



FEMA

FEMA Region V Great Lakes Coastal Flood Study

Pilot Study Webinar

Berrien County, Michigan

February 26, 2014

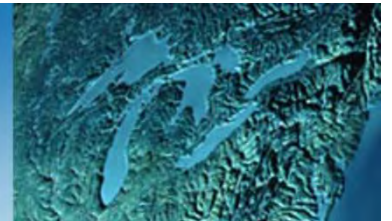
RiskMAP

Increasing Resilience Together



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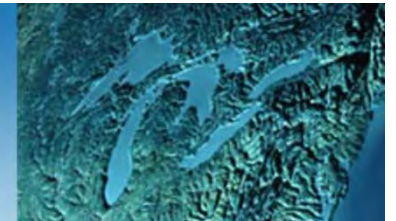
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Pilot Study Webinar Agenda



- **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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Background

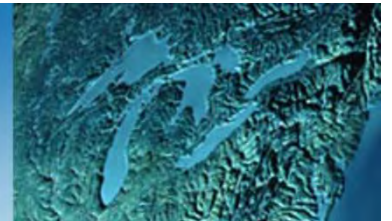
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Lake Michigan Upcoming Work

- 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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Pilot Study

Berrien County



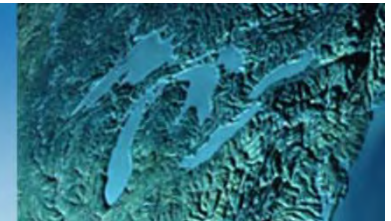
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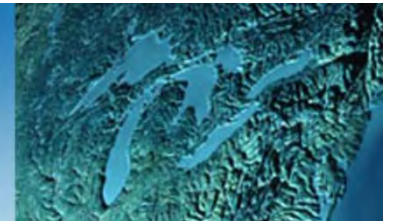
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Study Objective

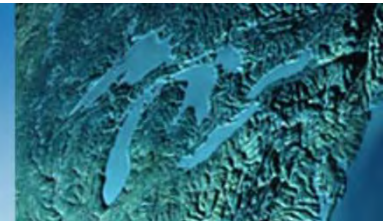
- Evaluate the revised guidelines for coastal flooding analyses and mapping in the Great Lakes (Appendix D.3 of the G&S) for the following:
 - Tools to simulation storm-induced erosion
 - Account for long-term variability in lake levels
 - Assess new methodologies to calculate wave runup
 - Compare the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



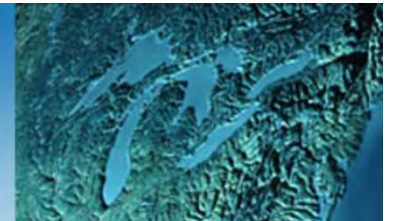
Revised Guidelines

■ 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

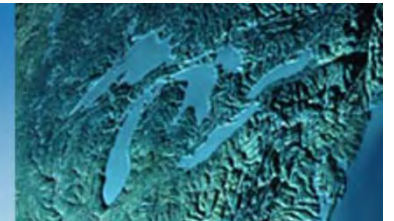
■ Wave Runup

- 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

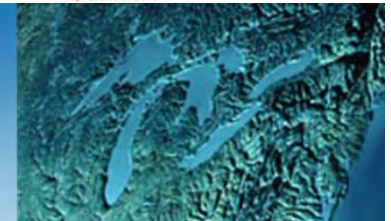
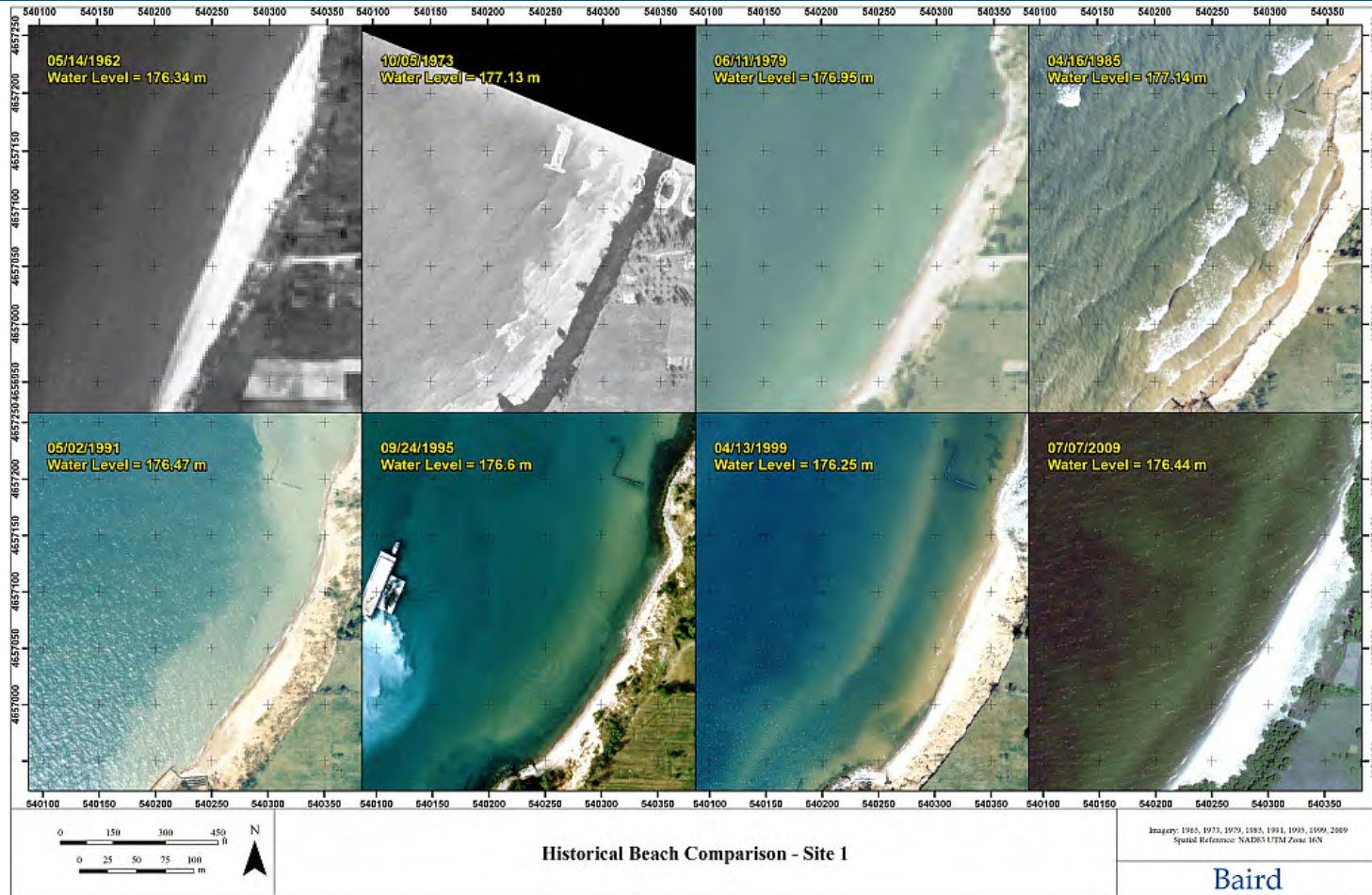


Project Site (Berrien County)

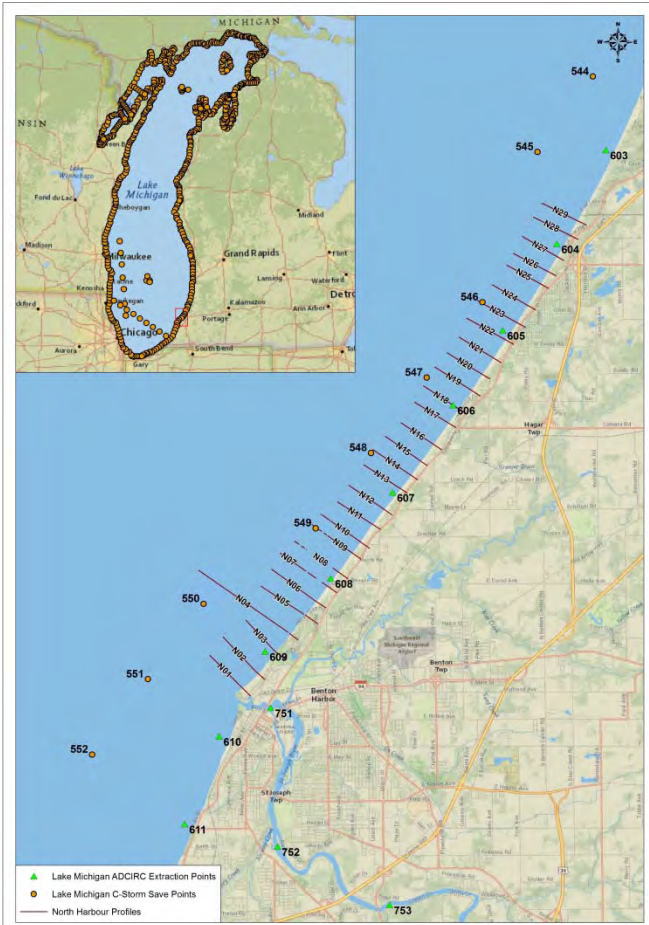
- Assembled historical beach and nearshore profiles
- 150 storm events from Engineering Research Development Center (ERDC): ADCIRC and WAM modeling (1960-2009)
- County divided into 10 shoreline reaches to define transect locations
- Testing and demonstration of various wave runup methodologies using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



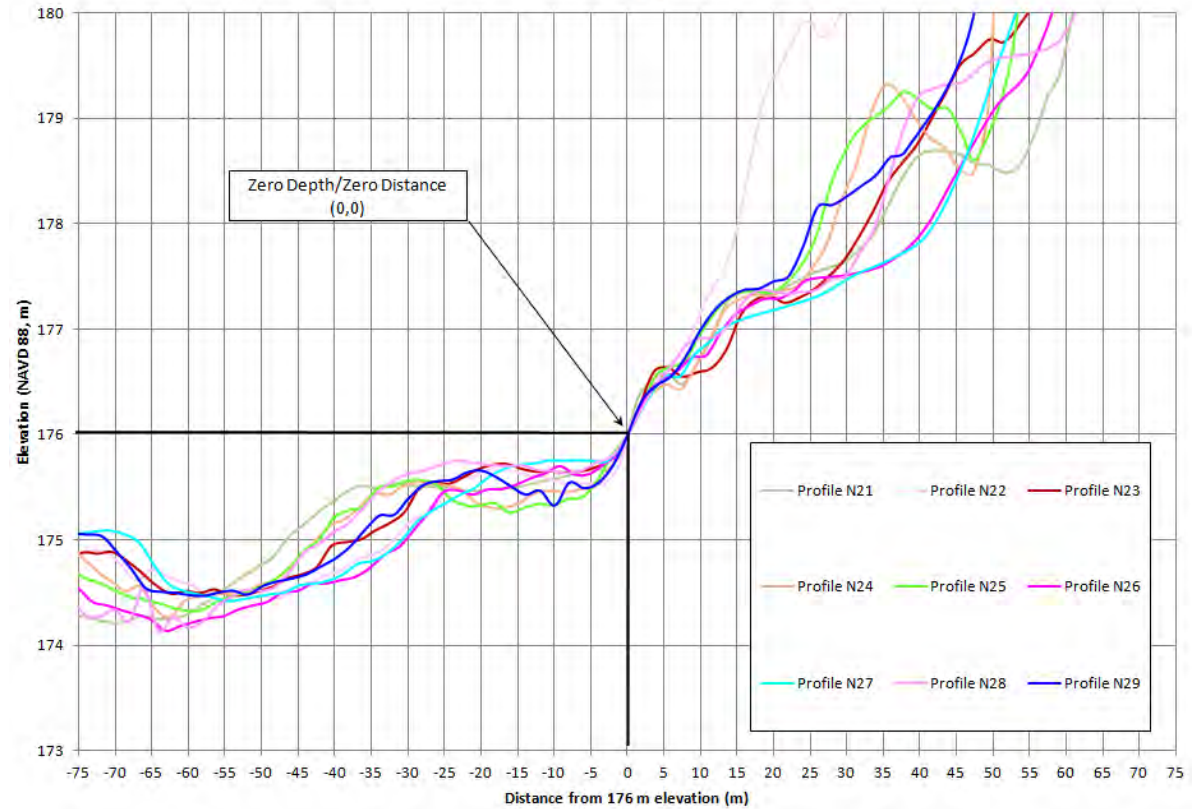
Historical Beach Conditions



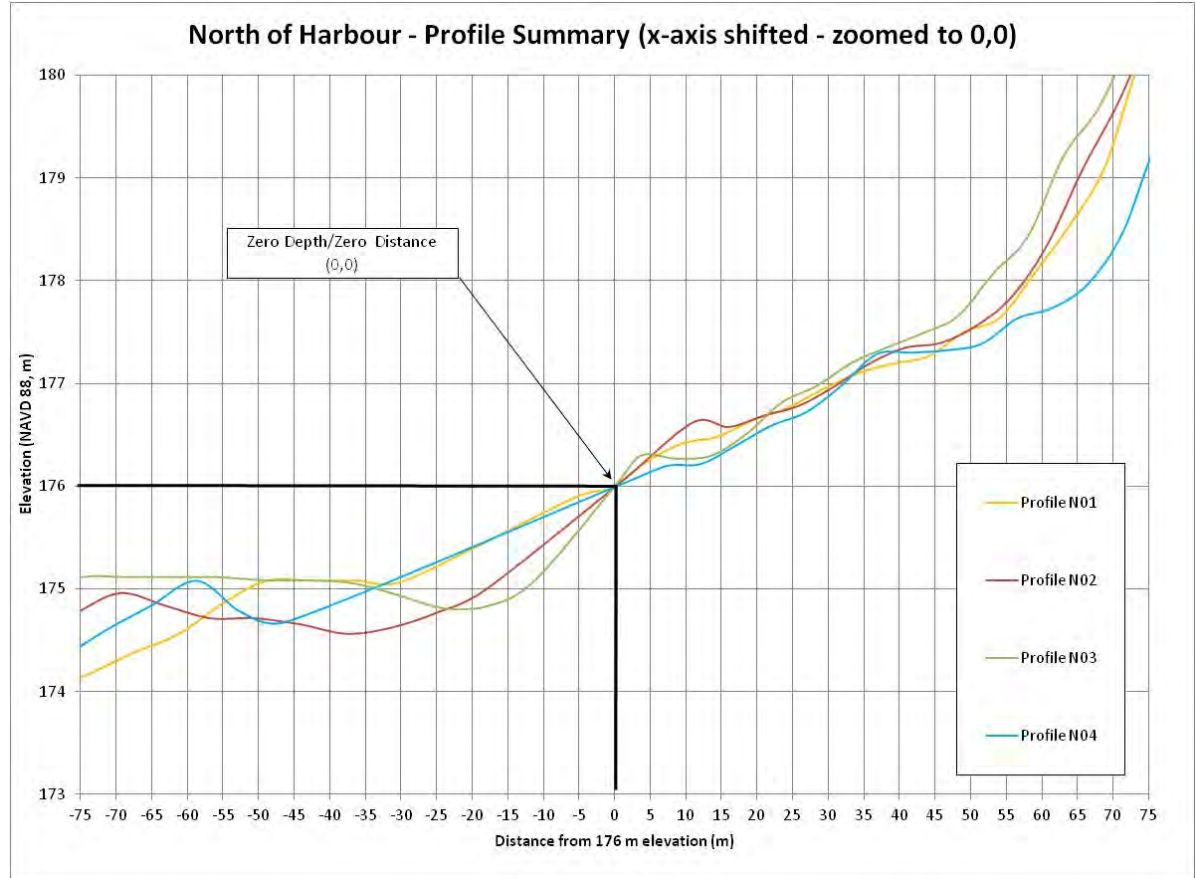
Beach Profile Data



North of Harbour - Profile Summary (x-axis shifted - zoomed to 0,0)



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

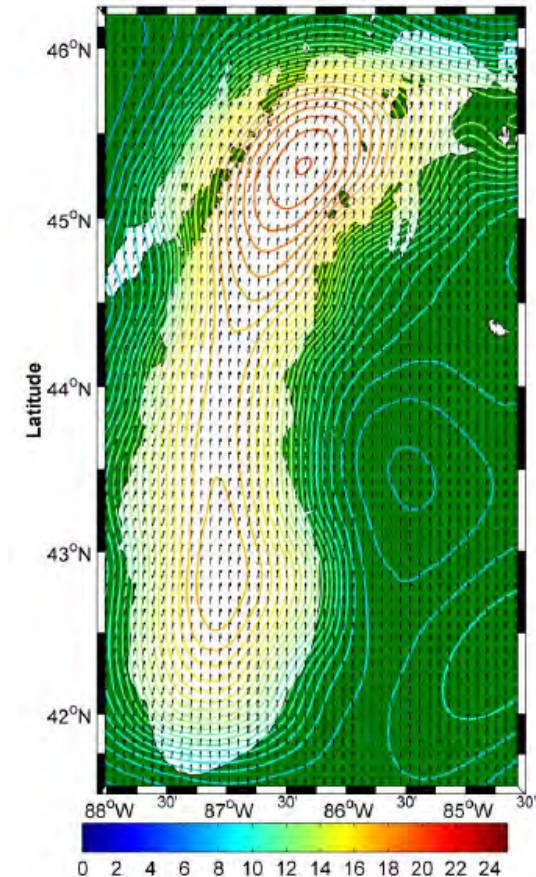
- **Local/County Level Activities**
 - Mapping level tasks performed at county level
 - Nearshore wave transformations with CSHORE
 - Wave runup calculations



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

CFSR-05D-72SRes STORM6A-1993-268 Basin (Res 0.02 °)
Wind Spd and Dir at DATE: 19931001080000



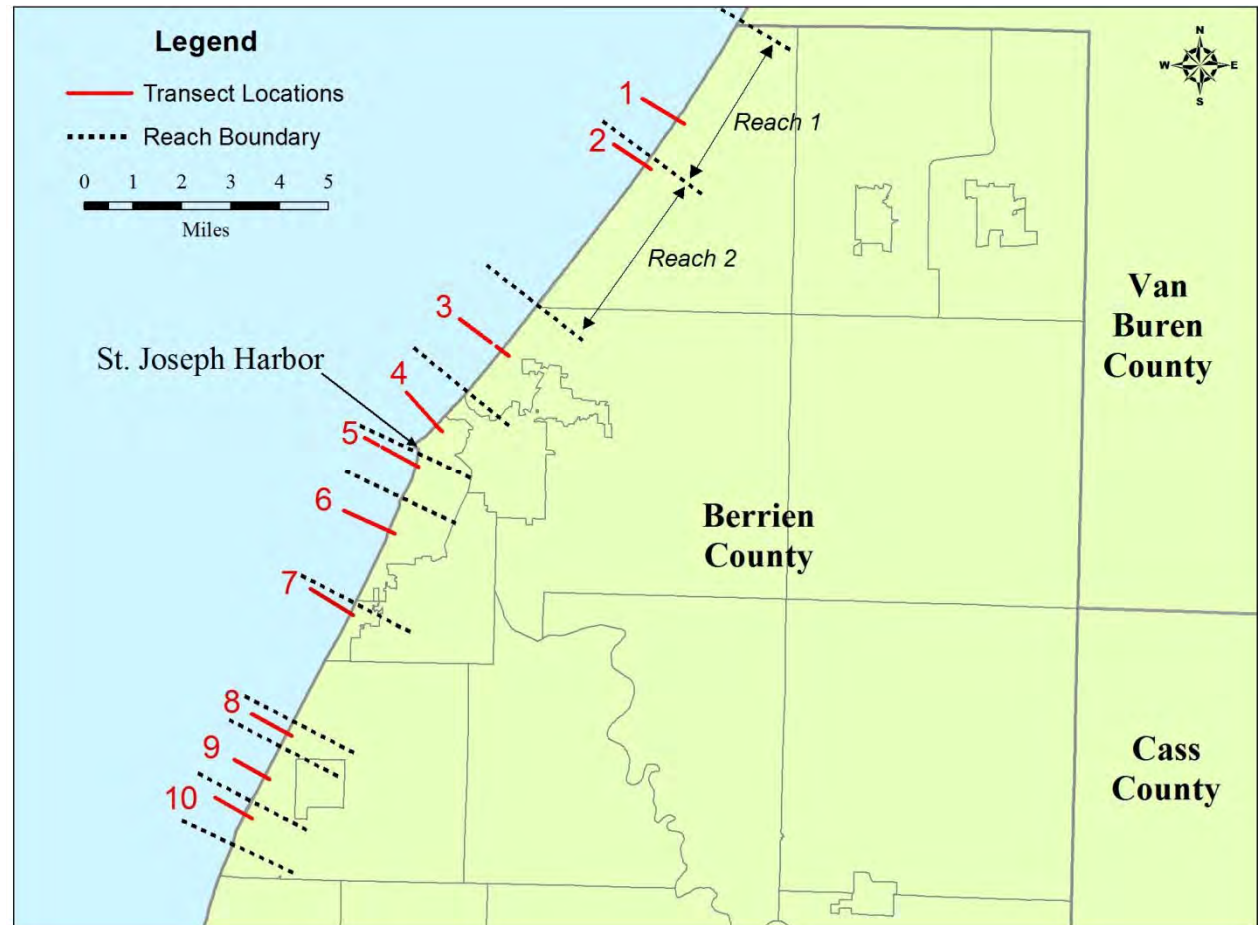
Surf Zone Modeling Approach

- 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



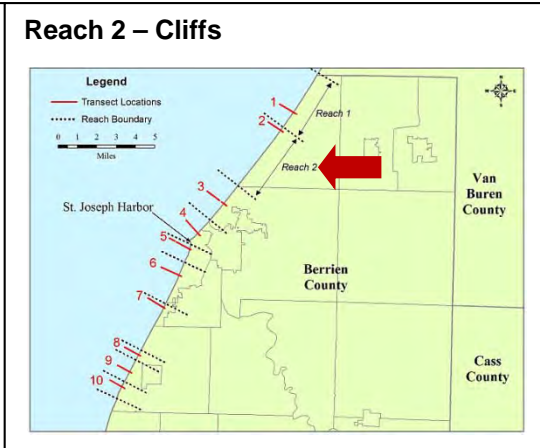
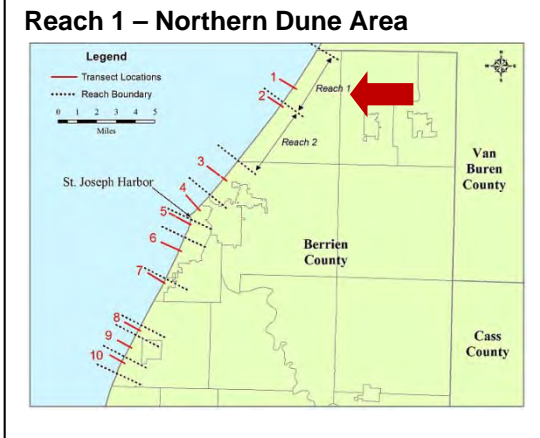
Transect Spacing

- Geomorphic Reaches Define Transect Spacing



Reach Examples

- Reach 1 and 2



Coastal Erosion

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



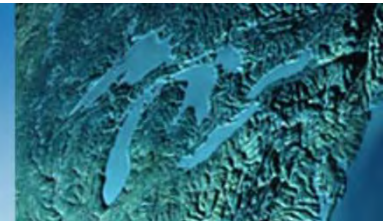
Wave Runup

- 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

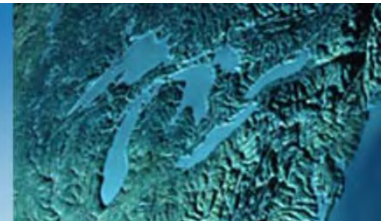
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Study Progression

- 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

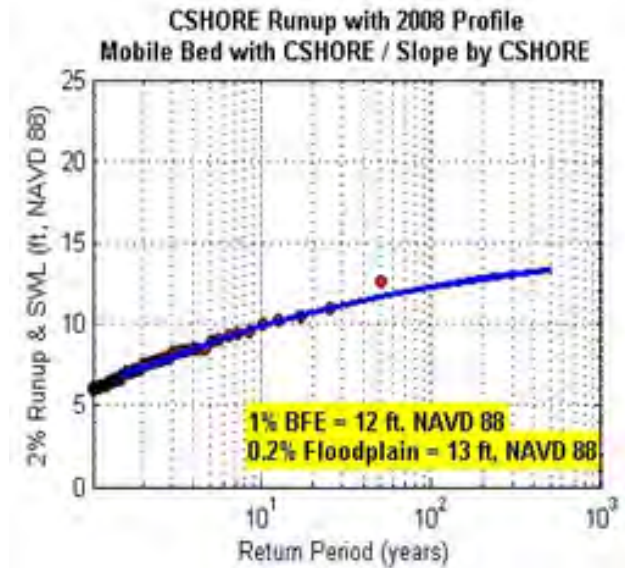
September 2012

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):

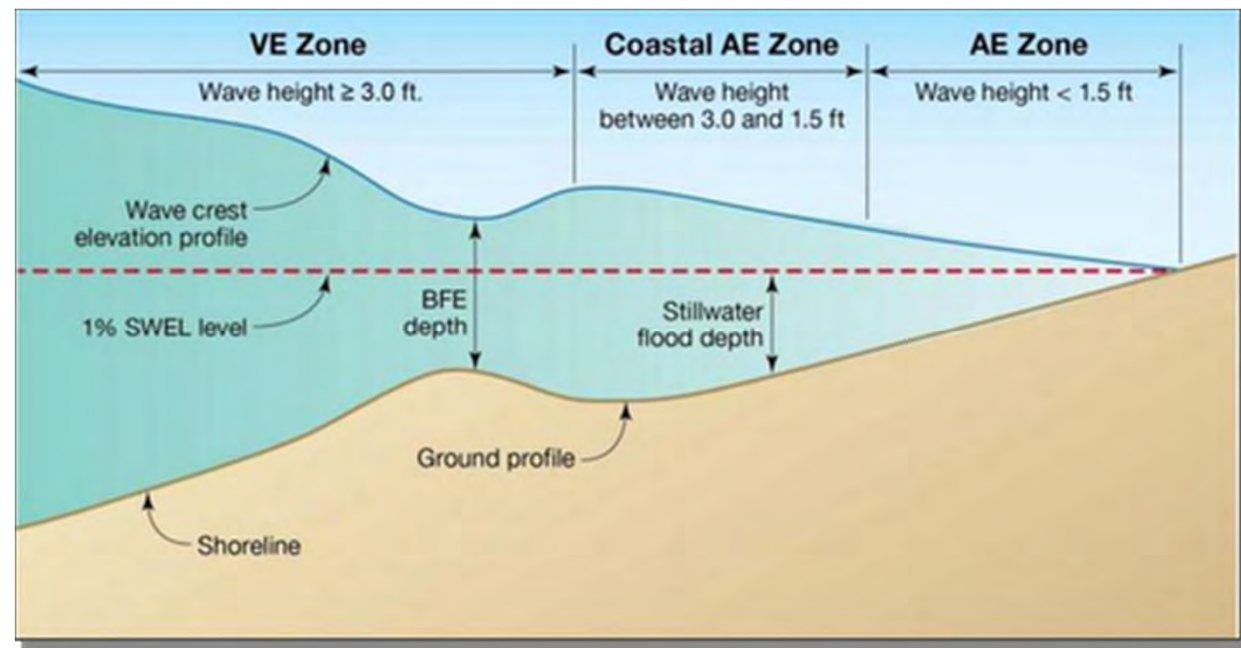
- **VE Zones**
 - Currently mapped based on wave height / runup depth ($H_s > 3$ ft)
 - This procedure was developed for the Atlantic, Pacific, and Gulf Coasts
 - FEMA recognizes it may not be appropriate for Great Lakes
- **An independent study will be performed to determine the appropriateness of mapping 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

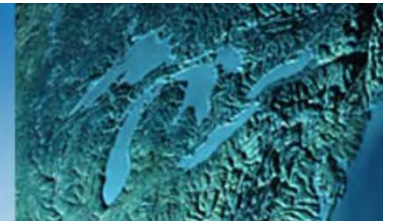
FEMA Procedure Memorandum No. 50, 2008 (LiMWA)

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



Who to Contact

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- State Partner
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