Transport (LST) analysis was completed with COSMOS
  - In-house numerical model for the simulation of coastal processes



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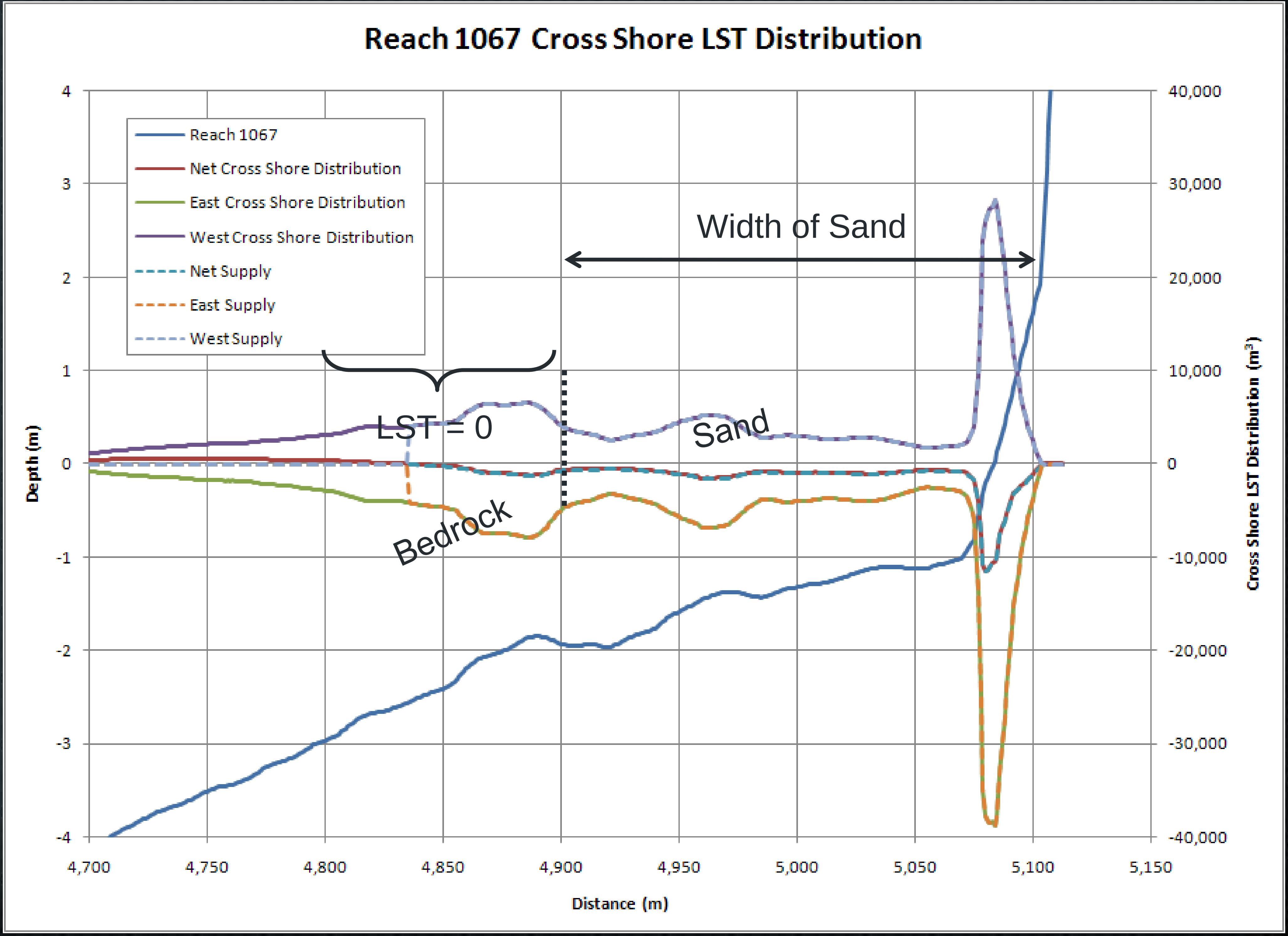
Supply Limited Conditions



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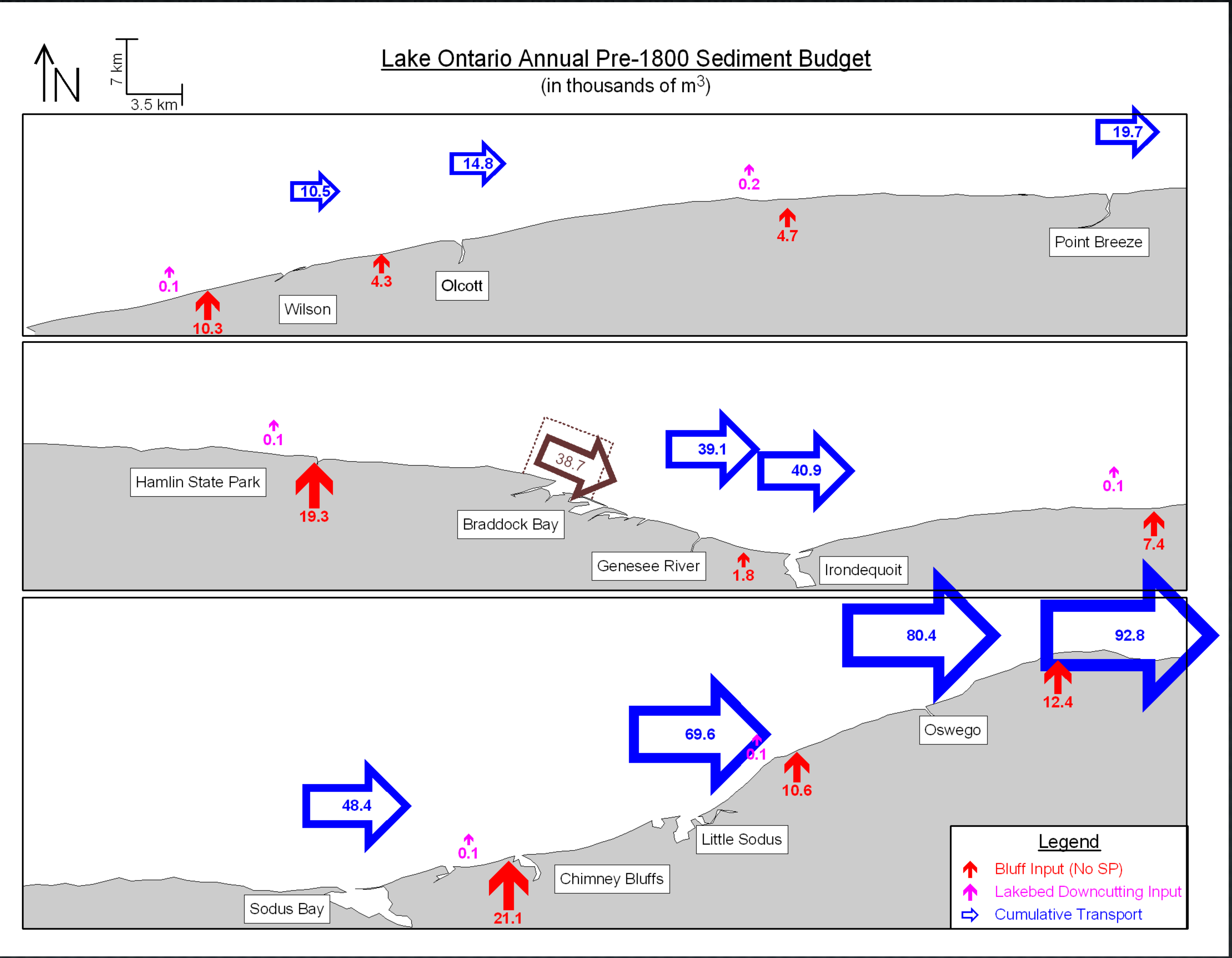
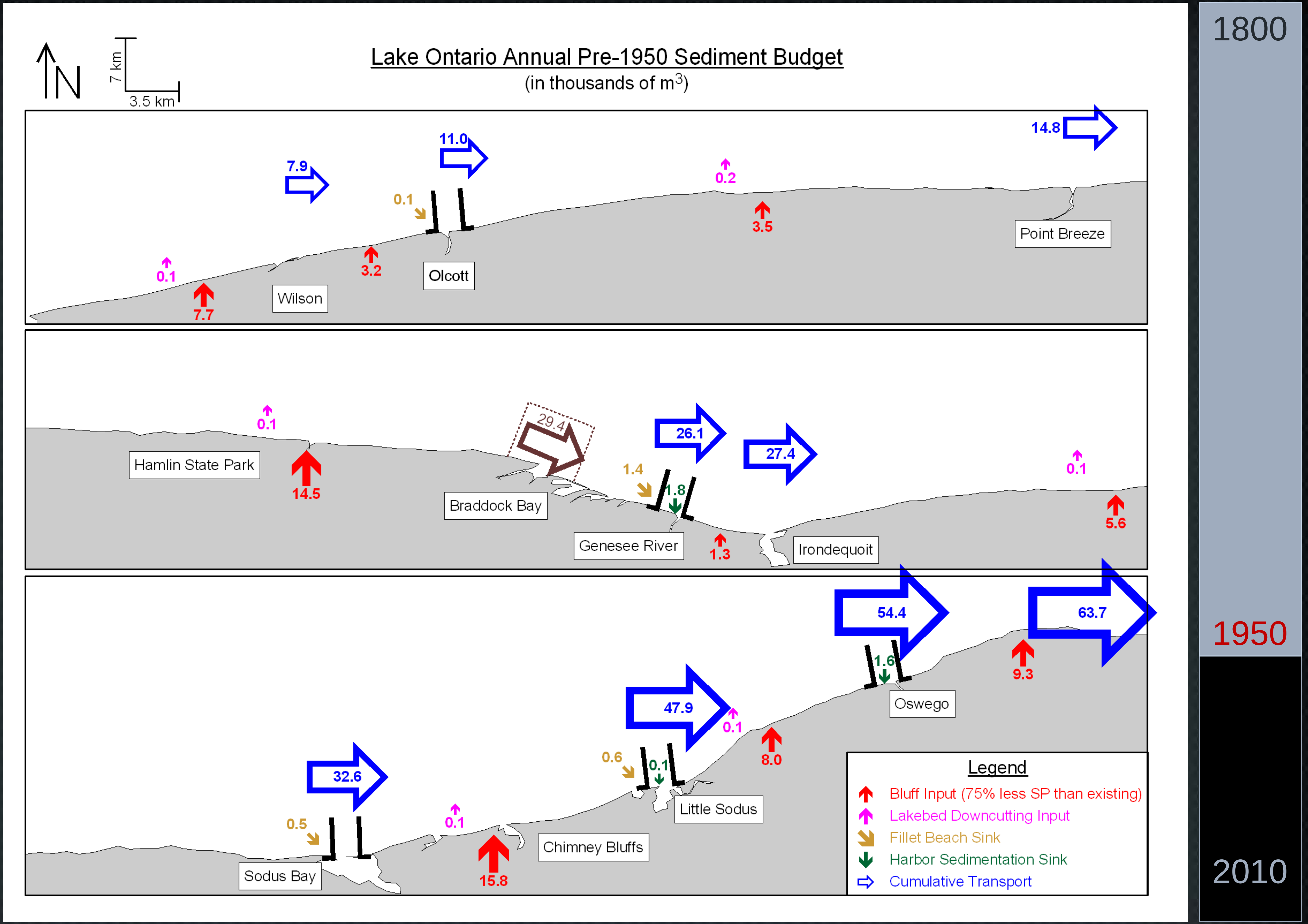


1800

1950

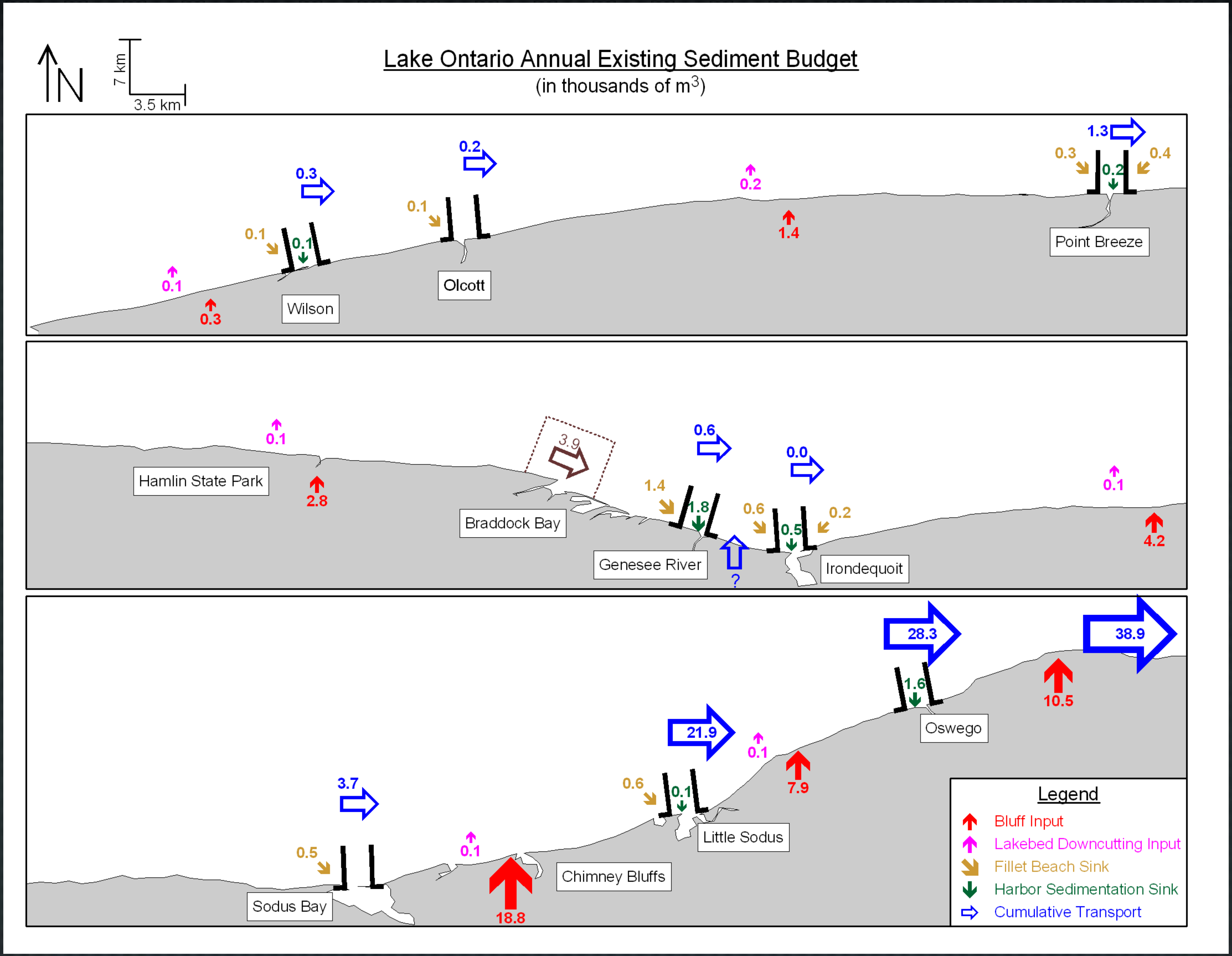
2010

Baird



N
7 km
3.5 km
Lake Ontario Annual Pre-1950 Sediment Budget
(in thousands of m3)
7.9
11.0
14.8
0.1
0.2
3.5
0.1
3.2
Olcott
Point Breeze
Wilson
7.7
0.1
29.4
26.1
27.4
0.1
Hamlin State Park
14.5
1.4
1.8
Braddock Bay
5.6
Genesee River
1.3
Irondequoit
54.4
63.7
1.6
9.3
47.9
Oswego
0.1
8.0
0.6
0.1
32.6
Little Sodus
0.5
0.1
Chimney Bluffs
15.8
Sodus Bay
Legend
Bluff Input (75% less SP than existing)
Lakebed Downcutting Input
Fillet Beach Sink
Harbor Sedimentation Sink
Cumulative Transport
1800
1950
2010

Baird



1800

1950

2010

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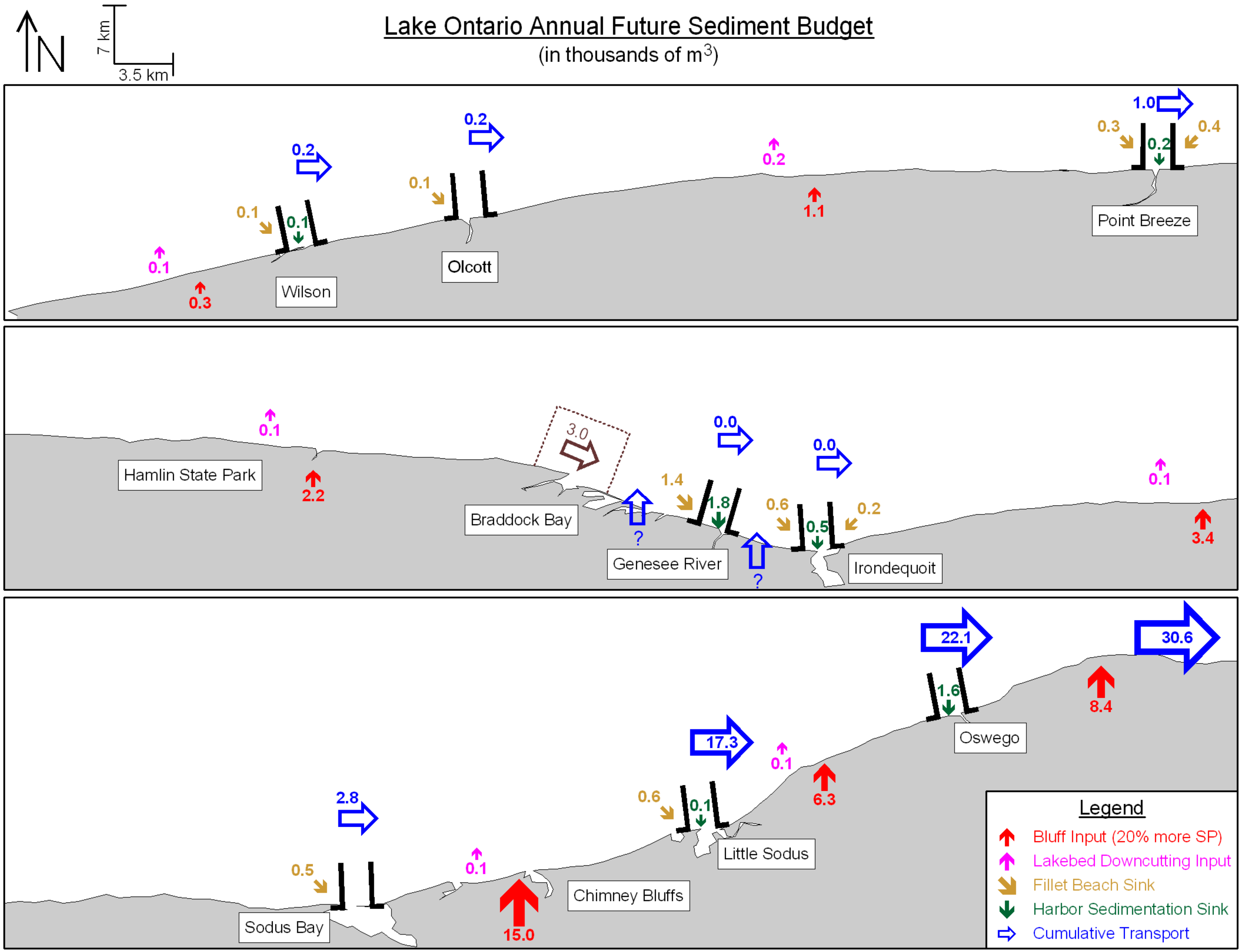
Lake Ontario Annual Future Sediment Budget

(in thousands of m^3)



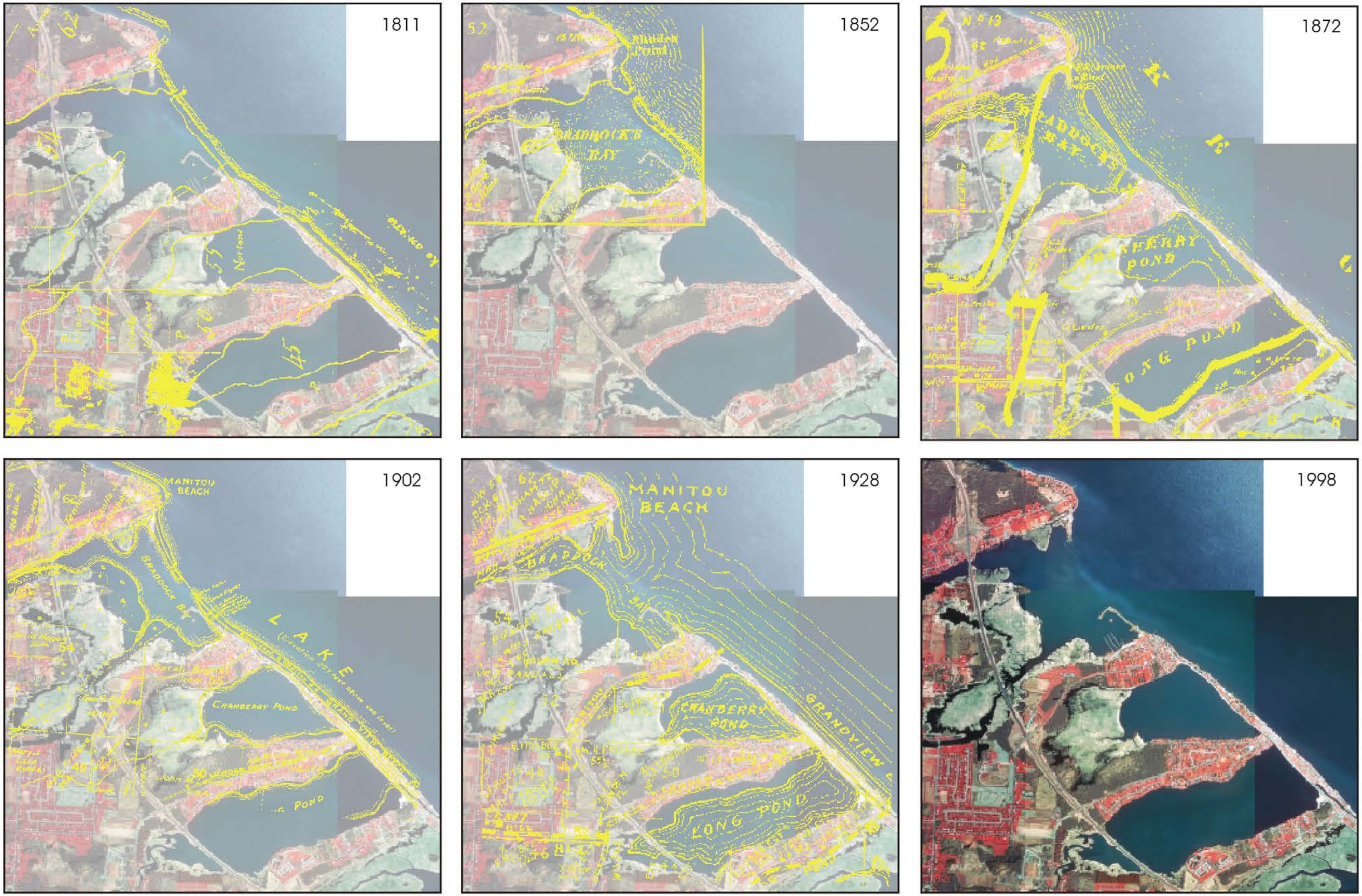
1800

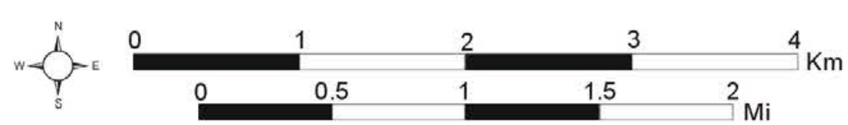
1950

2010

Future

Baird





Notes: 1. Historic imagery from *Eight Miles Along The Shore*, 1982 by Virginia Tomkiewicz and Shirley Cox Husted.
2. Geo-referencing of historic maps is approximate.

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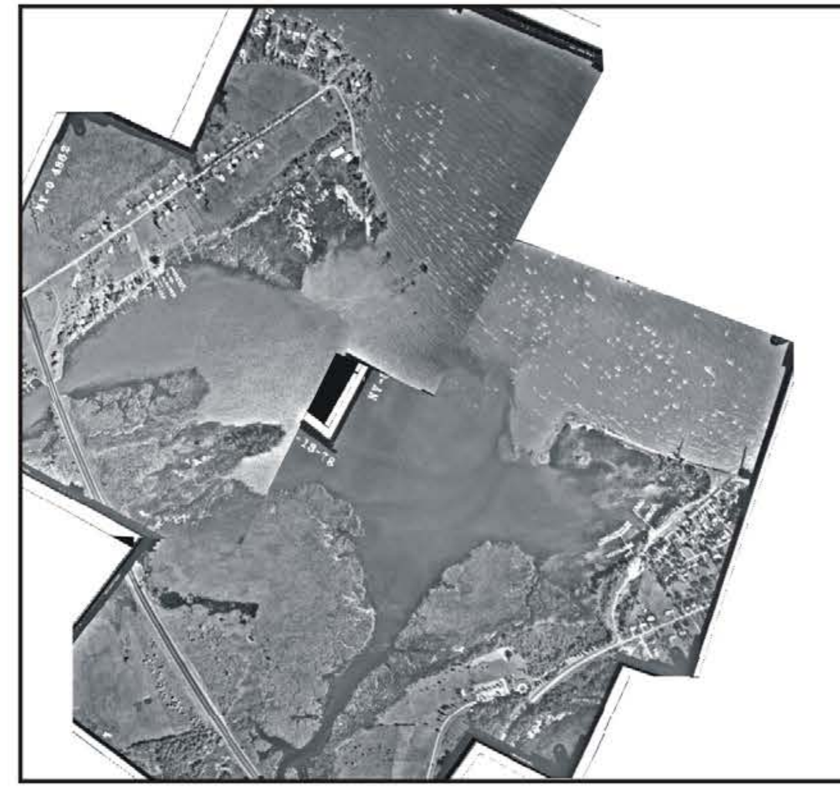
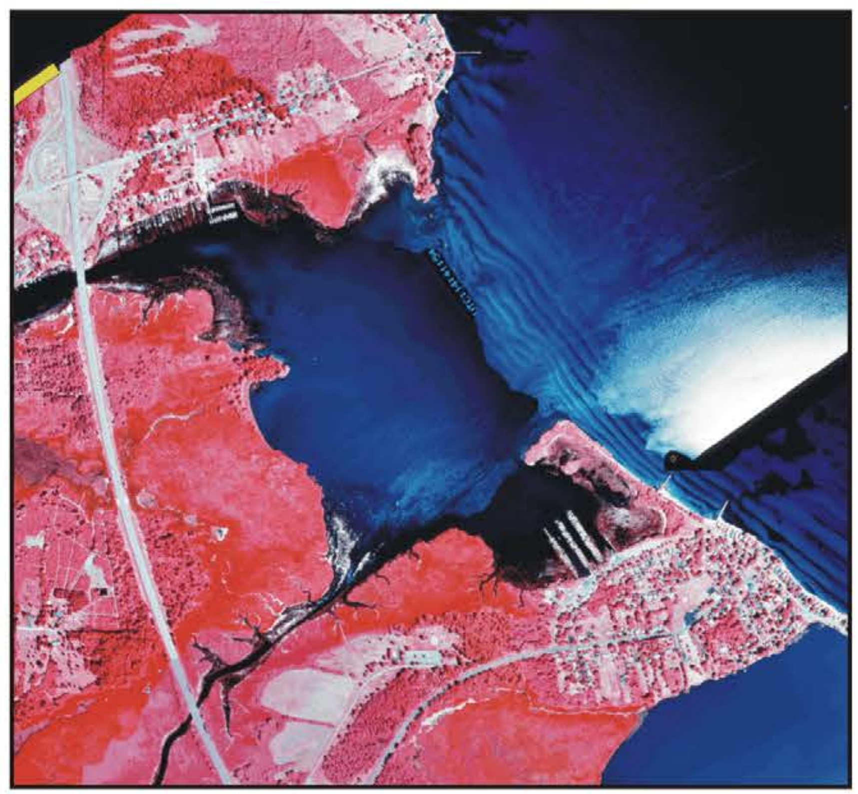
1958

1966

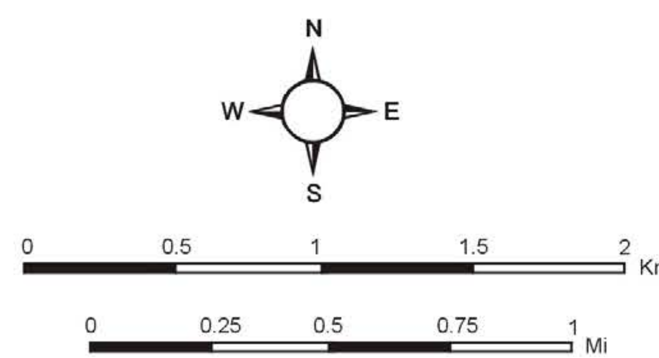


1978

1988



2001



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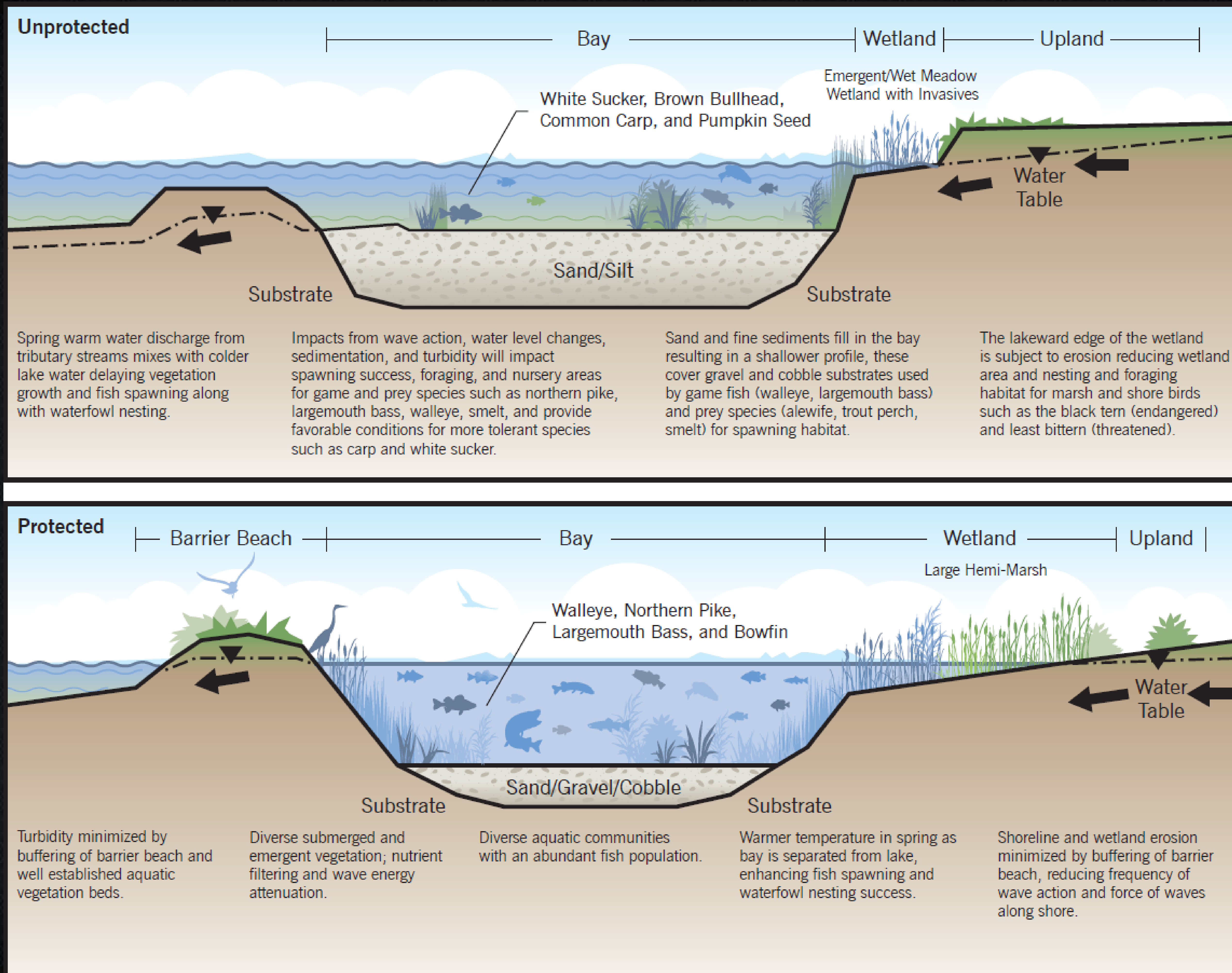
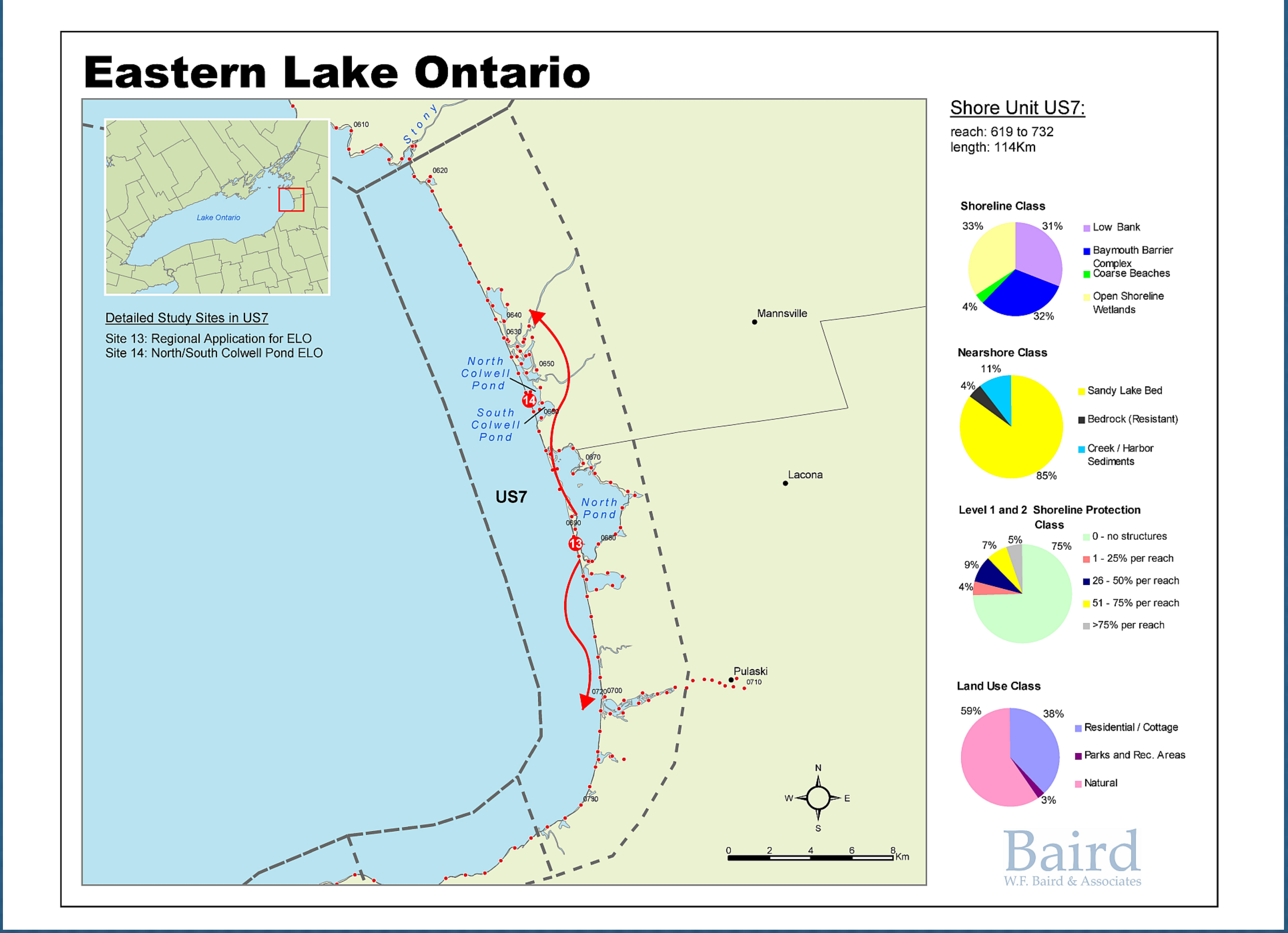

Unprotected
Bay
Wetland
Upland
Emergent/Wet Meadow Wetland with Invasives
White Sucker, Brown Bullhead, Common Carp, and Pumpkin Seed
Water Table
Sand/Silt
Substrate
Substrate
Spring warm water discharge from tributary streams mixes with colder lake water delaying vegetation growth and fish spawning along with waterfowl nesting.
Impacts from wave action, water level changes, sedimentation, and turbidity will impact spawning success, foraging, and nursery areas for game and prey species such as northern pike, largemouth bass, walleye, smelt, and provide favorable conditions for more tolerant species such as carp and white sucker.
Sand and fine sediments fill in the bay resulting in a shallower profile, these cover gravel and cobble substrates used by game fish (walleye, largemouth bass) and prey species (alewife, trout perch, smelt) for spawning habitat.
The lakeward edge of the wetland is subject to erosion reducing wetland area and nesting and foraging habitat for marsh and shore birds such as the black tern (endangered) and least bittern (threatened).
Protected
Barrier Beach
Bay
Wetland
Upland
Large Hemi-Marsh
Walleye, Northern Pike, Largemouth Bass, and Bowfin
Water Table
Sand/Gravel/Cobble
Substrate
Substrate
Turbidity minimized by buffering of barrier beach and well established aquatic vegetation beds.
Diverse submerged and emergent vegetation; nutrient filtering and wave energy attenuation.
Diverse aquatic communities with an abundant fish population.
Warmer temperature in spring as bay is separated from lake, enhancing fish spawning and waterfowl nesting success.
Shoreline and wetland erosion minimized by buffering of barrier beach, reducing frequency of wave action and force of waves along shore.

Case Study: Eastern Lake Ontario Sediment Budget



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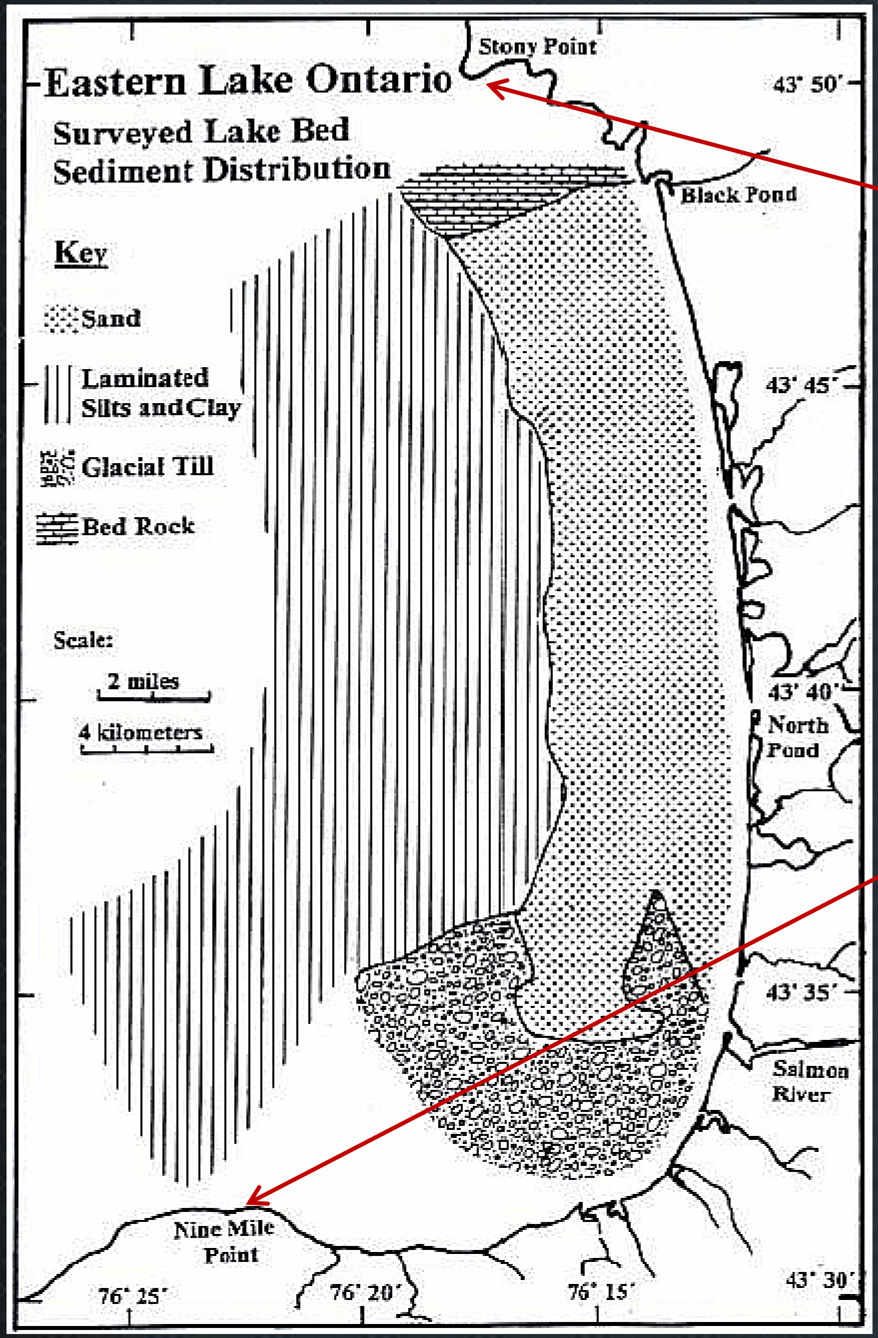
East Lake Ontario (ELO)



- Stony Point: Bedrock
- Nine Mile: Bedrock

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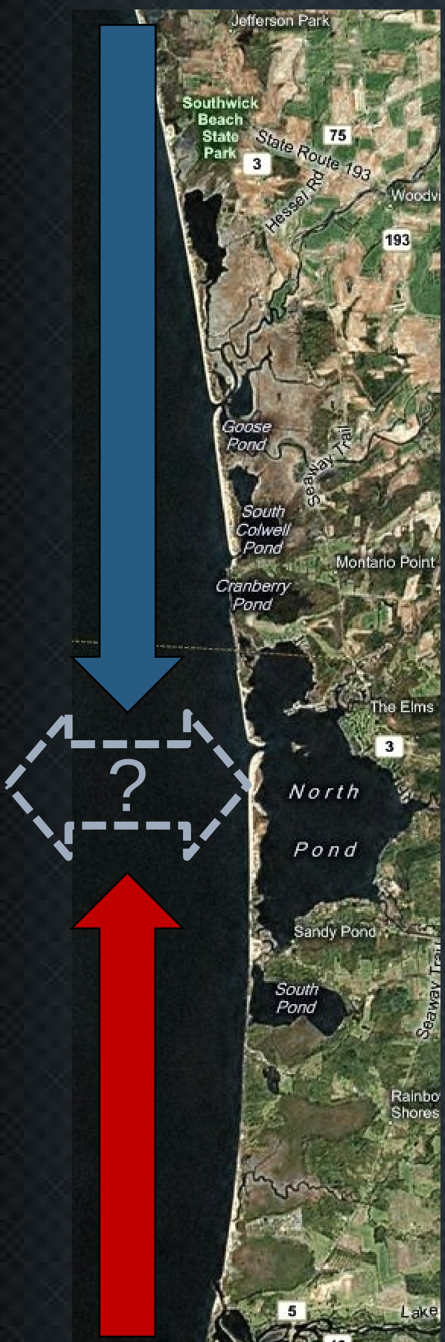
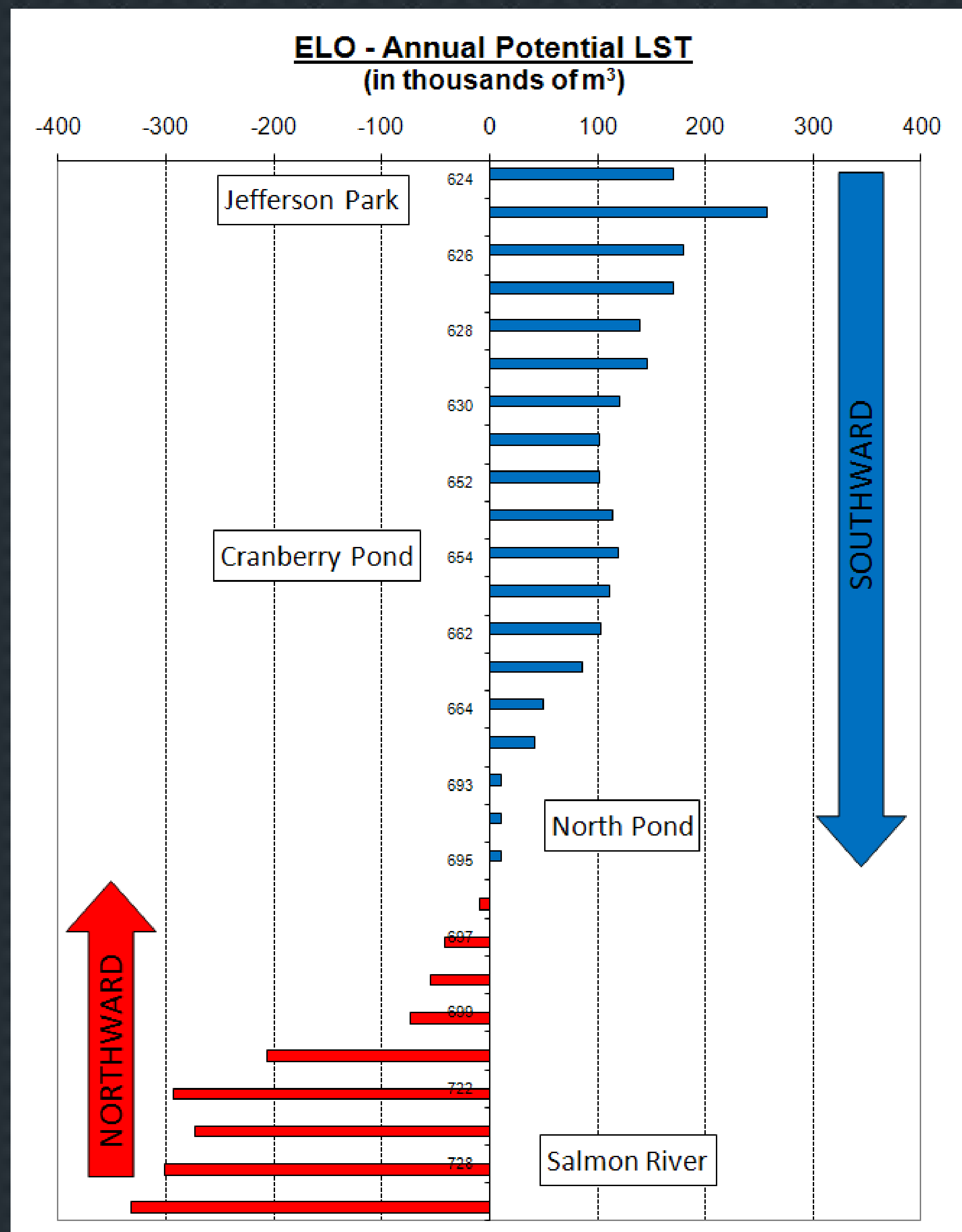
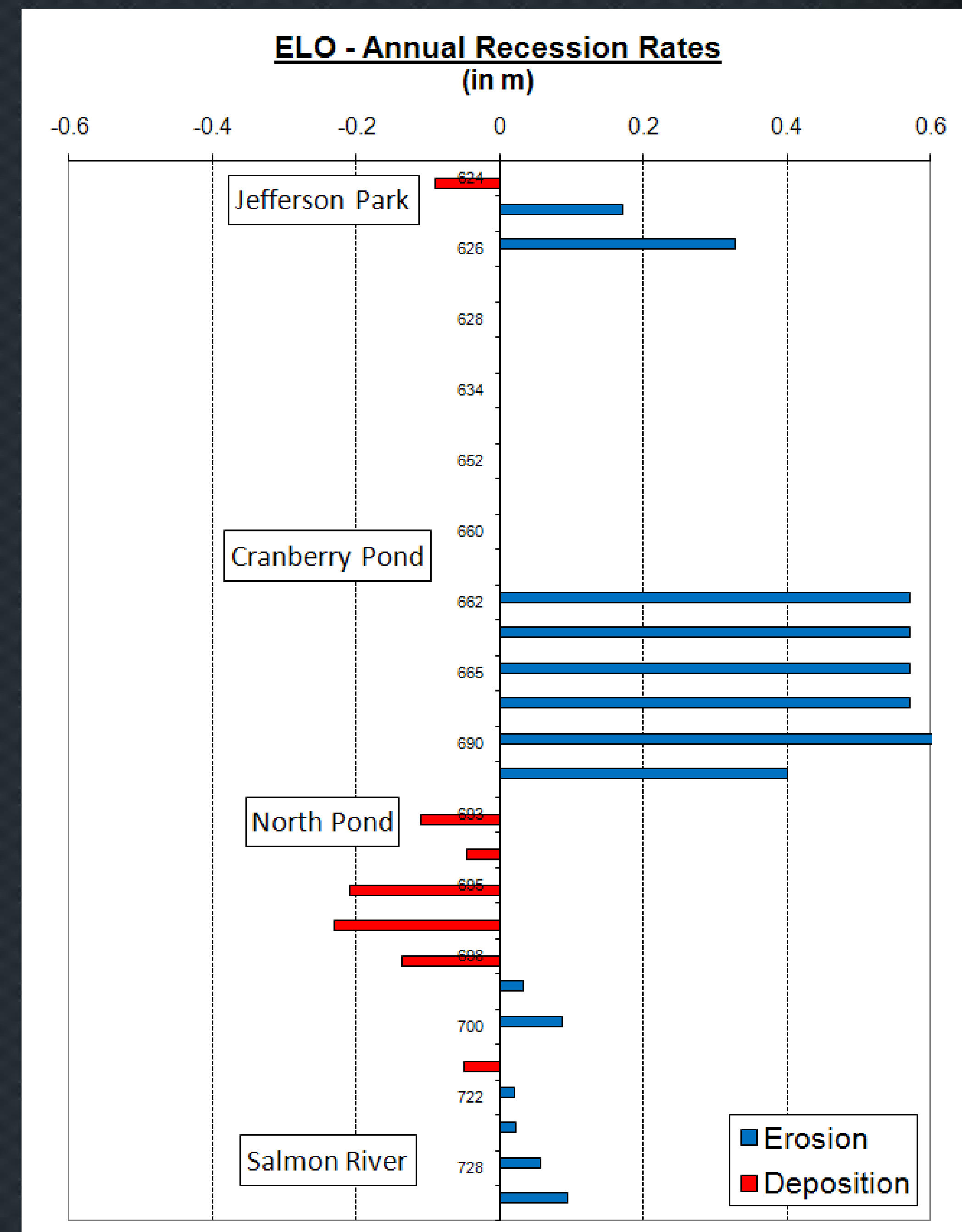
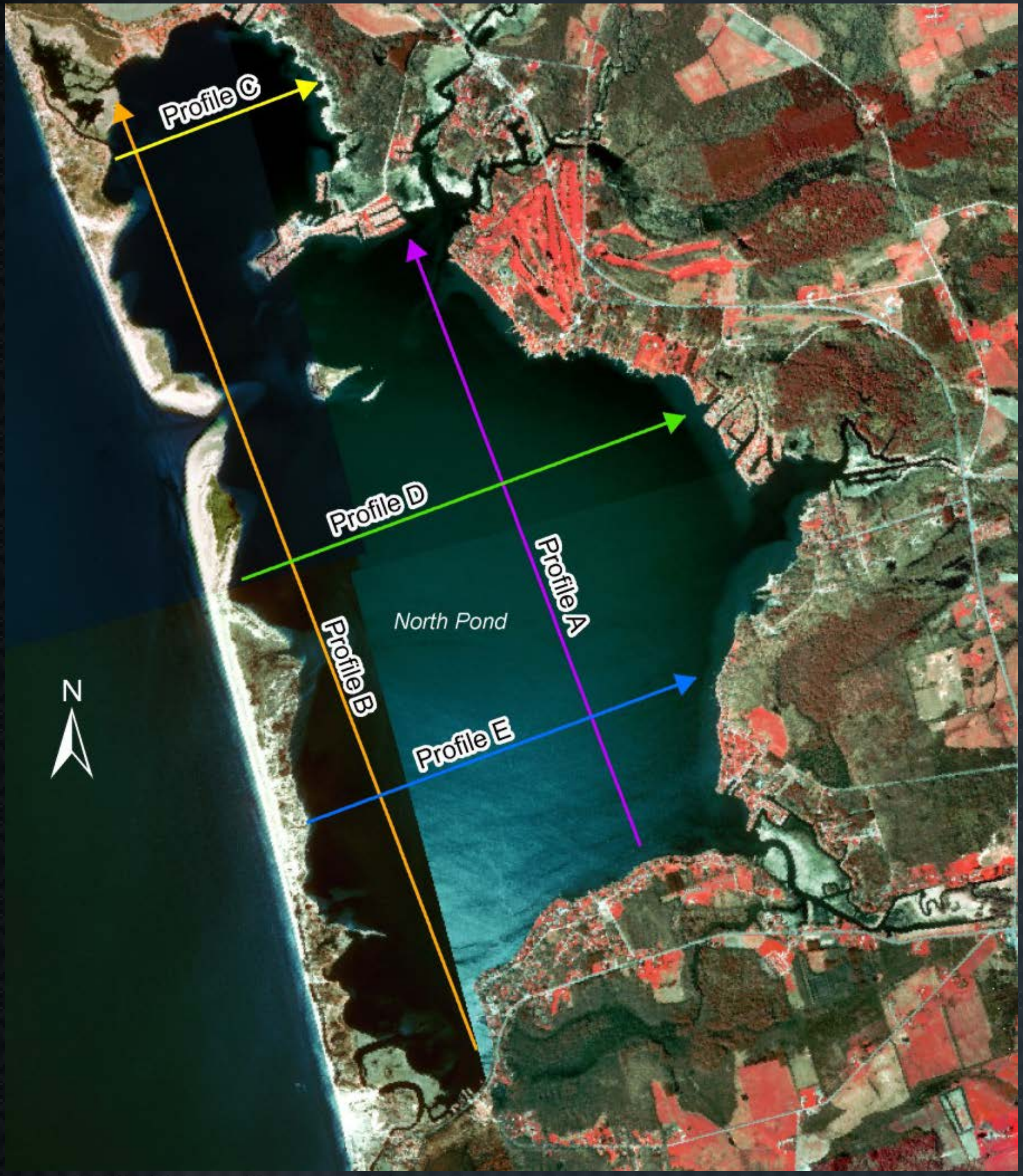
ELO – Sediment Transport

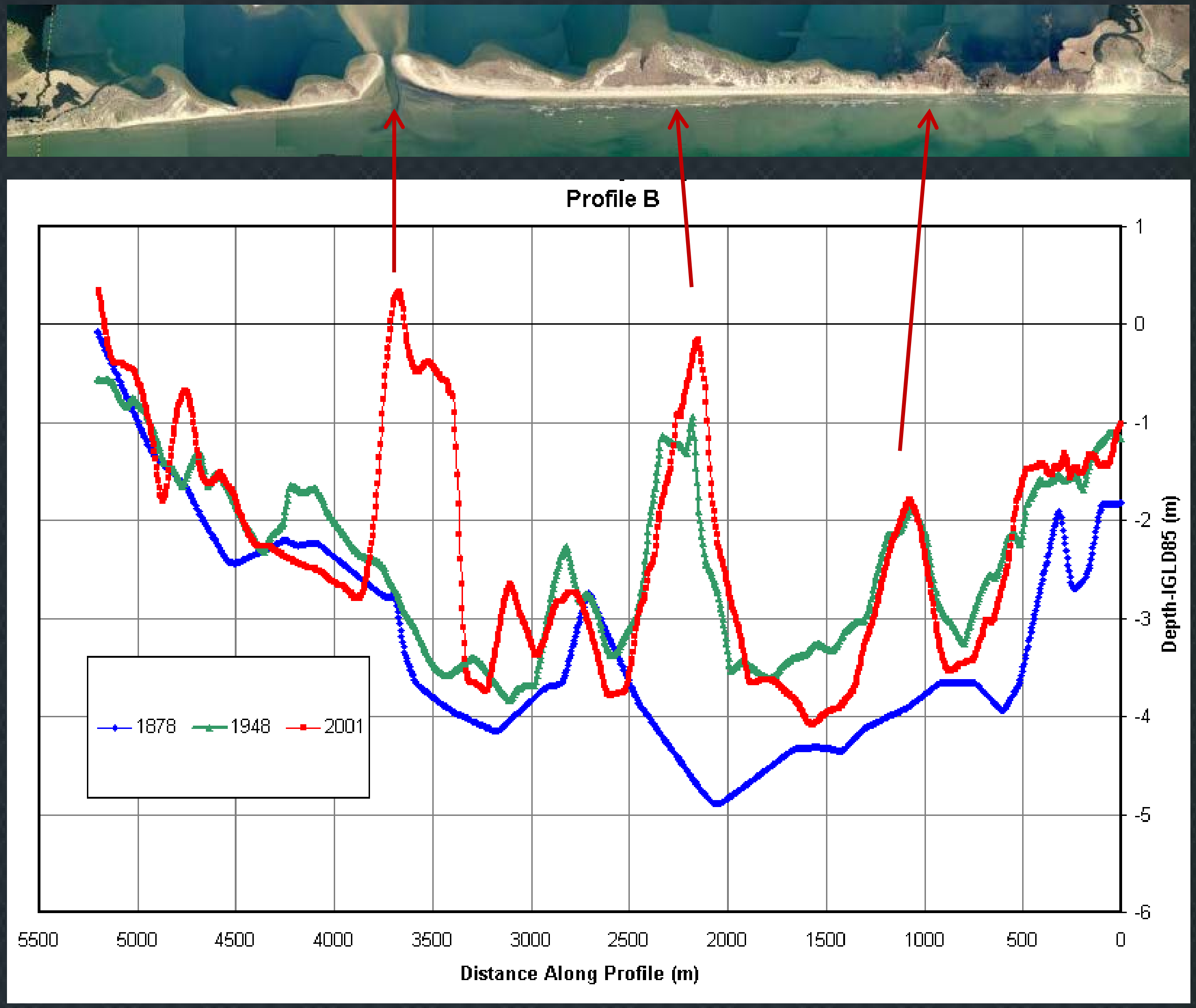






ELO – North Pond





- History of inlet migration
- Significant sink in the ELO system ($\sim$40k m^3/yr)

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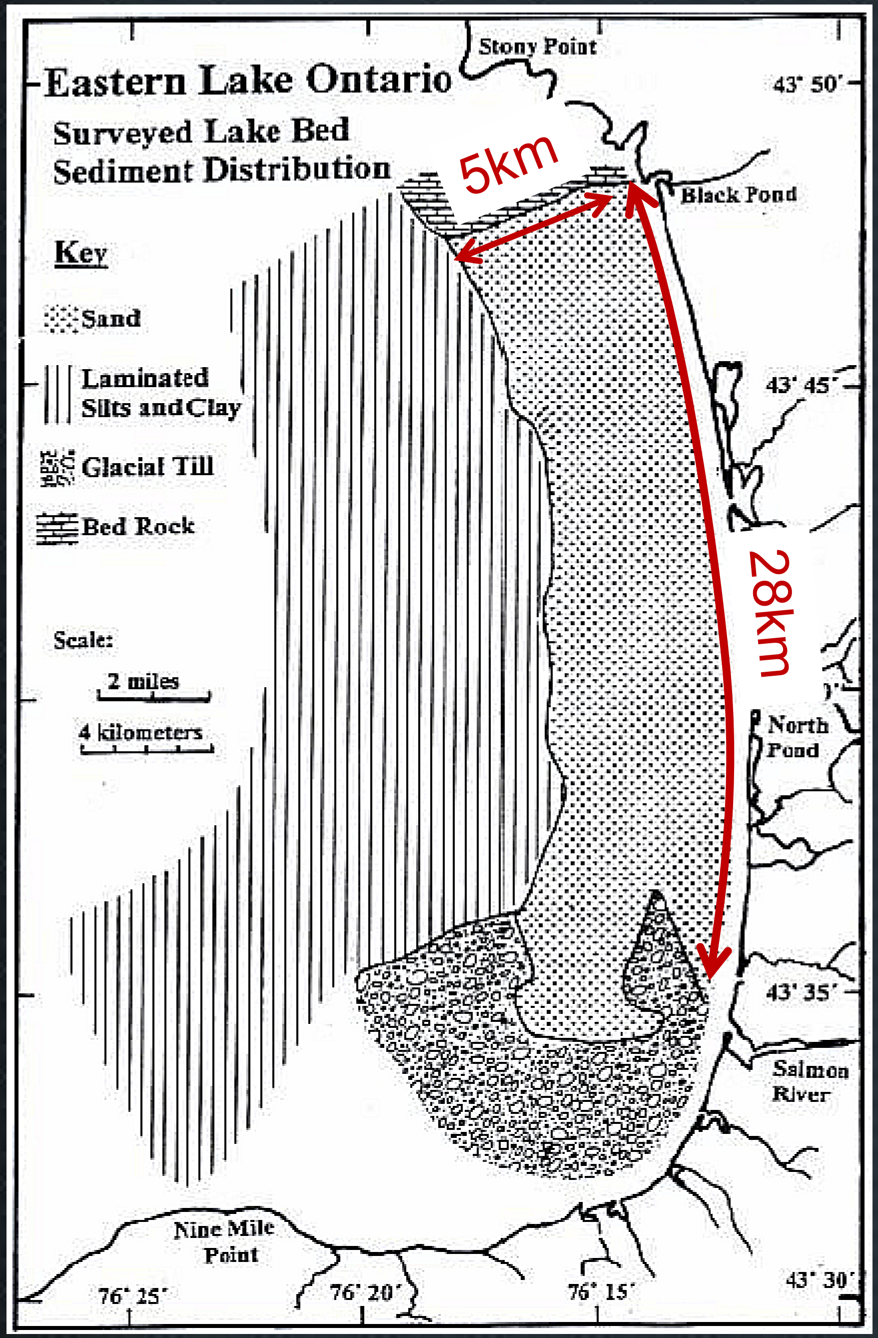
ELO – Isostatic Rebound



- 2.3 mm/yr
- Lakebed remains in equilibrium, then the rebounding surface must erode
- Rebound of sand sheet is a significant sediment source in the nearshore

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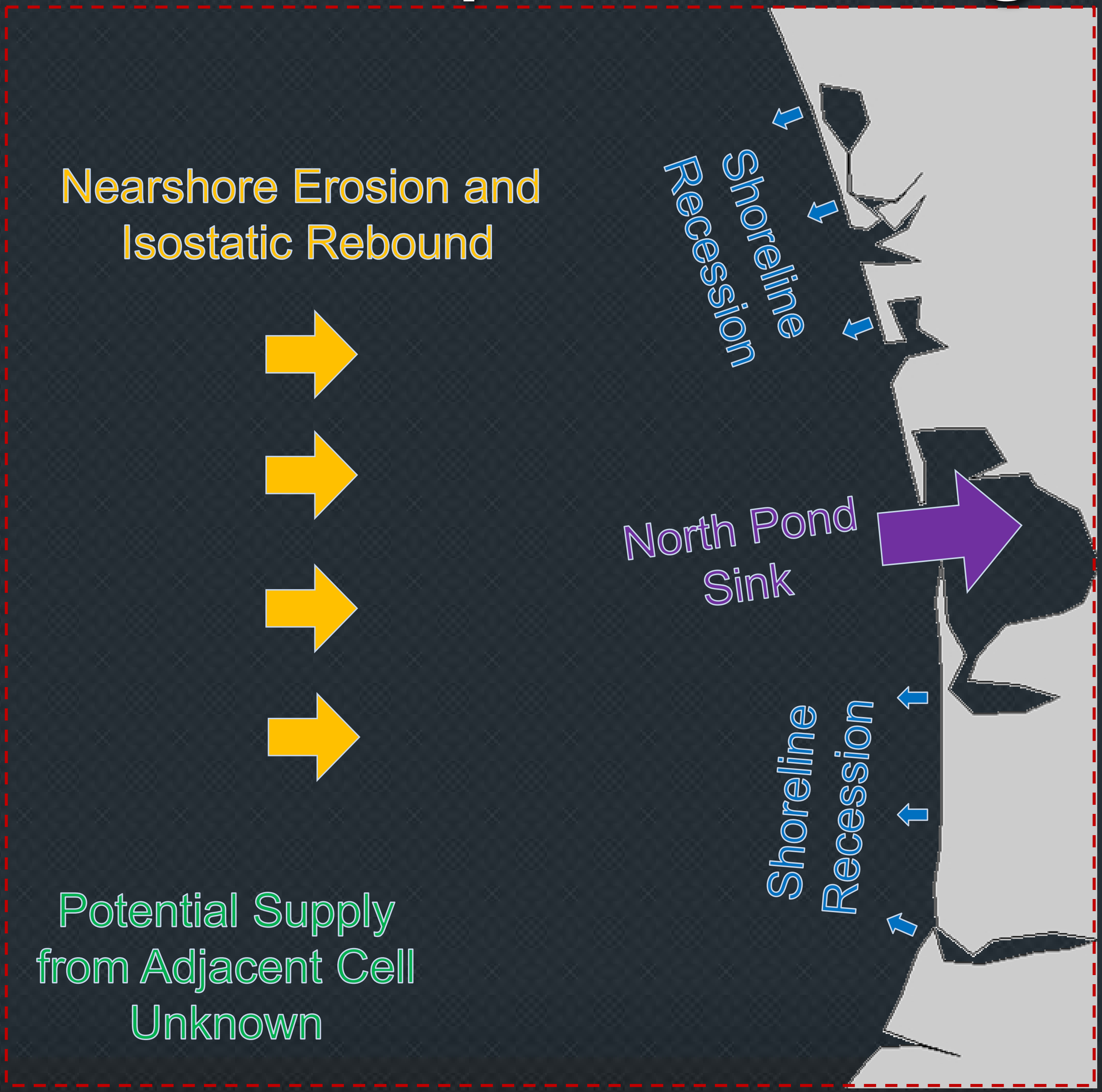
ELO – Conceptual Budget



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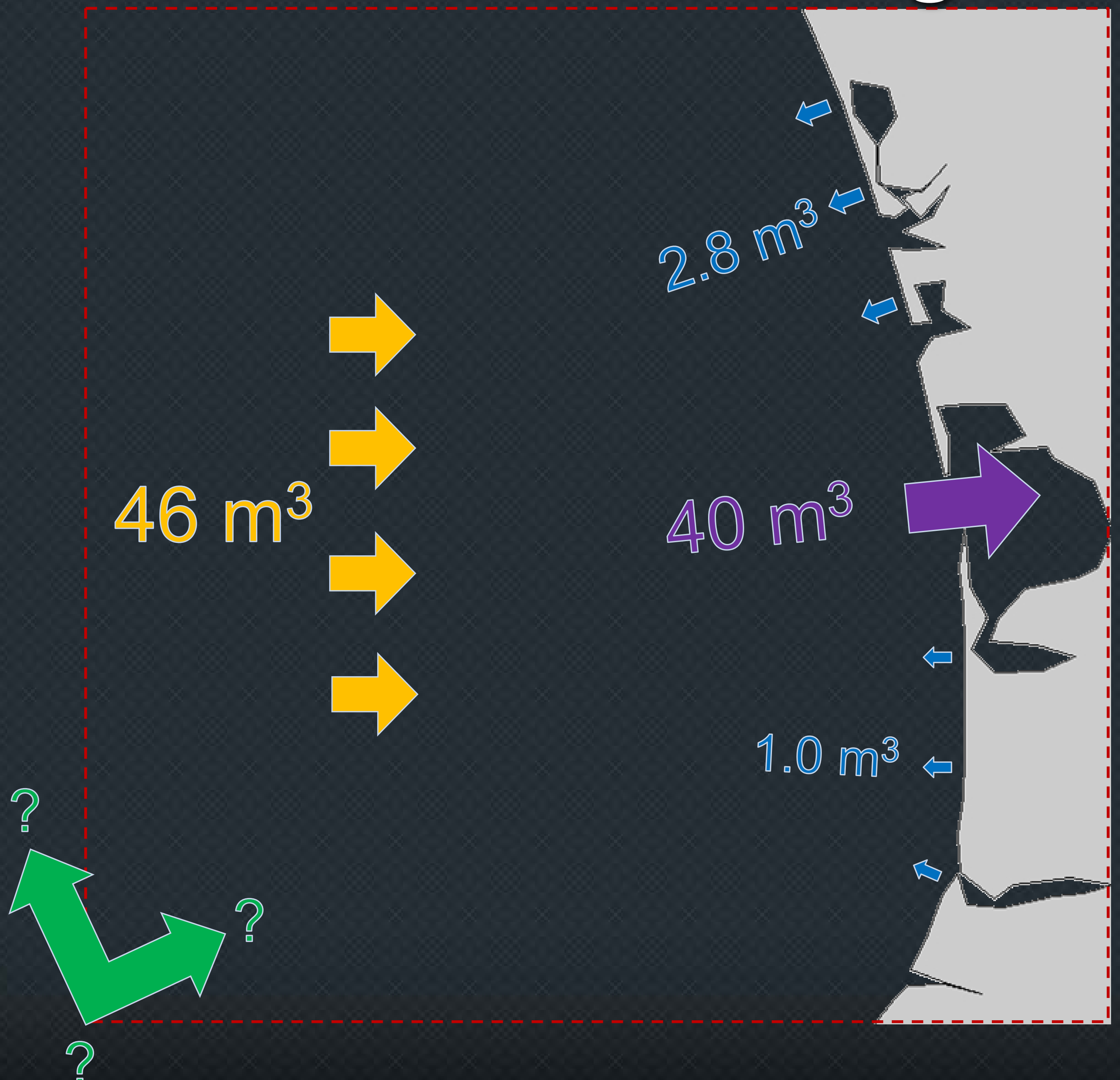
ELO – Sediment Budget



Note: All values in thousands

V – Questions

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