

Calibration and Application of a Fine-Scale Model to Evaluate Sediment Dynamics in Toledo Harbor and the Western Basin of Lake Erie

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Funded by USACE-Buffalo District
through sub-contract to Ecology &
Environment, Buffalo, NY

An aerial photograph of a coastal city and harbor area, showing buildings, roads, and water. The image is partially obscured by a blue gradient on the right side of the slide.

Presentation Outline

- Project Background
- Project Objectives
- Overview of Model Development
- Sediment Transport Calibration Results
- Model Application Results
- Summary

Project Background

- Maumee Bay / Toledo Harbor dredging:
 - Annual volume: ~640,000 yd³ (2004-08)
 - ~70% to open lake disposal
 - Annual cost: ~\$5 million
- Major sediment “sources”:
 - Maumee River
 - Wind-wave resuspension
- Need for linked watershed-receiving water model to support comprehensive system management planning:
 - Sediment management
 - Nearshore water quality management (GLRI)
 - Navigation
 - Coastal erosion
 - Flood control

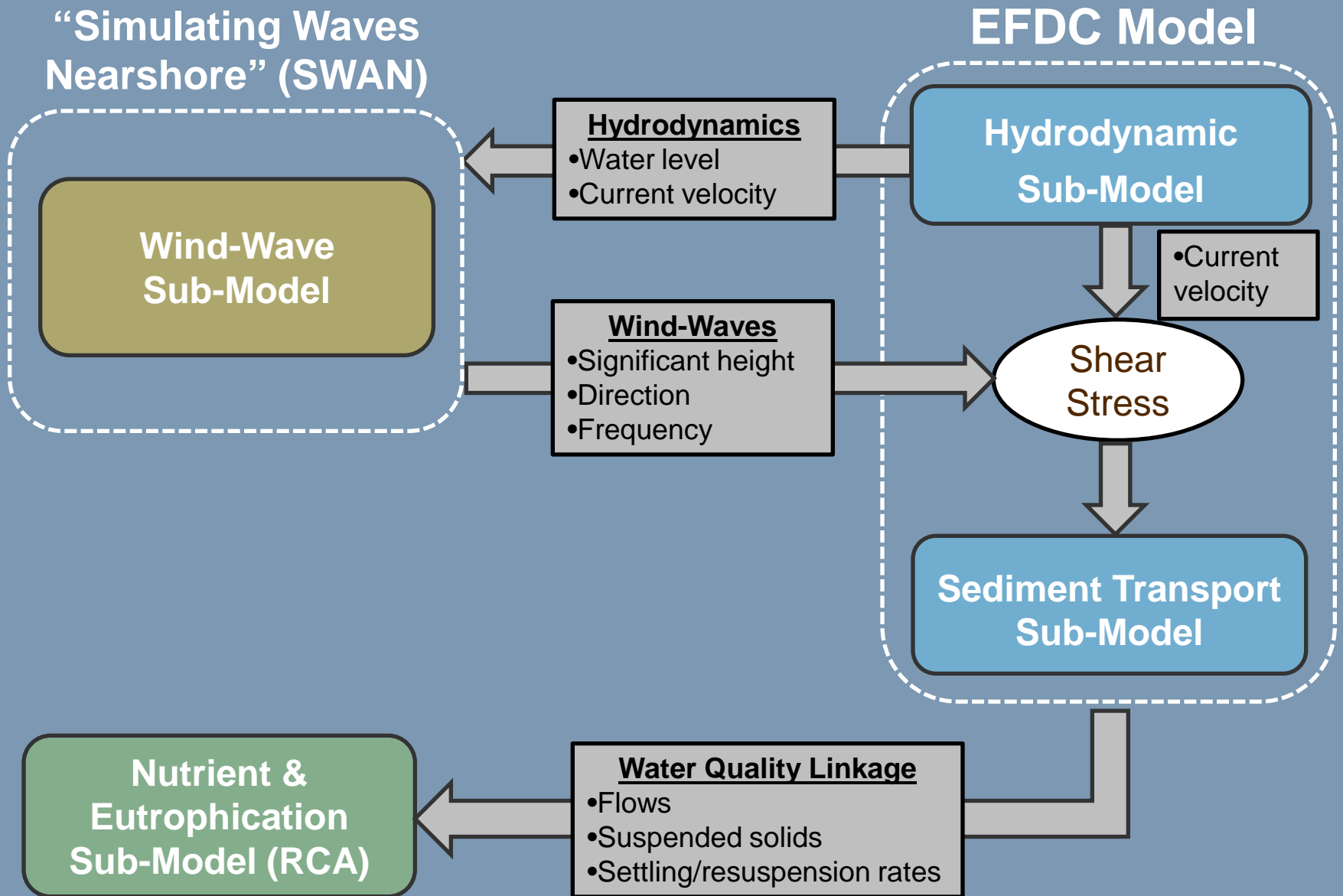




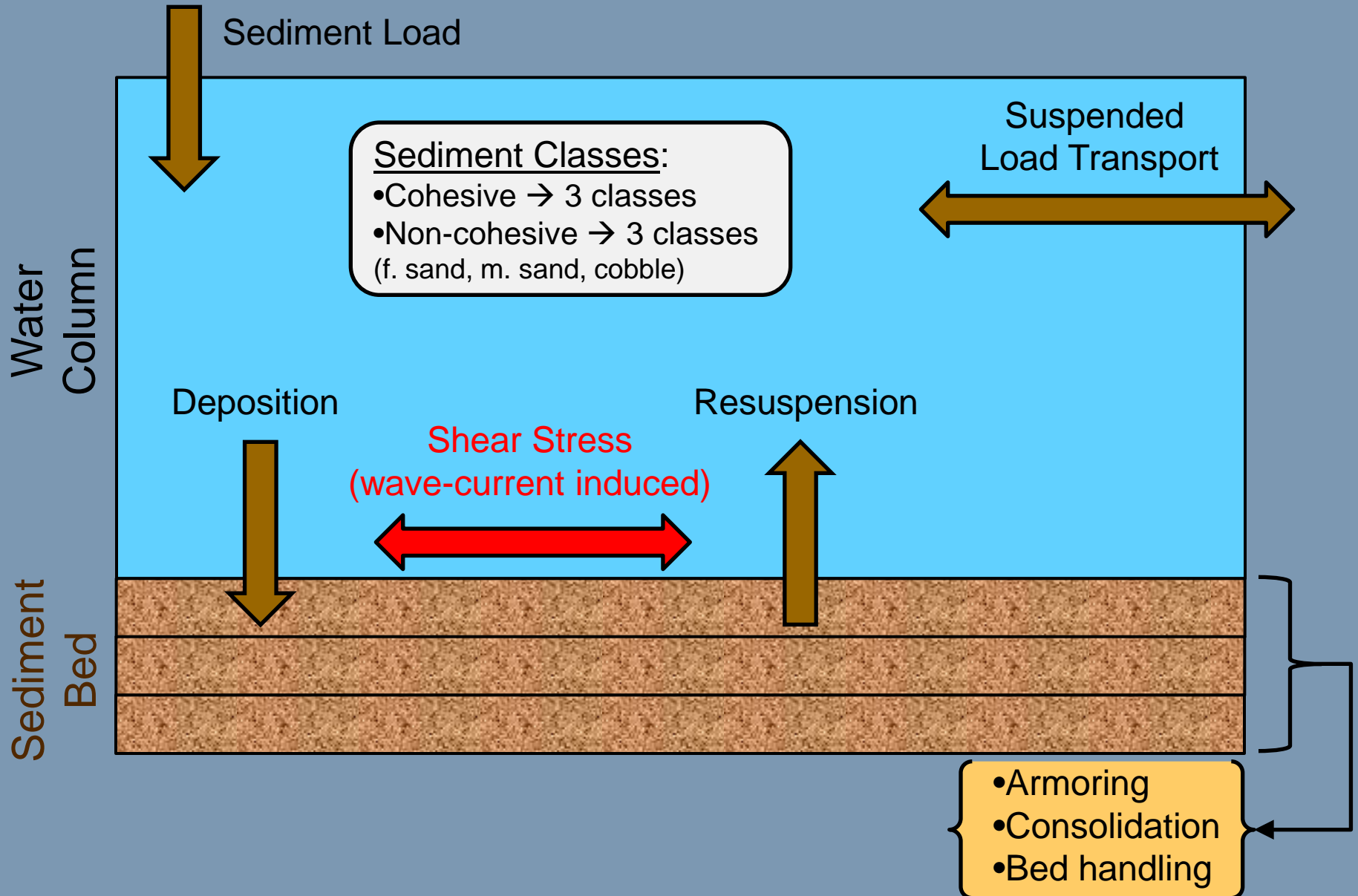
Project Objectives

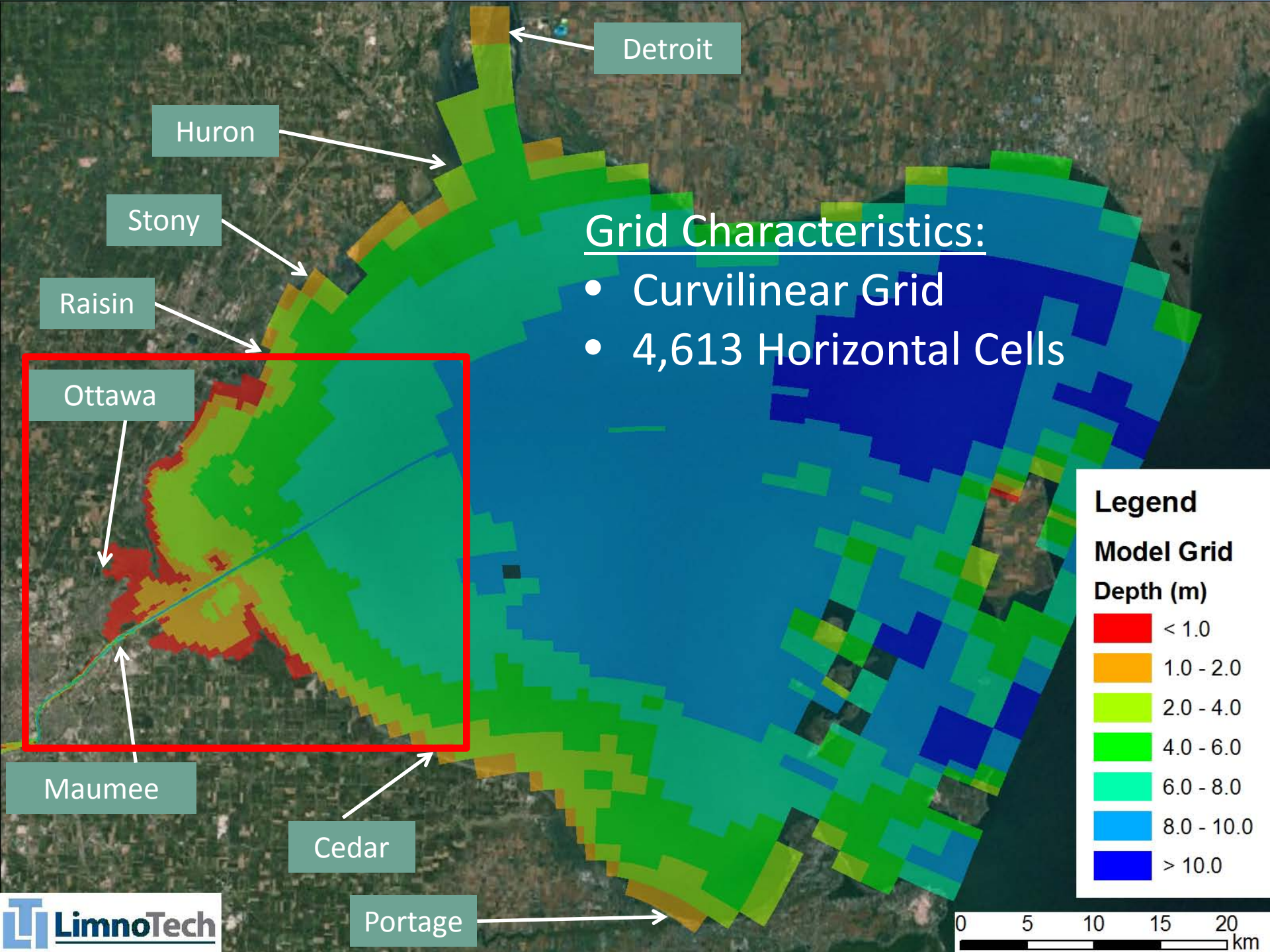
- Quantitatively connect external (tributary/watershed NPS, point sources) and internal (e.g., sediment resuspension) pollutant sources to lake ecological endpoints:
 - Sediment → sedimentation and turbidity
 - Nutrients → nuisance & harmful algal blooms
- Support USACE management decisions:
 - Minimize need for dredging and impact
 - Beneficial reuse
 - Habitat enhancement (shoal areas)
- Synthesize monitoring/modeling data and advance our understanding of the system (WLEB Partnership)

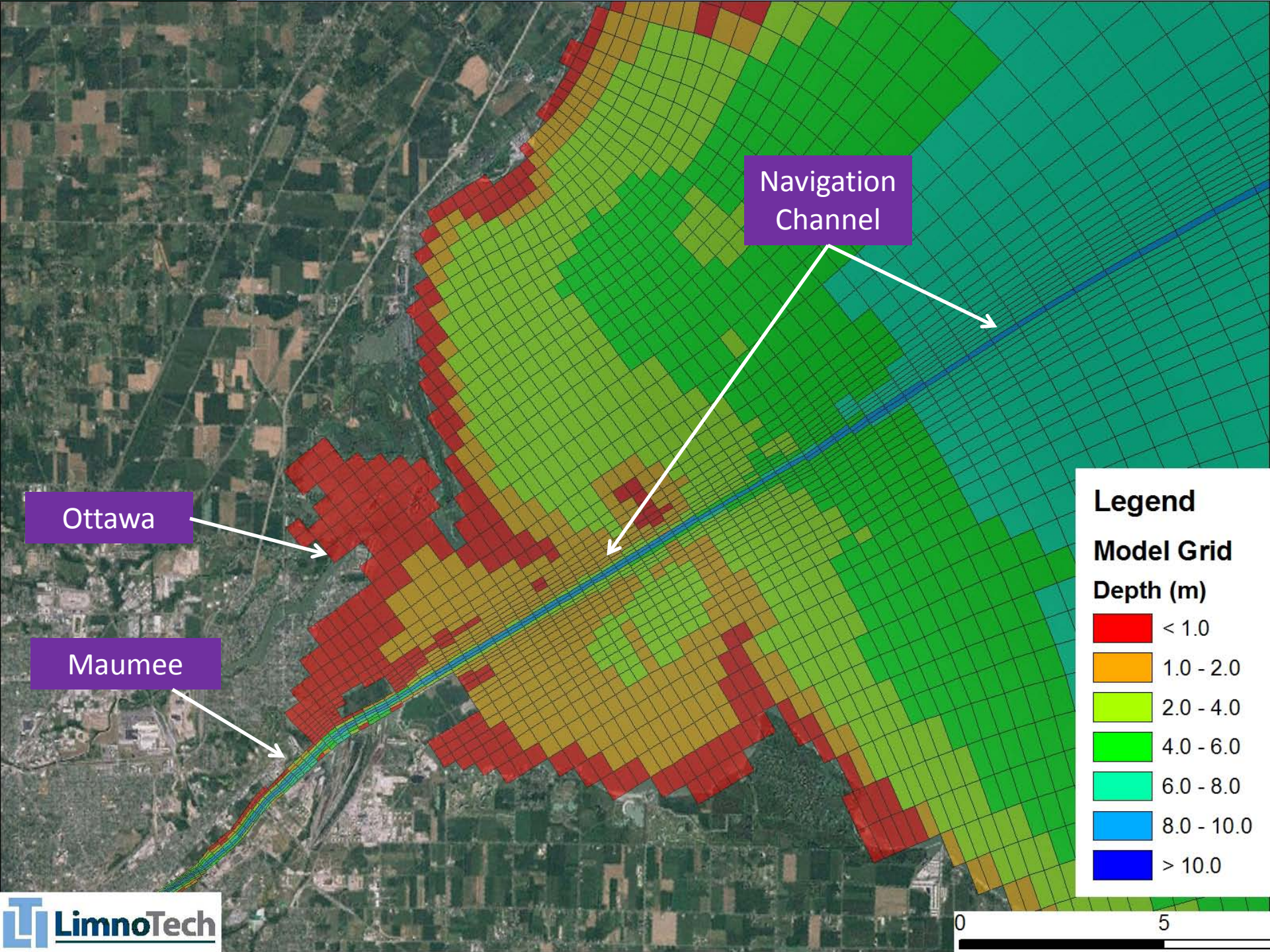
Lower Maumee River – Maumee Bay Model Framework



Sediment Transport Model Processes







Ottawa

Maumee

Navigation Channel

Legend

Model Grid

Depth (m)

- < 1.0
- 1.0 - 2.0
- 2.0 - 4.0
- 4.0 - 6.0
- 6.0 - 8.0
- 8.0 - 10.0
- > 10.0



Model Development / Calibration

■ Physical Data:

- Bathymetric: NOAA, USACE
- Hydrodynamic (flow, WL): USGS, NOAA
- Atmospheric (wind, etc.): NOAA/GLERL

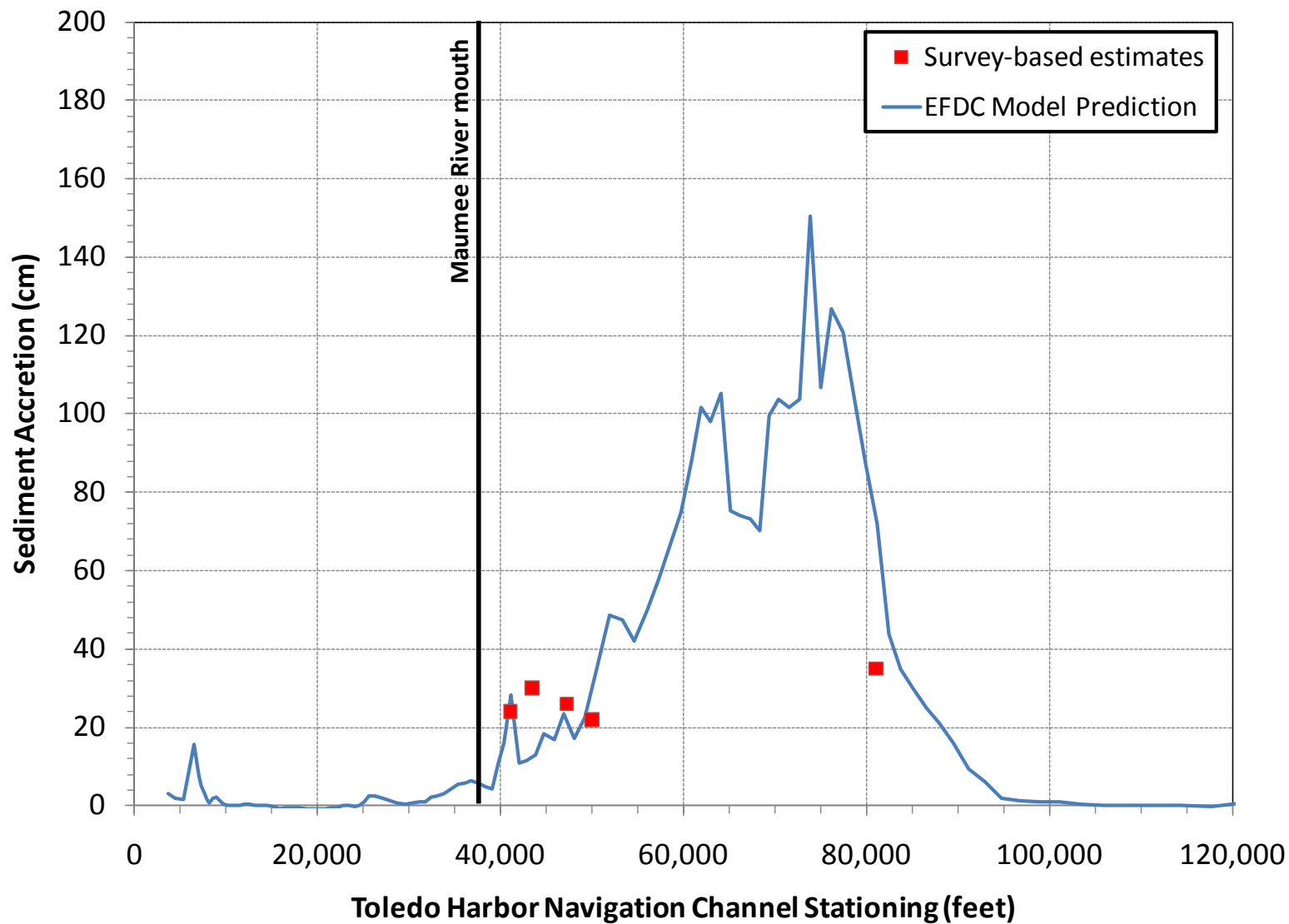
■ Sediment Data:

- Sediment bed characteristics:
 - Bathymetry changes (USACE dredge surveys)
 - Particle size distribution (GeoSea)
- Suspended sediment characteristics:
 - Maumee River @ Waterville (Heidelberg)
 - Maumee Bay (T. Bridgeman, UT)
- Satellite imagery (MODIS, Landsat)

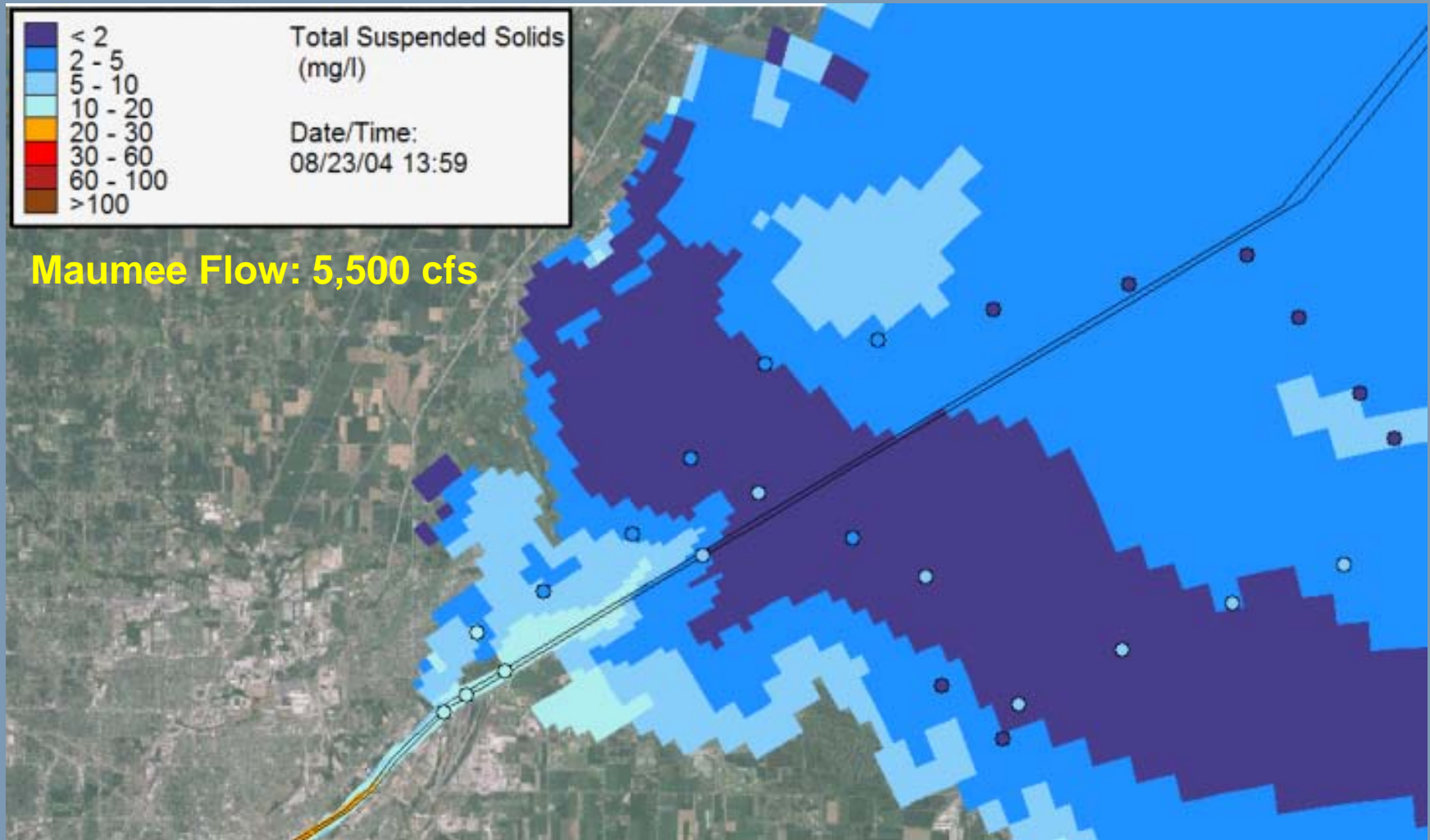
■ Water Quality Data:

- Heidelberg University – Waterville load data
- University of Toledo – Maumee Bay data
- IFYLE – western basin data

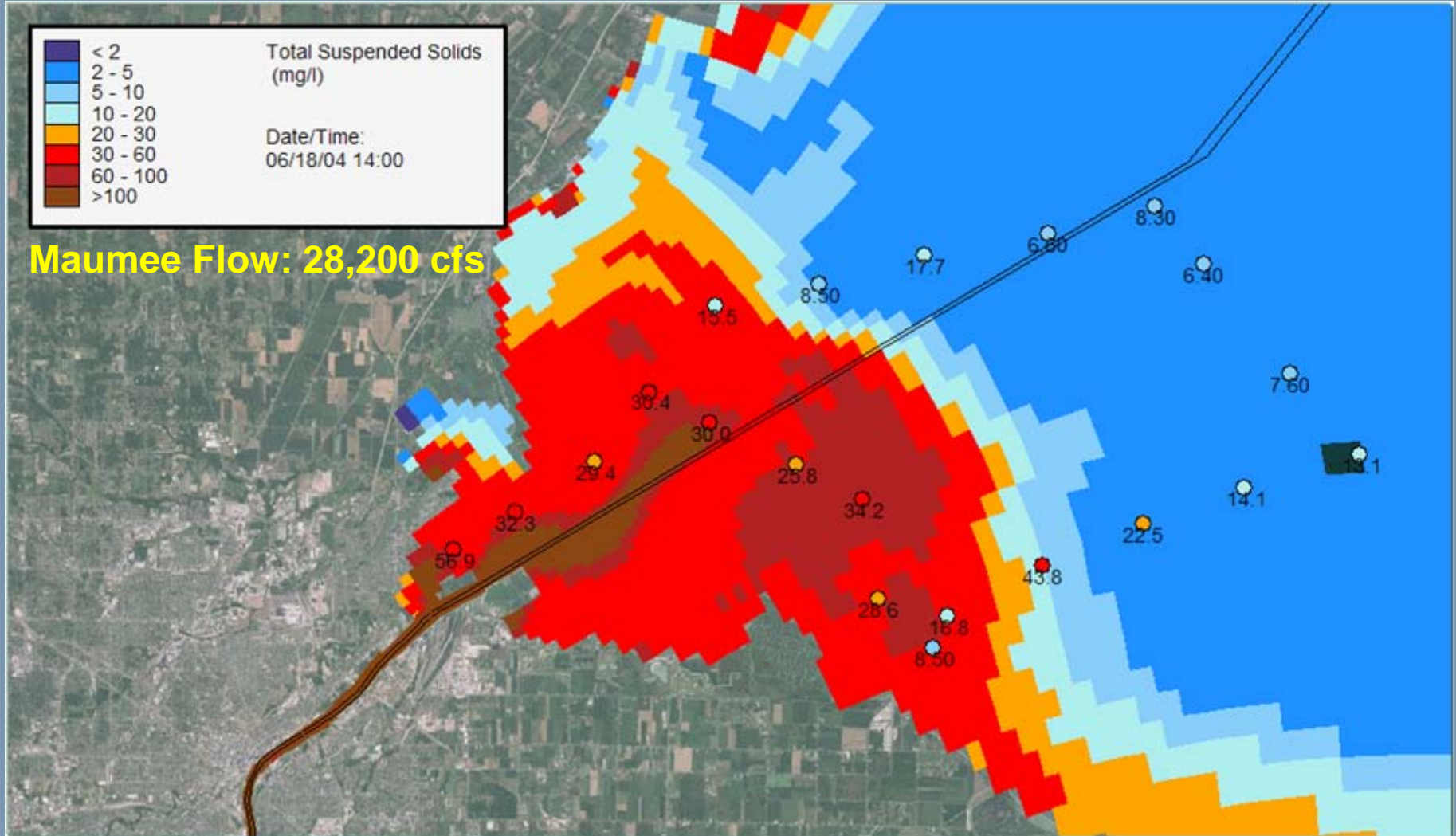
Calibration to Observed Deposition in Navigation Channel (3/23/04 – 5/11/05)



Model-Data Comparison for Total Suspended Solids (8/23/2004)

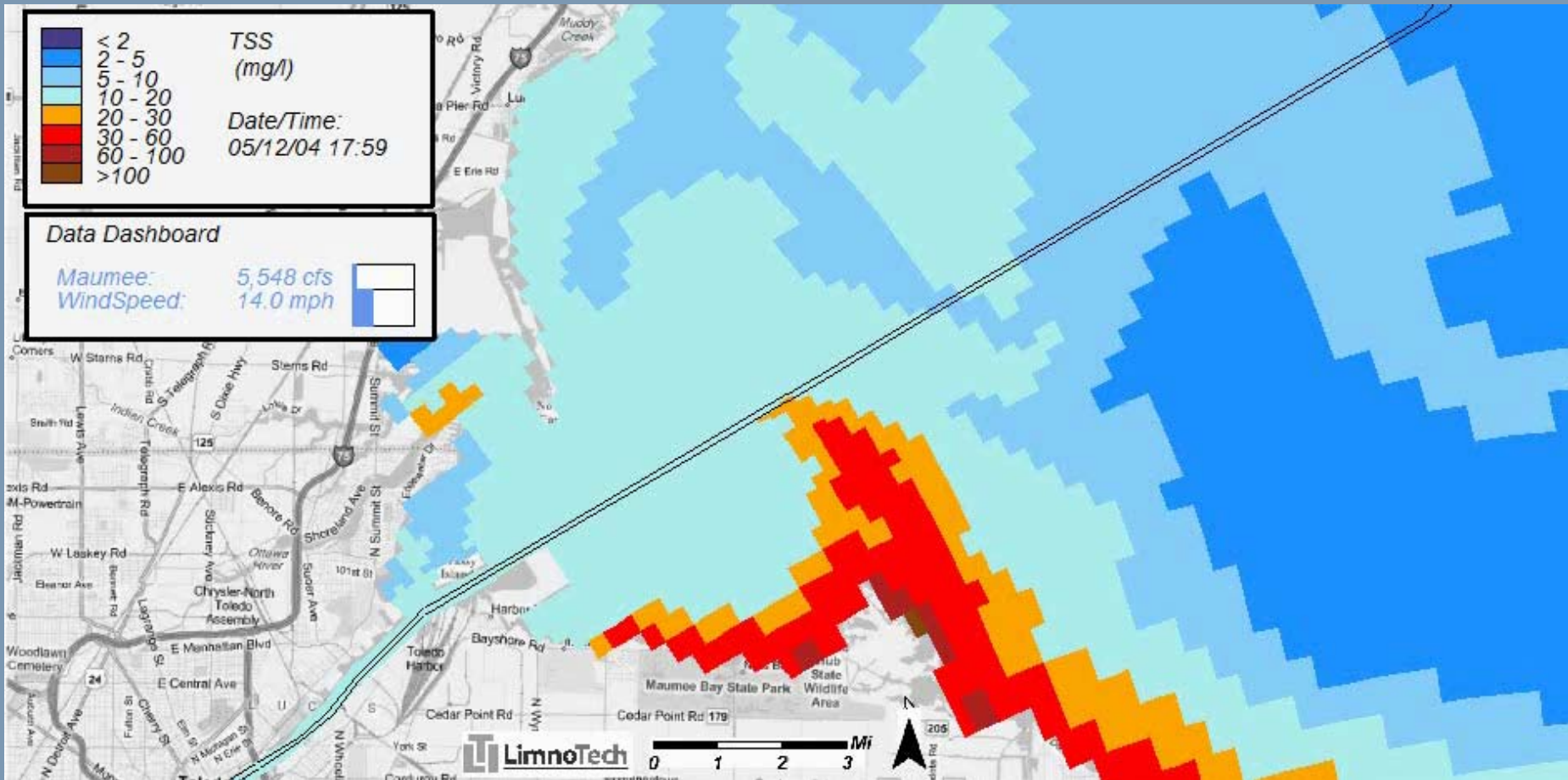


Model-Data Comparison for Total Suspended Solids (6/18/2004)



Data provided by Tom Bridgeman, University of Toledo

Total Suspended Solids Animation (June 2004 Runoff Event)



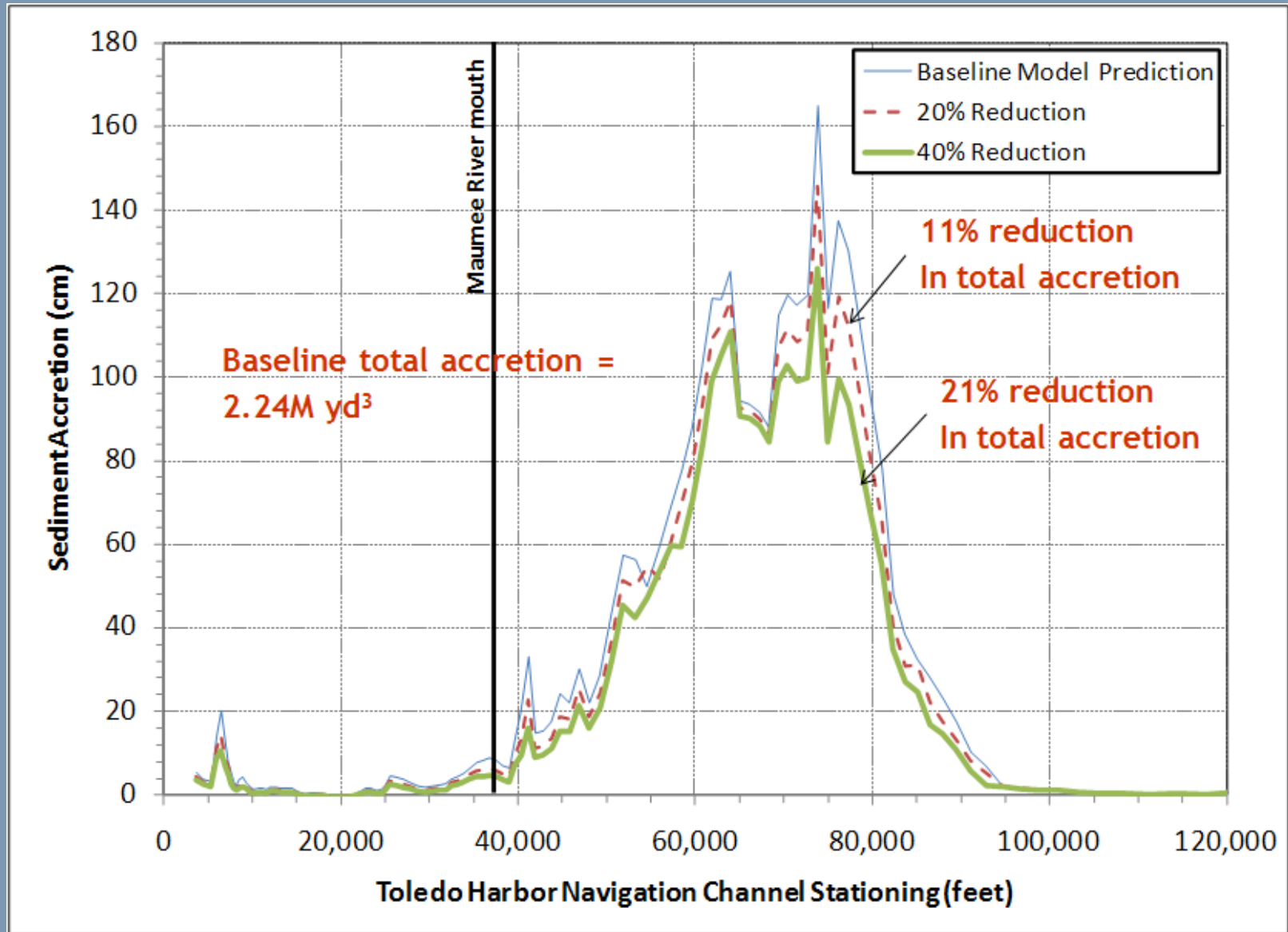
Data provided by Tom Bridgeman, University of Toledo



Model Application

1. Evaluation of reduced Maumee River sediment and nutrient loadings impacts on water quality conditions in Maumee Bay and the Western Basin
2. Evaluation of the stability of potential alternative locations for open-lake disposal of dredged sediments from the Toledo Harbor navigation channel
3. Evaluation of the impact of sediment and nutrient releases occurring during open-lake dredge disposal activities on water quality conditions in Maumee Bay and the Western Basin

Sediment Accretion in Nav Channel for Load Reduction Scenarios

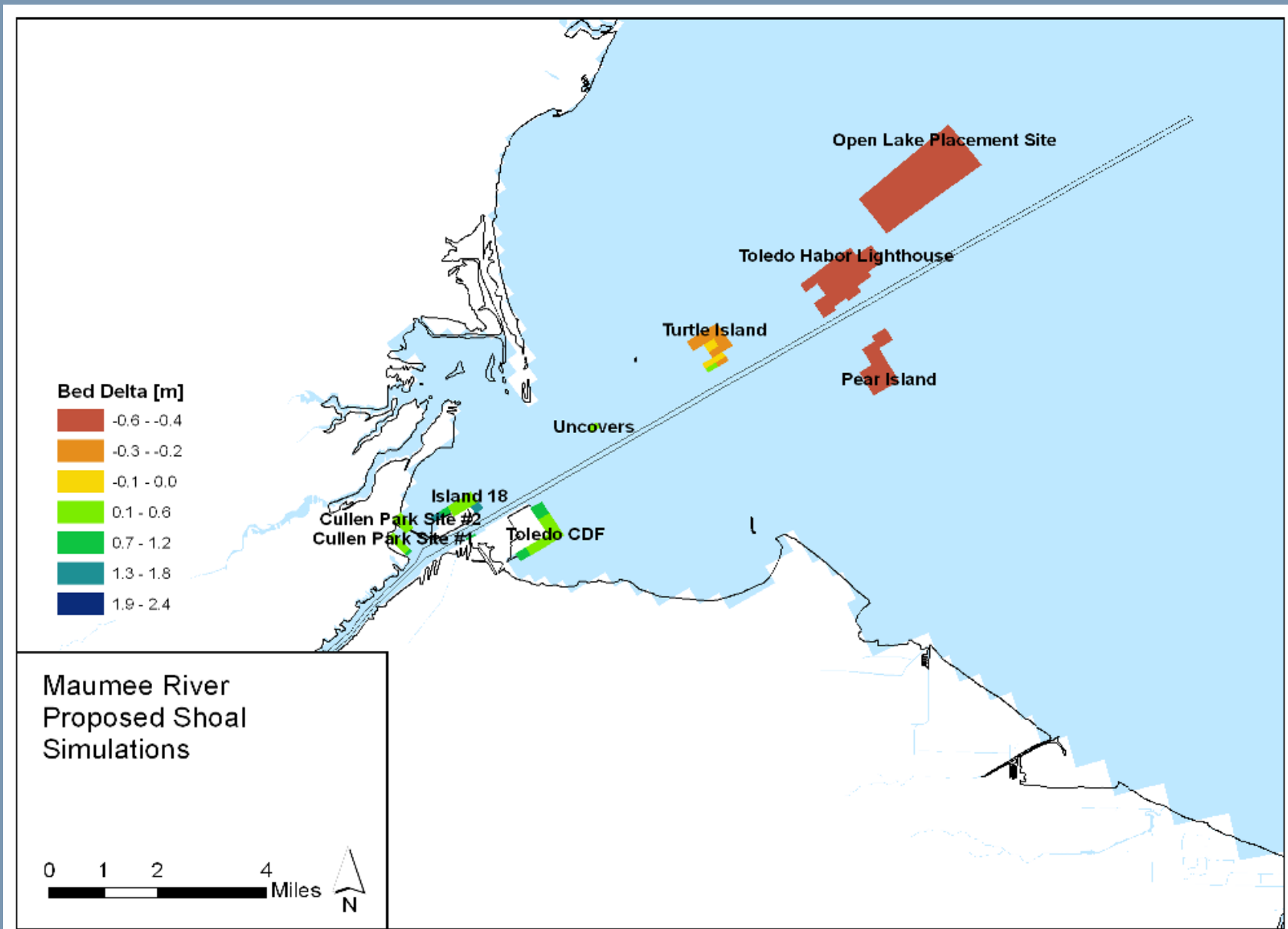




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Simulation of Bed Elevation Changes in Proposed Shoal Areas During 2004-05

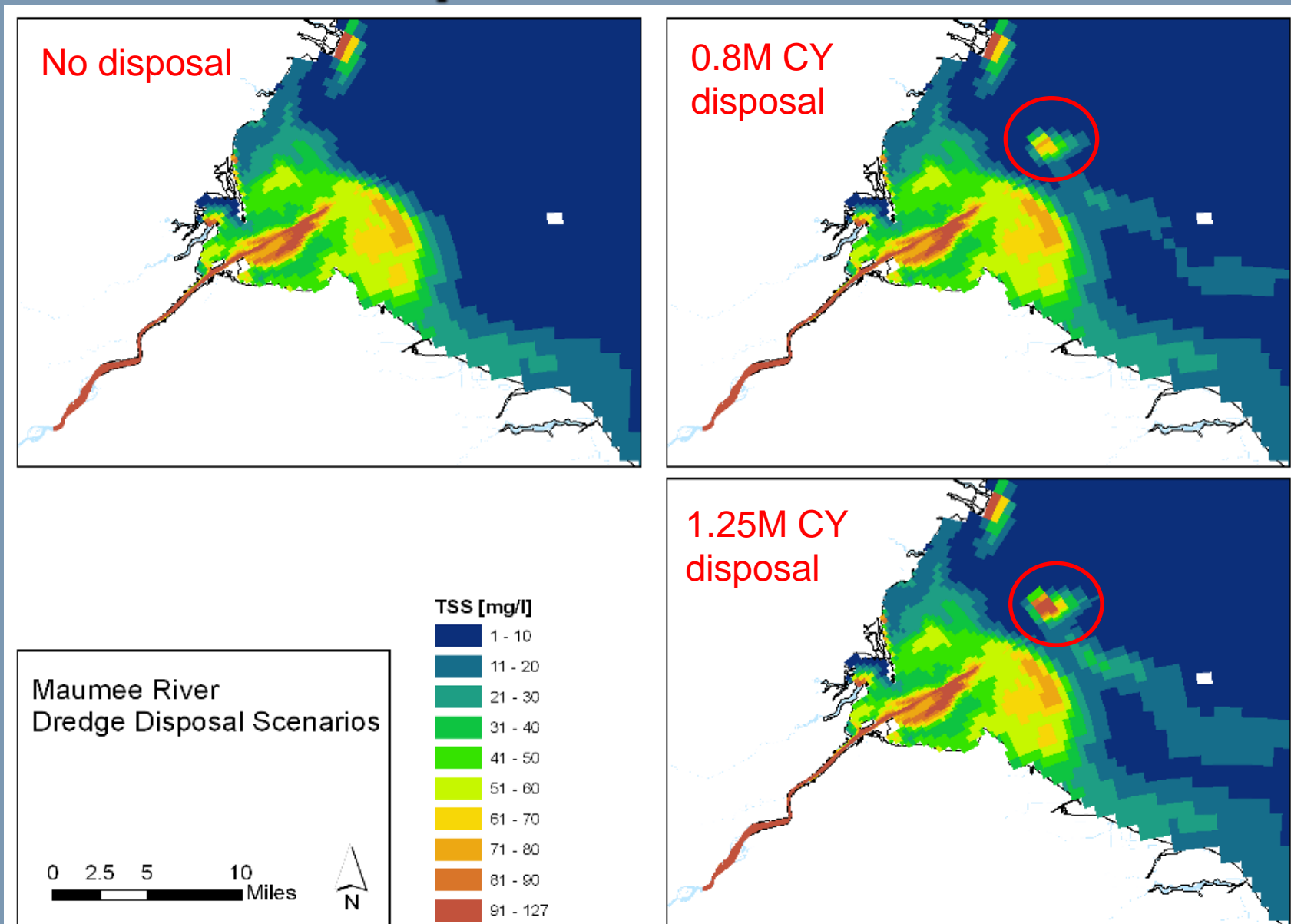




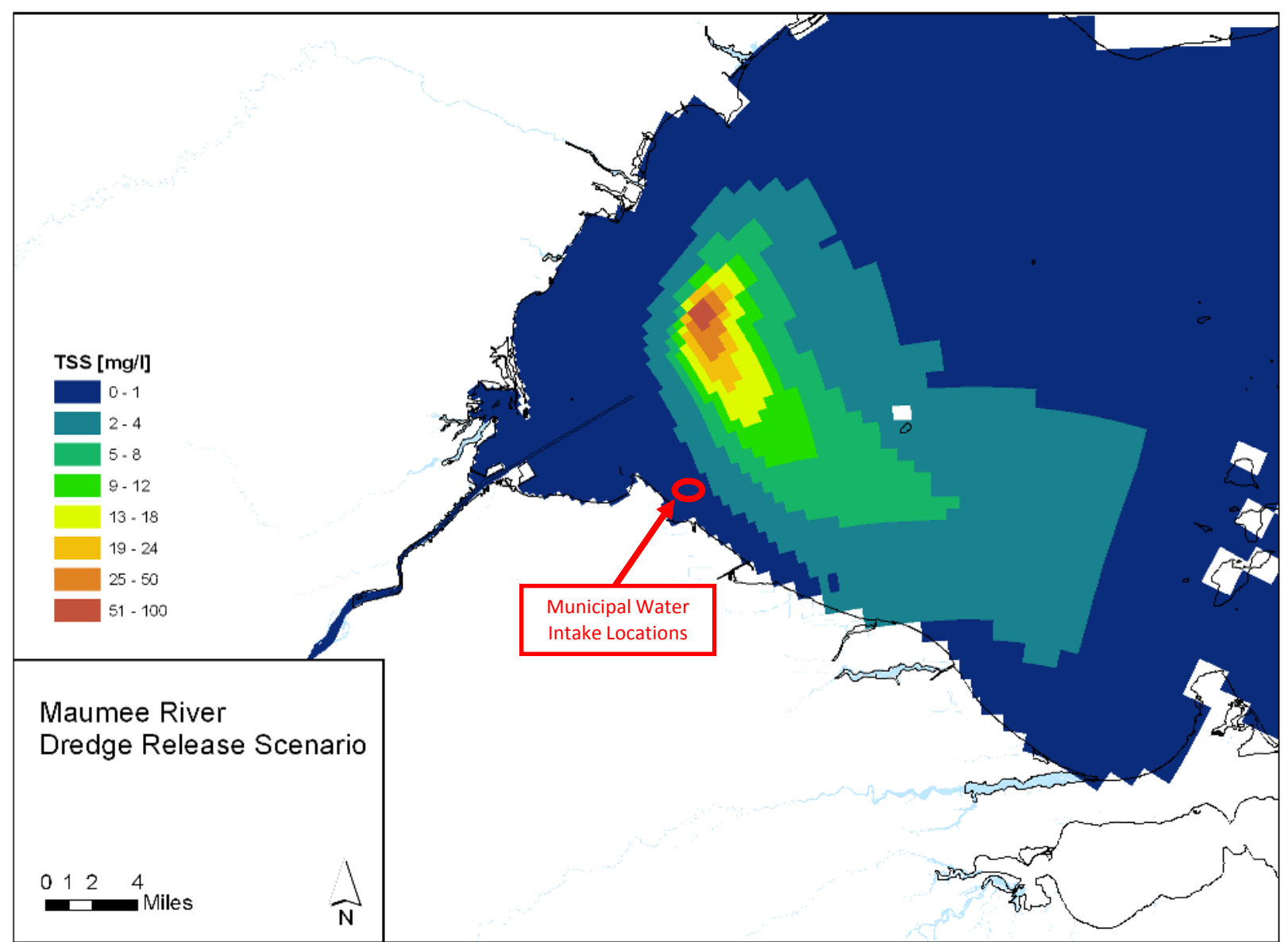
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Summer Average TSS for Dredge Disposal Scenarios



Differential for summer average TSS for 1.25M CY open-lake dredge disposal vs. no disposal





Use of LMR-MB Model to Support Management Programs

- Quantify relative contribution of all sources to ecosystem endpoints of concern
 - Turbidity in Maumee Bay and western basin
 - Sedimentation in navigation channel
- Support planning and management decisions for BMPs and erosion control in the watershed
 - Reduction in dredging needs
 - Improvement in water quality in Western Basin
- Support USACE sediment management planning
 - Locate dredged material disposal areas (open-lake, habitat enhancements) and assess long-term stability
 - Design of in-stream and Harbor control structures that reduce dredging costs and sediment impacts in lake

Questions?

■ Acknowledgements:

- Funding: USACE Buffalo District

- Data Sources:

- USACE Buffalo District
- Heidelberg University
- University of Toledo (T. Bridgeman)
- GeoSea

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