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FEMA Region V
Great Lakes Coastal Flood Study

Pilot Study Webinar

Berrien County, Michigan

February 26, 2014

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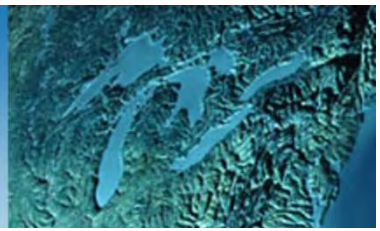
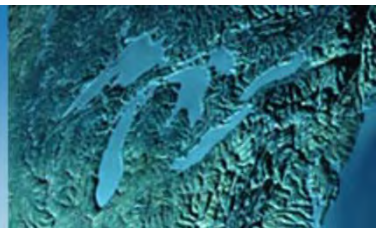


Pilot Study Webinar
Agenda

- Great Lakes Coastal Flood Study Background
- Demonstration Project Background
  - Study objective
  - Project site determination and background
- Modeling Approach
  - Regional study approach
  - Local modeling activities
- Results and Conclusions
  - Study results and recommendations
  - Revised approach
  - Next steps



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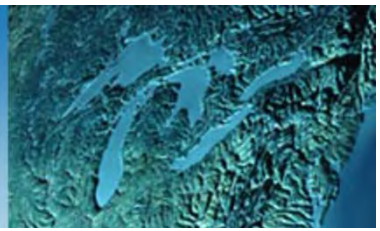
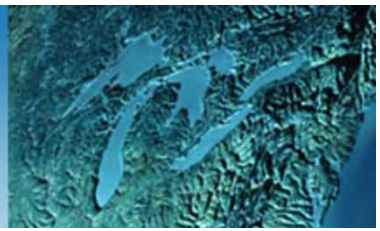


Lake Michigan Upcoming Work

- Technical Workshop: June 7, 2012
- Discovery Kick-off: June 21, 2012
- Discovery Report: February 2013
- Demo Project: January 2014
- Workmap Meeting: April-May, 2014
- Preliminary Maps: September 2014



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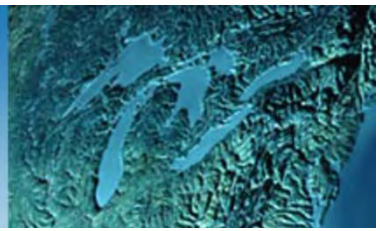
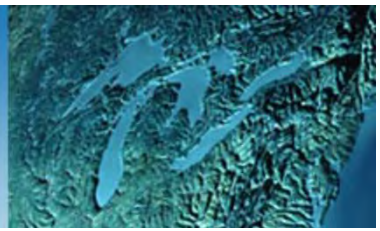
Study Objective

- Evaluate the revised guidelines for coastal flooding analyses and mapping in the Great Lakes (Appendix D.3 of the G&S) for the following:
  - Tools to simulation storm-induced erosion
  - Account for long-term variability in lake levels
  - Assess new methodologies to calculate wave runup
  - Compare the new Response vs. old Event Based Methodology



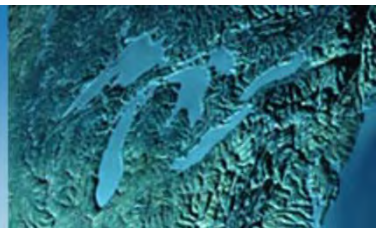
Revised Guidelines

- **Response-based vs. Event-based Methodology**
  - Model 150 of the most severe historical storms (Response) rather than a single 'representative' storm (Event)
  - Statistical analysis of storm flooding for 150 historical events to generate the BFEs
- **Storm-induced Erosion**
  - Utilize advanced numerical models for profile evolution vs. 'rule of thumb' eroded profiles (old approach)
  - Consider beach erosion for each individual event and how it affects wave transformation/runup



Revised Guidelines

- **Lake Level Variation**
  - Incorporate long-term lake level variation by simulating historical storm events at their actual lake level
  - Storm suite (150) encompasses events during both high and low lake levels
- **Wave Runup**
  - Empirical equations (Mase/Melby, van der Meer, EurOtop)
  - Empirical-based models (ACES, Runup 2.0)
  - Numerical surf zone dynamics models (CSHORE)

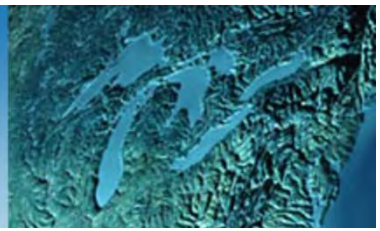


Project Site Determination

- Exposure to coastal flood risk
- Availability of data (modern and historical)
- Ability to test D.3 guidance on different shore types found throughout Great Lakes
- Status of on-going flood studies

Berrien County Background

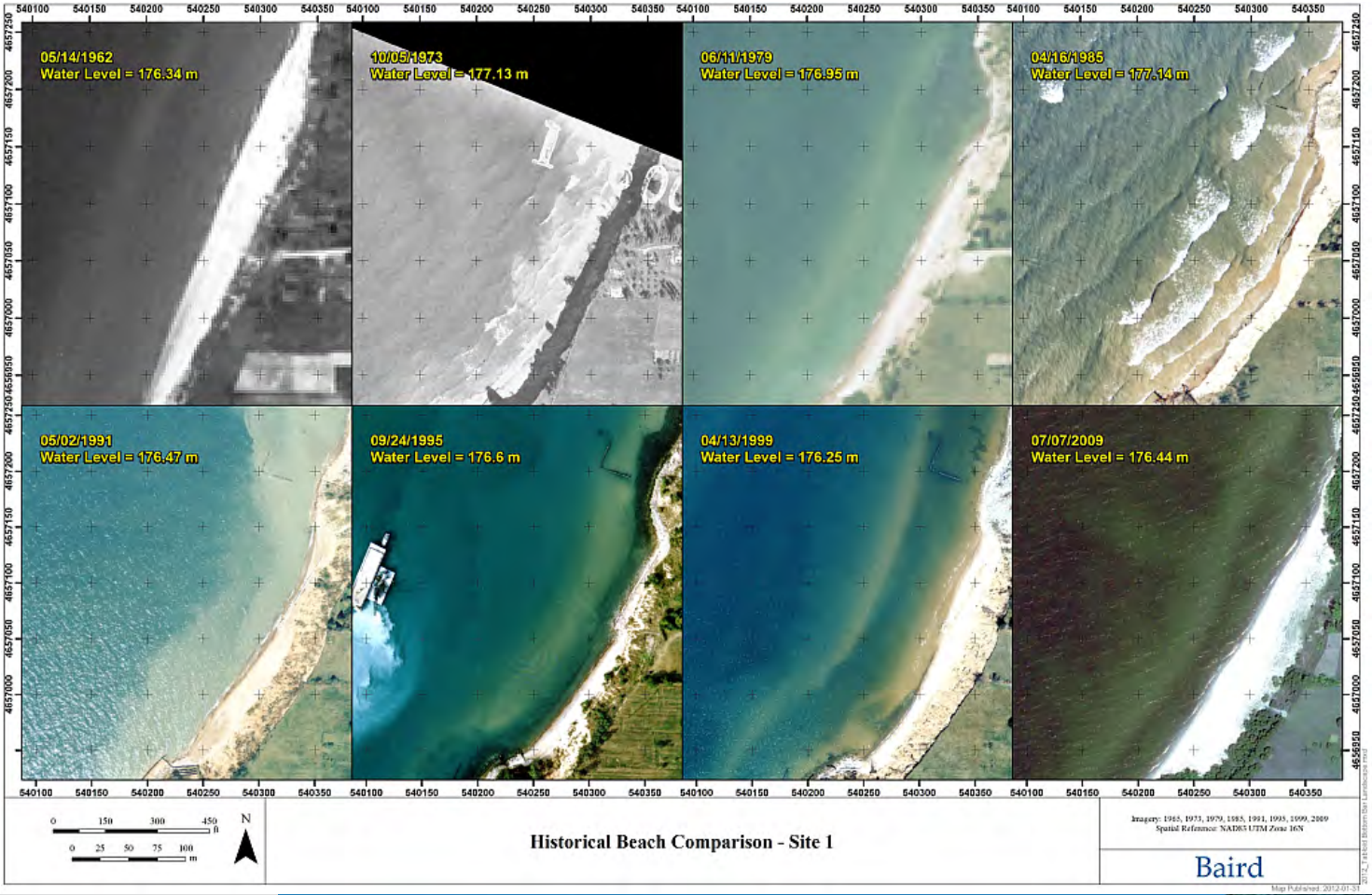
- Vulnerable to Coastal Flooding
- Data Rich County
- Multiple Shoreline Types
  - Sandy beaches and dunes
  - Eroding bluffs
  - Fillet beaches adjacent to a jettied harbor
  - Institutional and private shoreline protection structures



Project Site (Berrien County)

- Assembled historical beach and nearshore profiles
- 150 storm events from Engineering Research Development Center (ERDC): ADCIRC and WAM modeling (1960-2009)
- County divided into 10 shoreline reaches to define transect locations
- Testing and demonstration of various wave runup methodologies using historical bathymetry and LIDAR
- Comparison of CSHORE numerical model results to empirical wave runup formulations

Historical Beach Conditions



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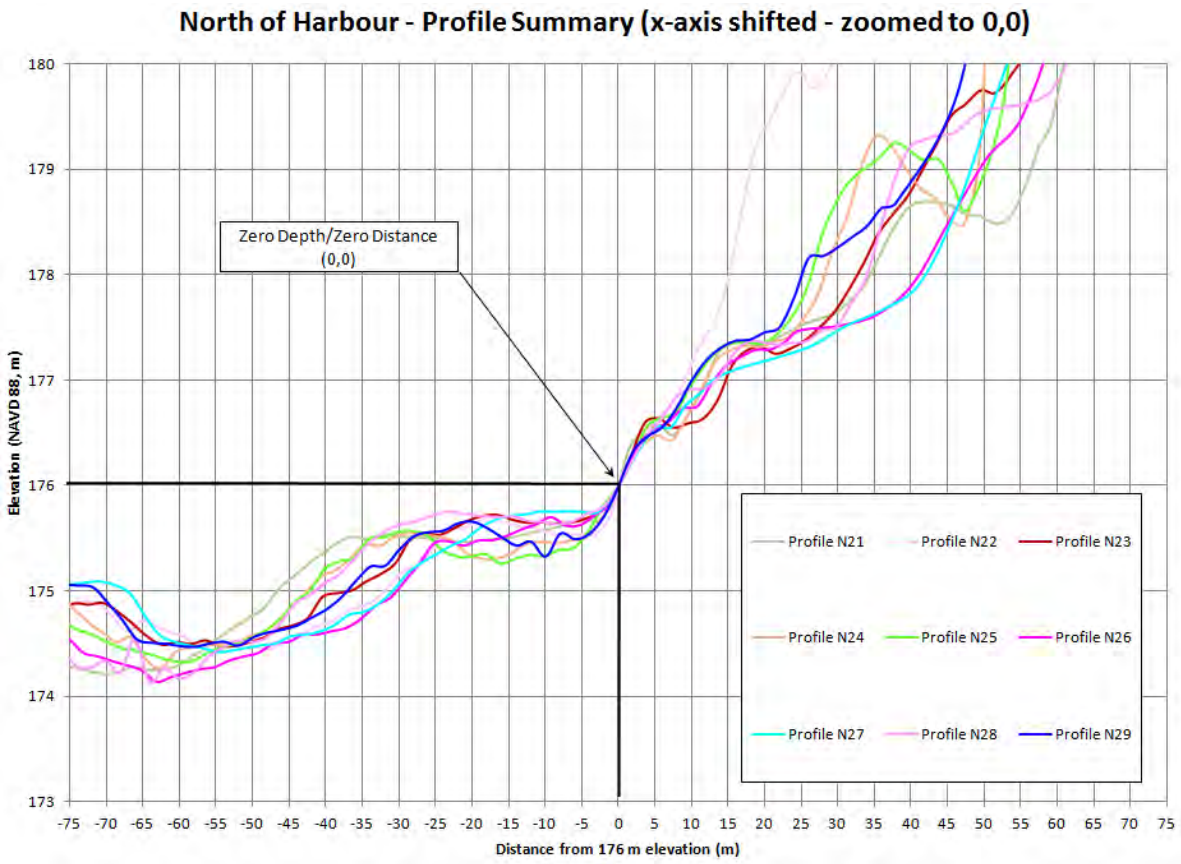
Beach Profile Data



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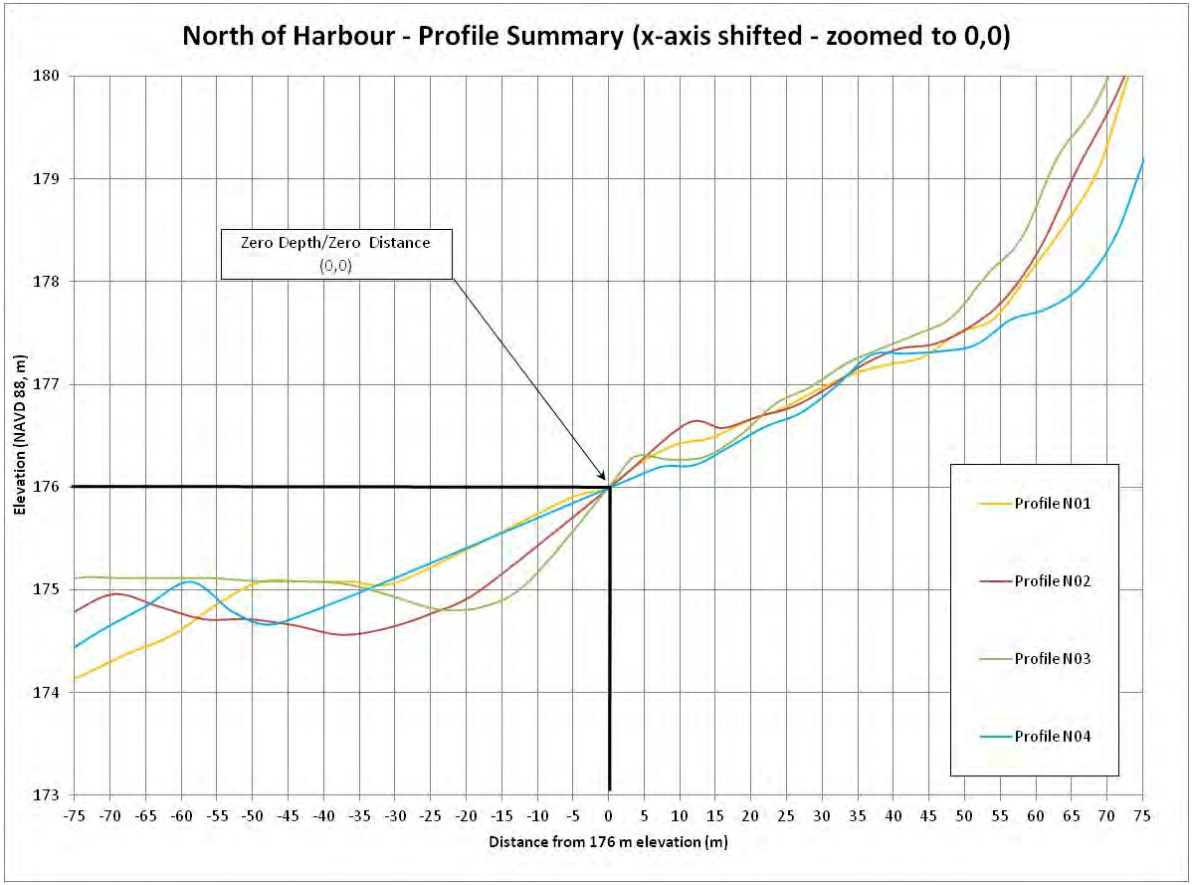
Beach Profile Data



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Modeling Approach

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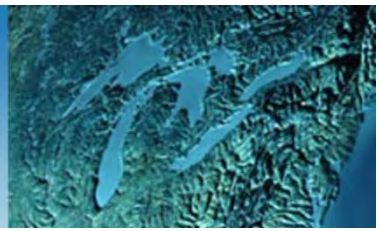
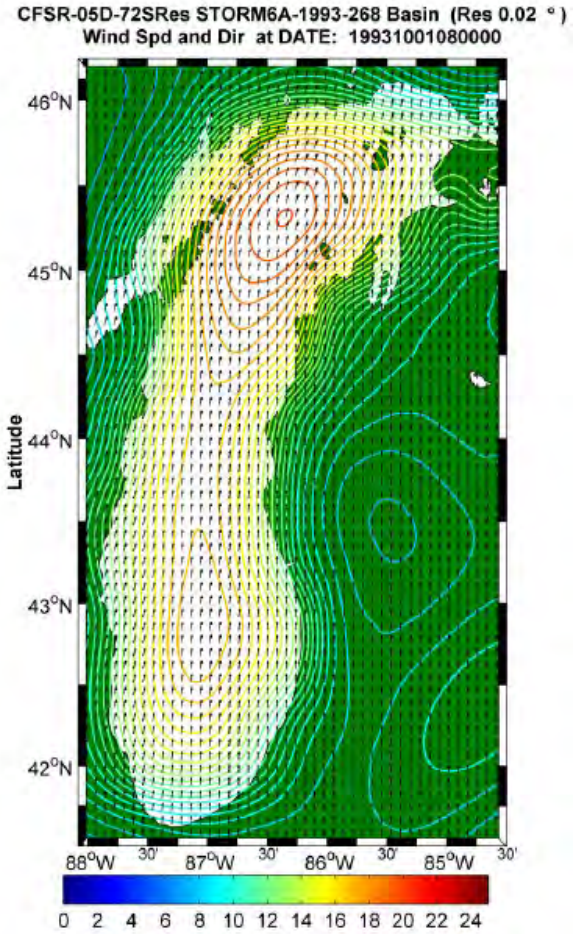


Study Approach

- **Lakewide Wave/Surge Study**
  - Model for entire lake (including Huron)
  - Calibrated against measured data
  - Improvement over county by county assessment
- **Local/County Level Activities**
  - Mapping level tasks performed at county level
  - Nearshore wave transformations with CSHORE
  - Wave runup calculations

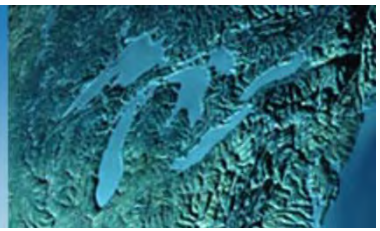
Lake-Wide Modeling Results

- 150 storm events from ERDC ADCIRC and WAM modeling (1960-2009)
- Water levels and wave parameters at hundreds of output points along the lake shore
- Wind, ice cover, long-term lake level considered



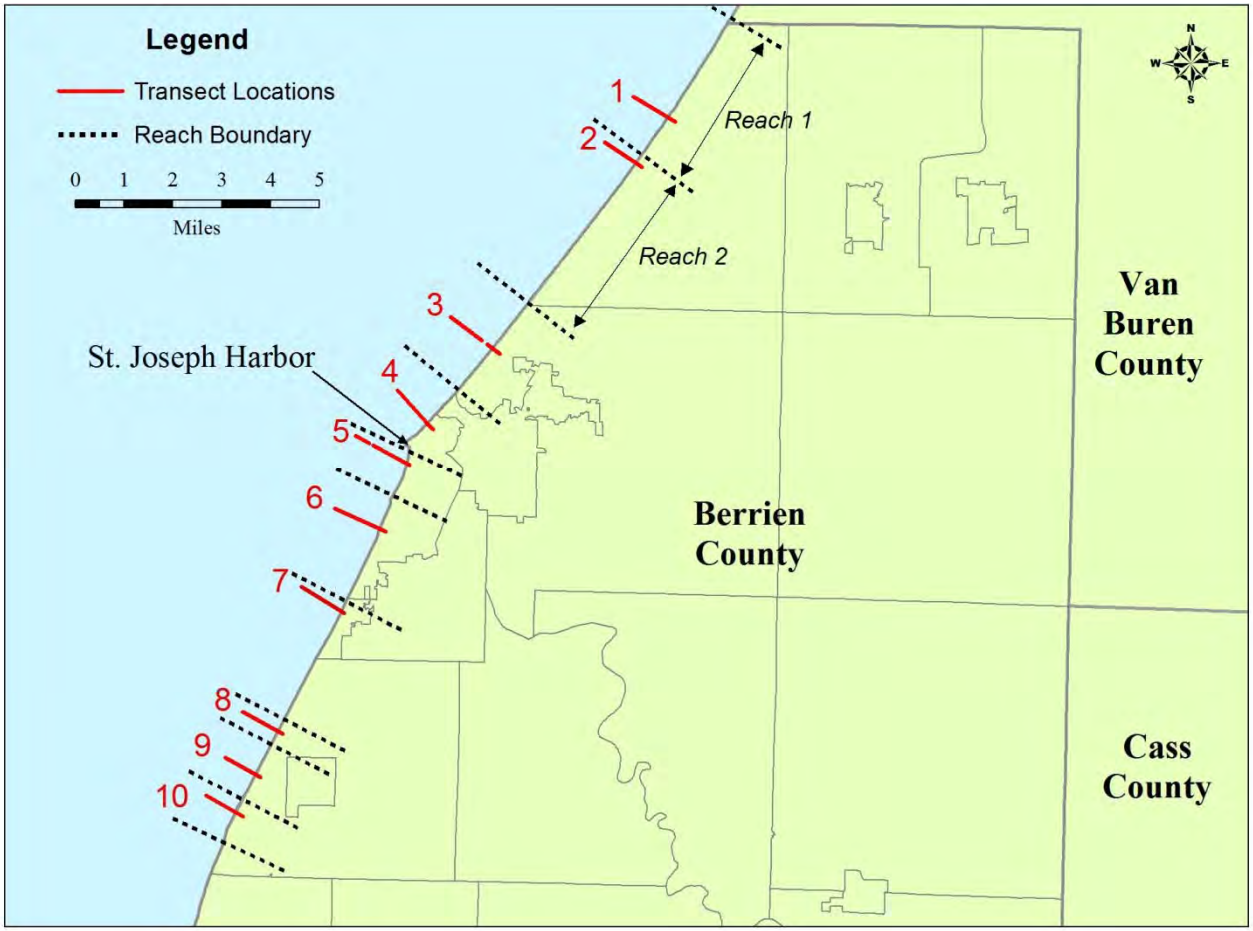
Surf Zone Modeling Approach

- Demonstration project allowed modeling approaches to be developed for:
  - Erosion
  - Wave Propagation
  - Wave Runup
- Followed revised guidance in Appendix D.3
- Modeling approaches investigated:
  - 1-D Models, including CSHORE
  - Historic beach profiles versus modern data



Transect Spacing

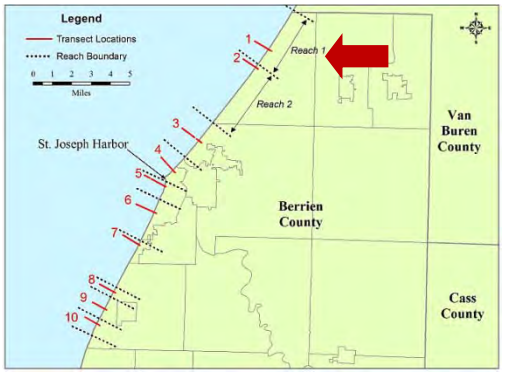
- Geomorphic Reaches Define Transect Spacing



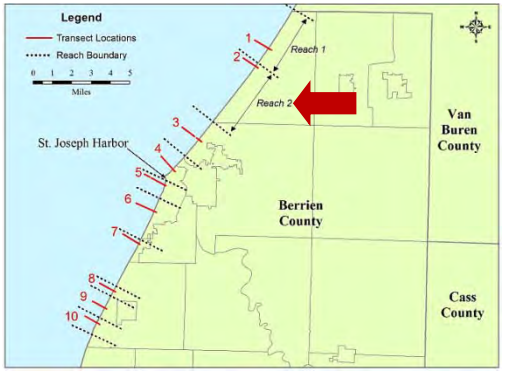
Reach Examples

- Reach 1 and 2

Reach 1 – Northern Dune Area



Reach 2 – Cliffs



Coastal Erosion

- Episodic, flood-related erosion due to coastal storms
- Does not consider long-term erosion hazard areas
- Evaluated prior to wave runup calculations

Wave Runup

- Uprush of water from wave action on beach
- NFIP definition of wave runup elevation is the value exceed by a 2% probability of exceedance – $R_{2\%}$
- Methodologies reviewed in Melby (2012)

CSHORE

- Developed by United States Army Corps of Engineers ERDC
- 1D model of wave runup and profile morphology (Johnson et al., 2011)
- Utilizes time-series of waves and water levels from ADCIRC and WAM modeling effort
- Key physical processes accounted for in model
- Tested, calibrated, and verified using physical model results

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Results and Conclusions

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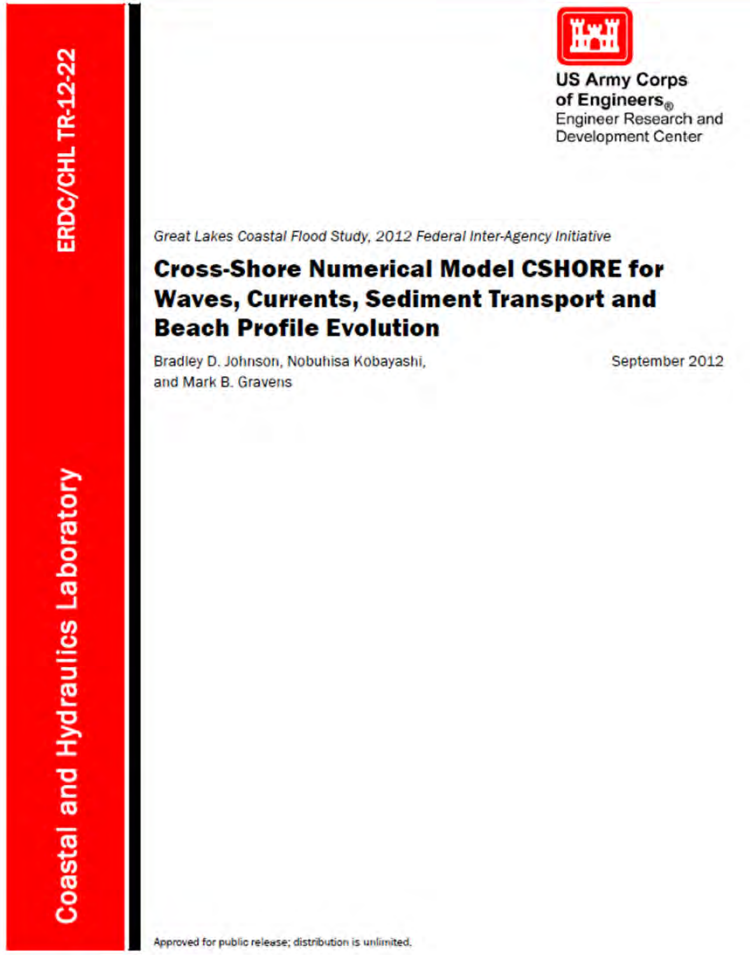
Study Progression

- Initial CSHORE code provided by ERDC (late 2012)
- Applied model to develop wave runup results (Jan 2013)
- Provided results to ERDC for consideration (Feb 2013)
- ERDC provided revised model code (March 2013)
- Transects reanalyzed using revised code (Jan 2014)


ERDC/CHL TR-12-22

Coastal and Hydraulics Laboratory

US Army Corps of Engineers®
Engineer Research and Development Center

Great Lakes Coastal Flood Study, 2012 Federal Inter-Agency Initiative

Cross-Shore Numerical Model CSHORE for Waves, Currents, Sediment Transport and Beach Profile Evolution

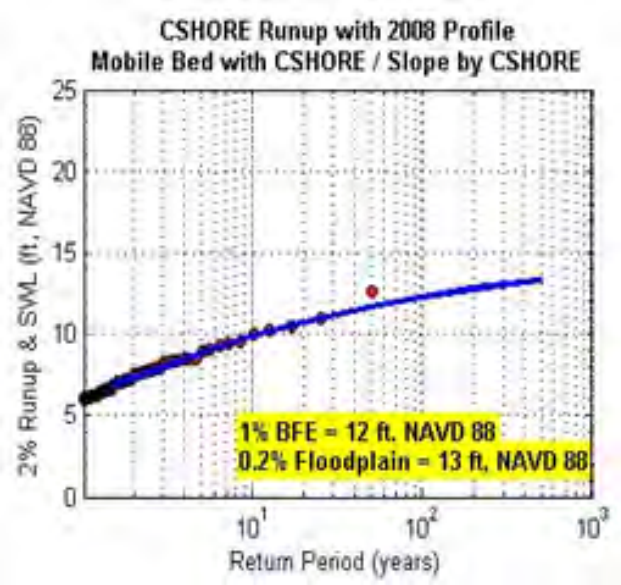
Bradley D. Johnson, Nobuhisa Kobayashi, and Mark B. Gravens

September 2012

Approved for public release; distribution is unlimited.

Revised Approach

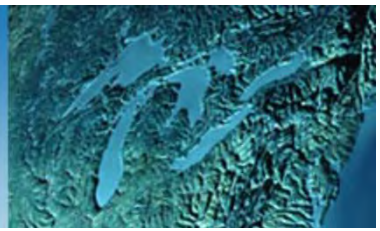
- Based on the results of the Demonstration Studies, ERDC recommendations and the guidance in Appendix D.3:
  - CSHORE will be used to determine coastal erosion for storms (beach sites)
  - CSHORE will be used to develop coastal BFEs and mapping extents for areas susceptible to wave runup



Coastal Flood Hazard Zones

FEMA developed a memorandum regarding the mapping of VE Zones along the Great Lakes (September 30, 2013):

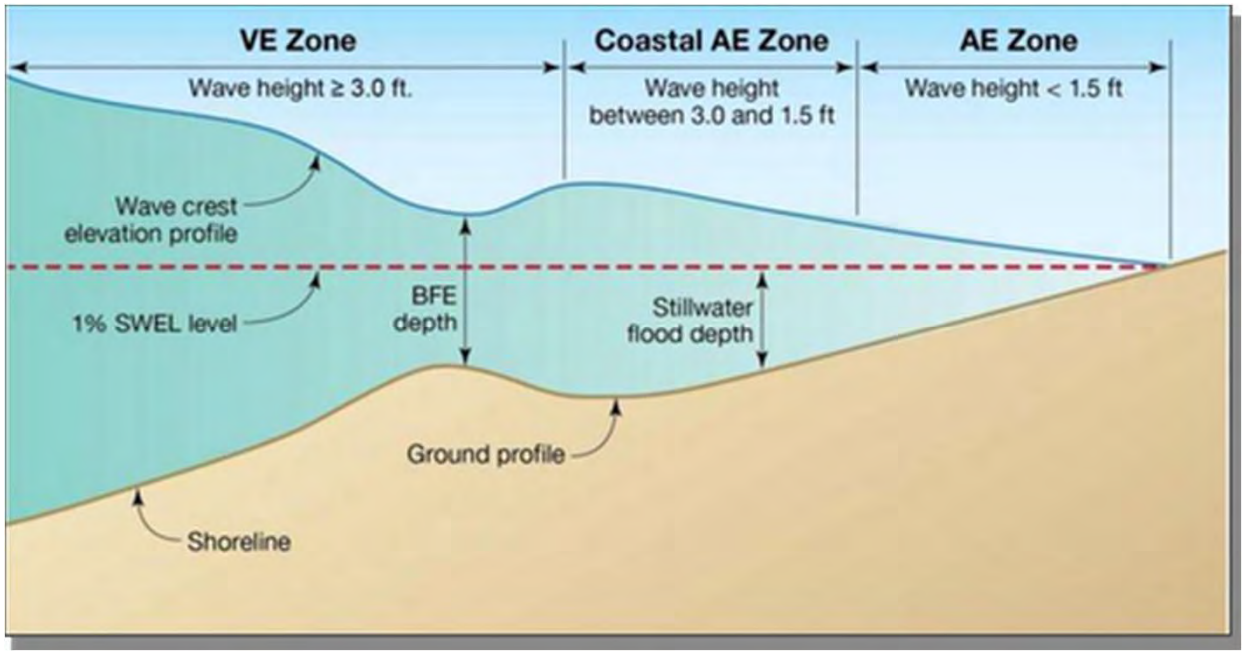
- VE Zones
  - Currently mapped based on wave height / runup depth (Hs > 3 ft)
  - This procedure was developed for the Atlantic, Pacific, and Gulf Coasts
  - FEMA recognizes it may not be appropriate for Great Lakes
- An independent study will be performed to determine the appropriateness of mapping VE Zones in Great Lakes
- In the interim:
  - VE Zones will be identified on work maps
  - VE Zones will not be mapped on regulatory products



VE Zones and LiMWA

FEMA Procedure Memorandum No. 50, 2008 (LiMWA)

- No Federal Insurance requirements tied to LiMWA
- Non-regulatory



Who to Contact

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