NEARSHORE DREDGED MATERIAL PLACEMENT AND TRANSPORT IN SOUTHERN LAKE MICHIGAN

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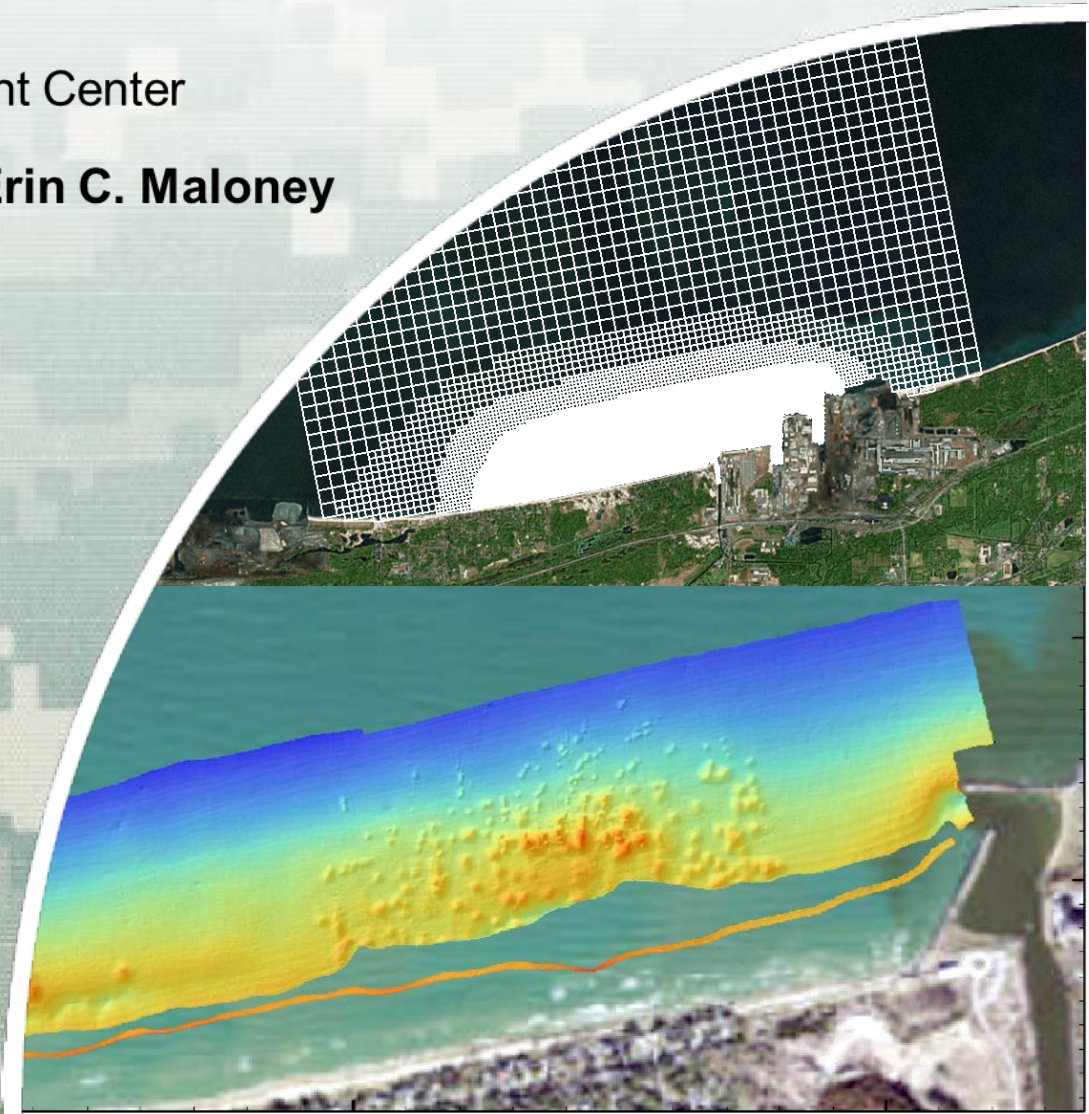

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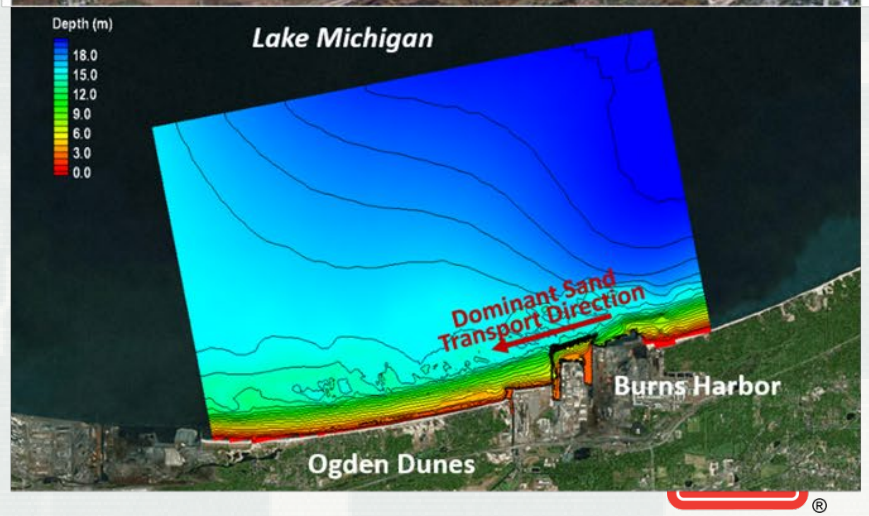
Outline

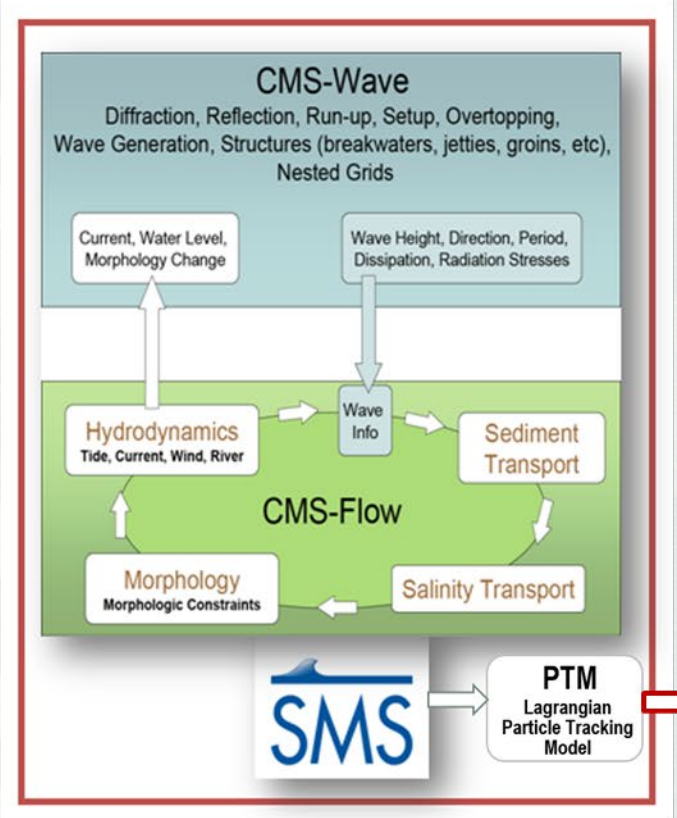
- Background
- Numerical Modeling Method
  - Coastal Modeling System (CMS)
  - Particle Tracking Model (PTM)
- Model setup
- Results
- Summary

Background

- Harbor/port complex and coastal structure interrupt natural littoral movement of sand
- Sand accretion/erosion pattern around the complex leaves Ogden Dunes little to no beach along the shoreline and put the residents and their property at greater risk from coastal hazards
- To protect the natural habitat and shoreline residences, USACE has placed 600,000 cy of dredged sand in the nearshore area as beach nourishment effort since 2006.
- This numerical modeling study is to examine the sediment transport of nearshore placed material under various hydrodynamic and wave conditions.



Numerical Modeling Method (CMS and PTM)



- CMS-Flow: Two-dimensional (2D) finite-volume model and calculate hydrodynamics, sediment transport
- CMS-Wave: 2D spectral wave transformation model, simulate important wave processes, including diffraction, refraction, reflection, wave breaking and dissipation mechanisms …
- Coupled system for waves, flows, and sediment transport and morphology change
- PTM is a Lagrangian particle tracker that models transport processes (advection, diffusion, deposition, etc) of representative parcels to determine constituent (sediment, contaminants, biologicals, etc) fate.

Hydrodynamic and Wave Data → Time-dependent Particle Positions P(t,X,Y,Z) → Deposition Accumulation Pathways

Study Domain

	CMS-Flow	CMS-Wave	
• Domain Size:			
	15.4 km	11.5 km	along shore
	10.6 km	7.4 km	cross shore
• No of Cells:			
	~ 80,000	~ 67,000	
• Cell Size:			
	10 ~ 300 m	10 ~ 180 m	

- Water Depth (MSL):

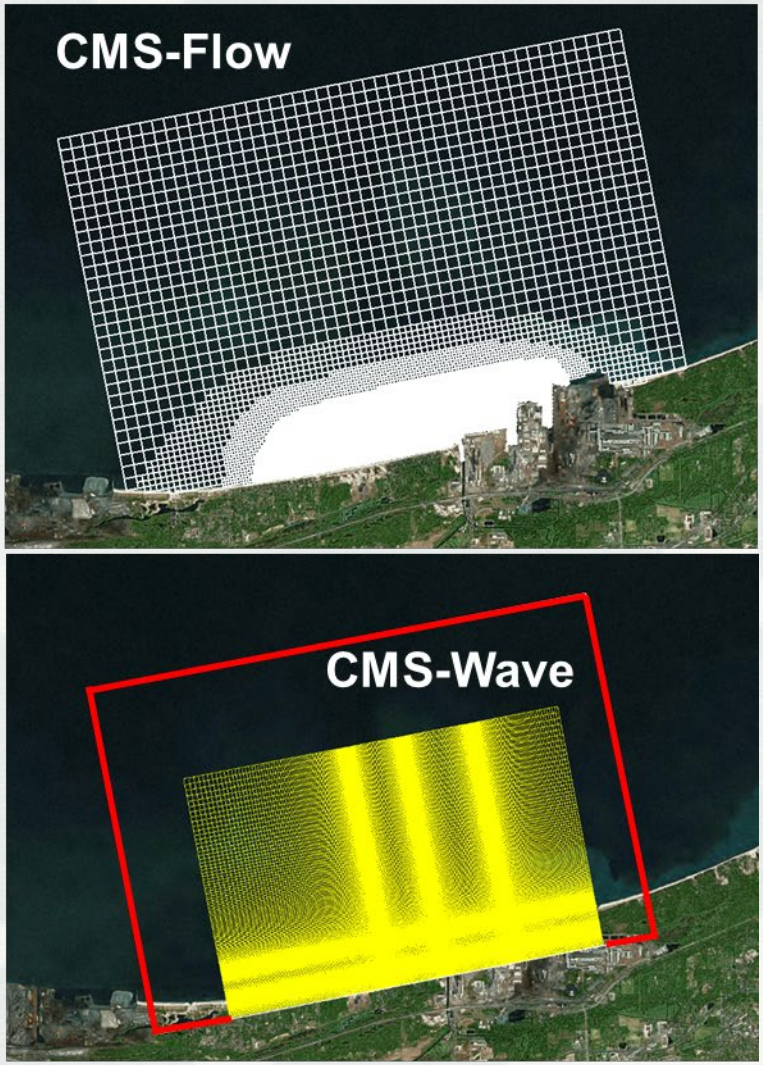
  -2 ~ 20 m

- Boundary Forcing:

  ~ Open lake

- Simulation Periods:

  ~ Jul 20 – Aug 30, 2016 (validation)
  ~ Oct 10 – Nov 20, 2016 (sediment transport/ morph change)



Data

Boundary forcing:

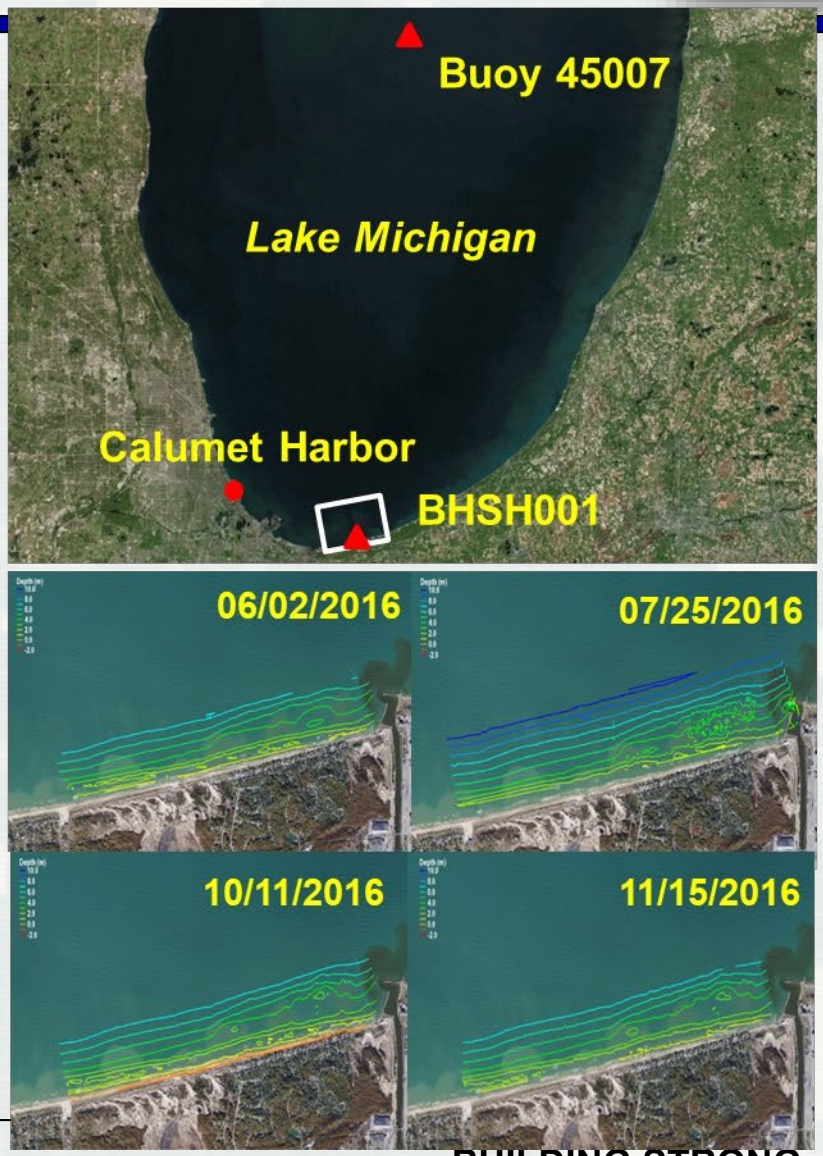
NOAA WL Gage (Calumet Harbor)
NOAA Buoy (#45007)
- Waves spectrum
- Wind

Model calibration/validation:

Nearshore ADCP gage (BHSH001)
Multibeam echosounder (MBES)
- Bathymetric and beach topographic surveys

Survey Periods

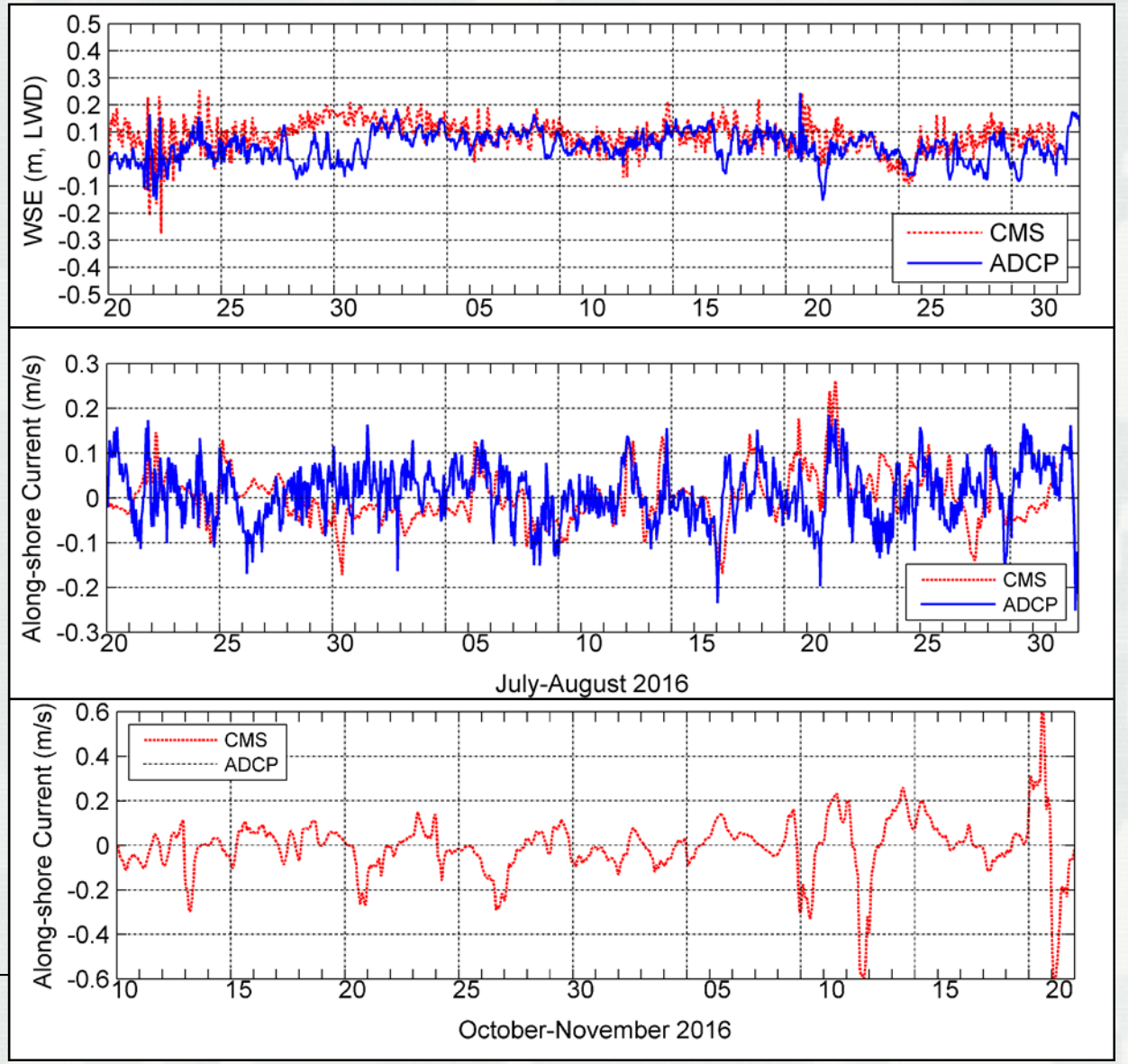
June-November 2016



Model Results
(water surface elevation and current)

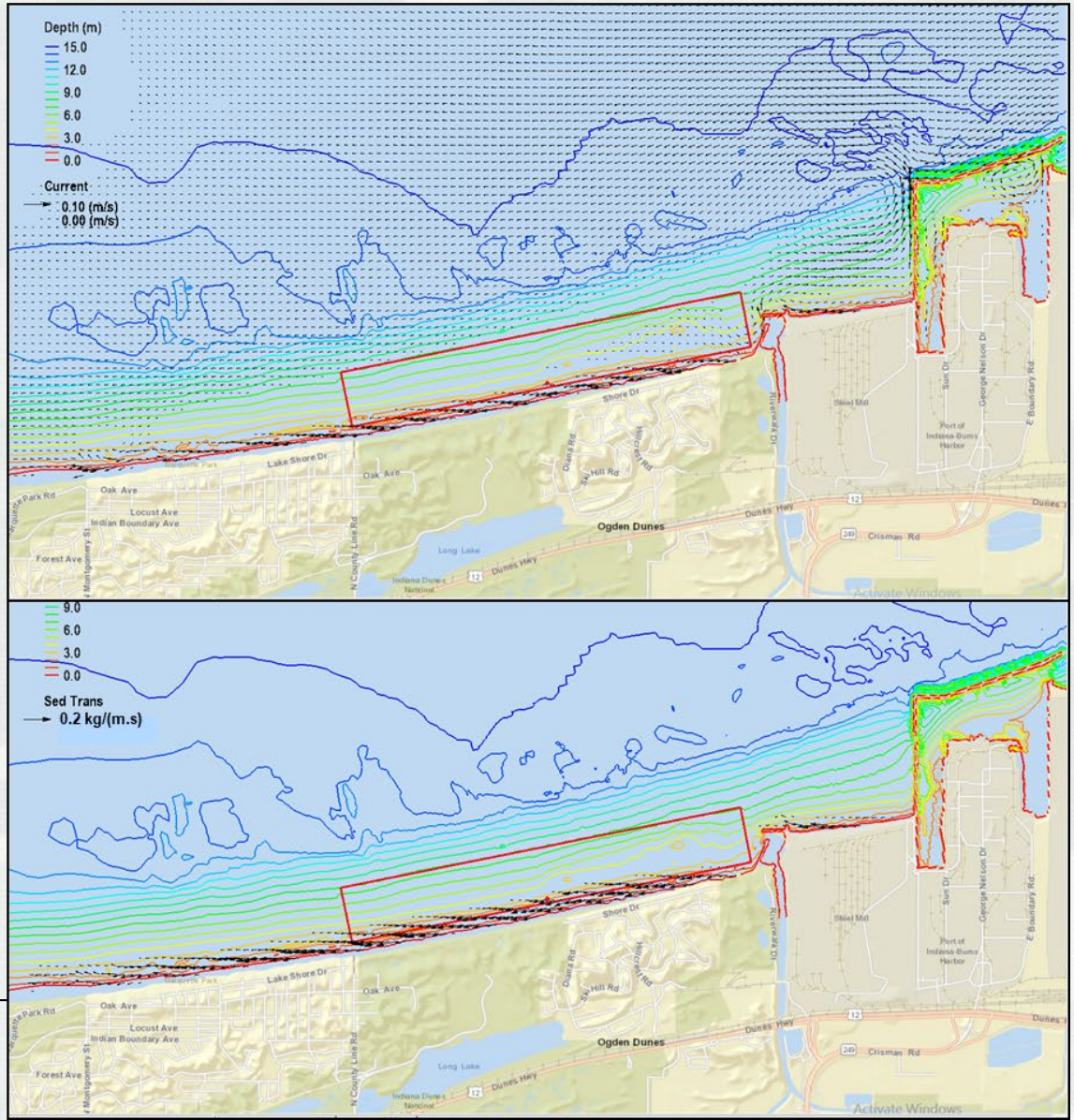
Water surface elevation and current measurements and calculations (time series)

- Jul 20-Aug 30, 2016
- Oct 10-Nov 20, 2016



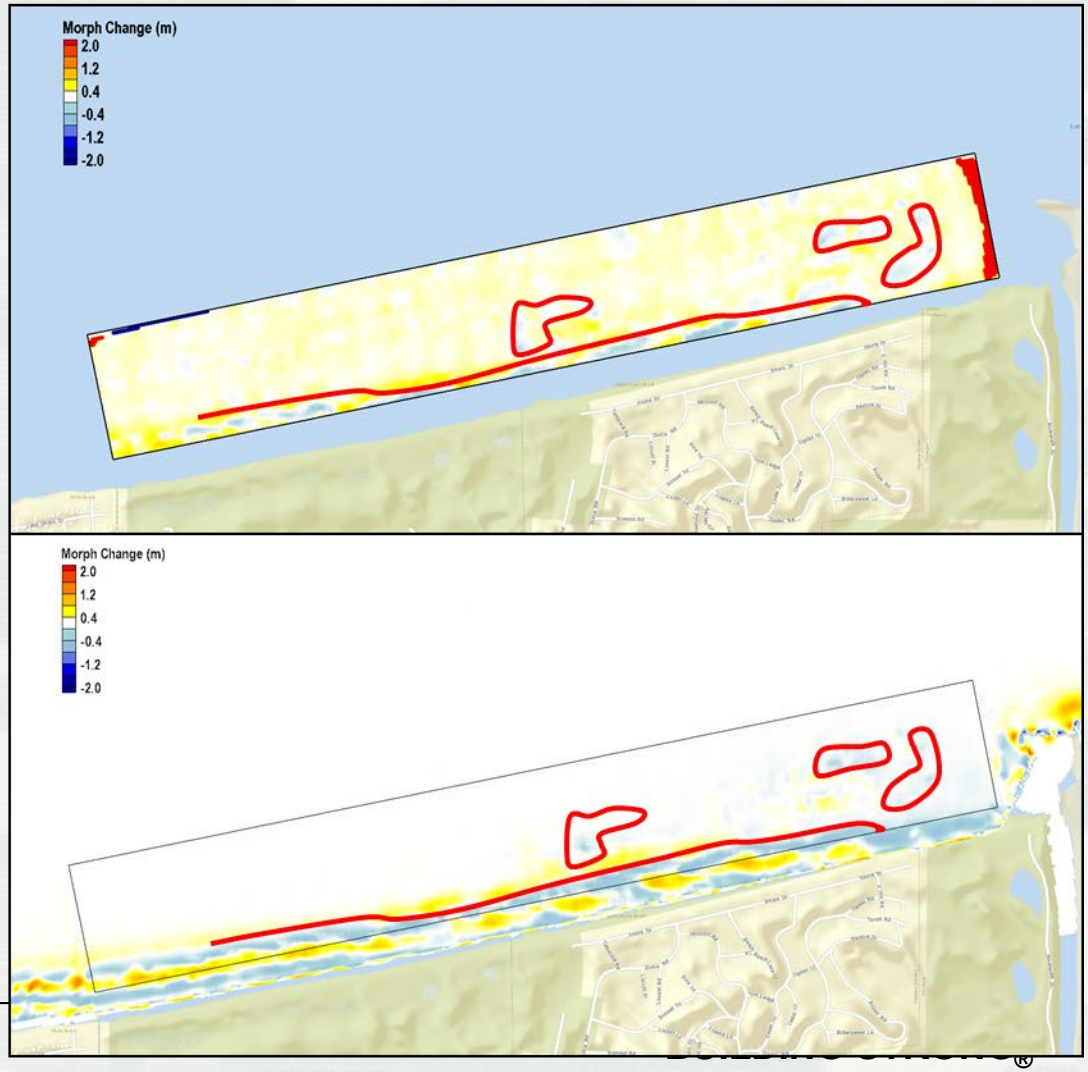
Current and Sediment Transport

- Averaged current and sediment transport vectors (Oct 10 – Nov 15, 2016)
- Strong longshore transport west of harbor/port complex

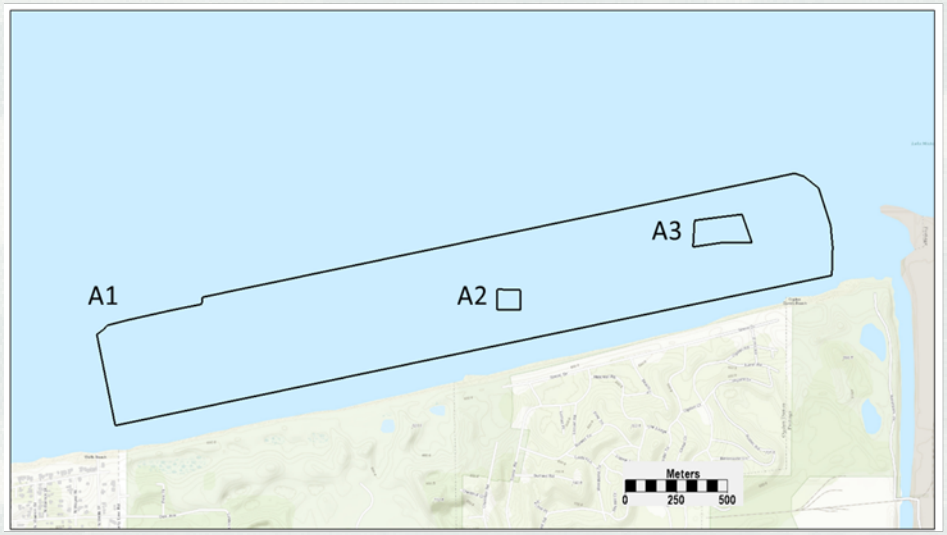


Morphology Change

- Measured and calculated morphology change (Oct 10 – Nov 15, 2016)
- Sediment erosion and accumulation on the nearshore side
- Sediment accumulation in the offshore area (survey data)
- Because of weak currents the offshore accretion could be attributed to measurement errors (±3 cm to 10 cm)



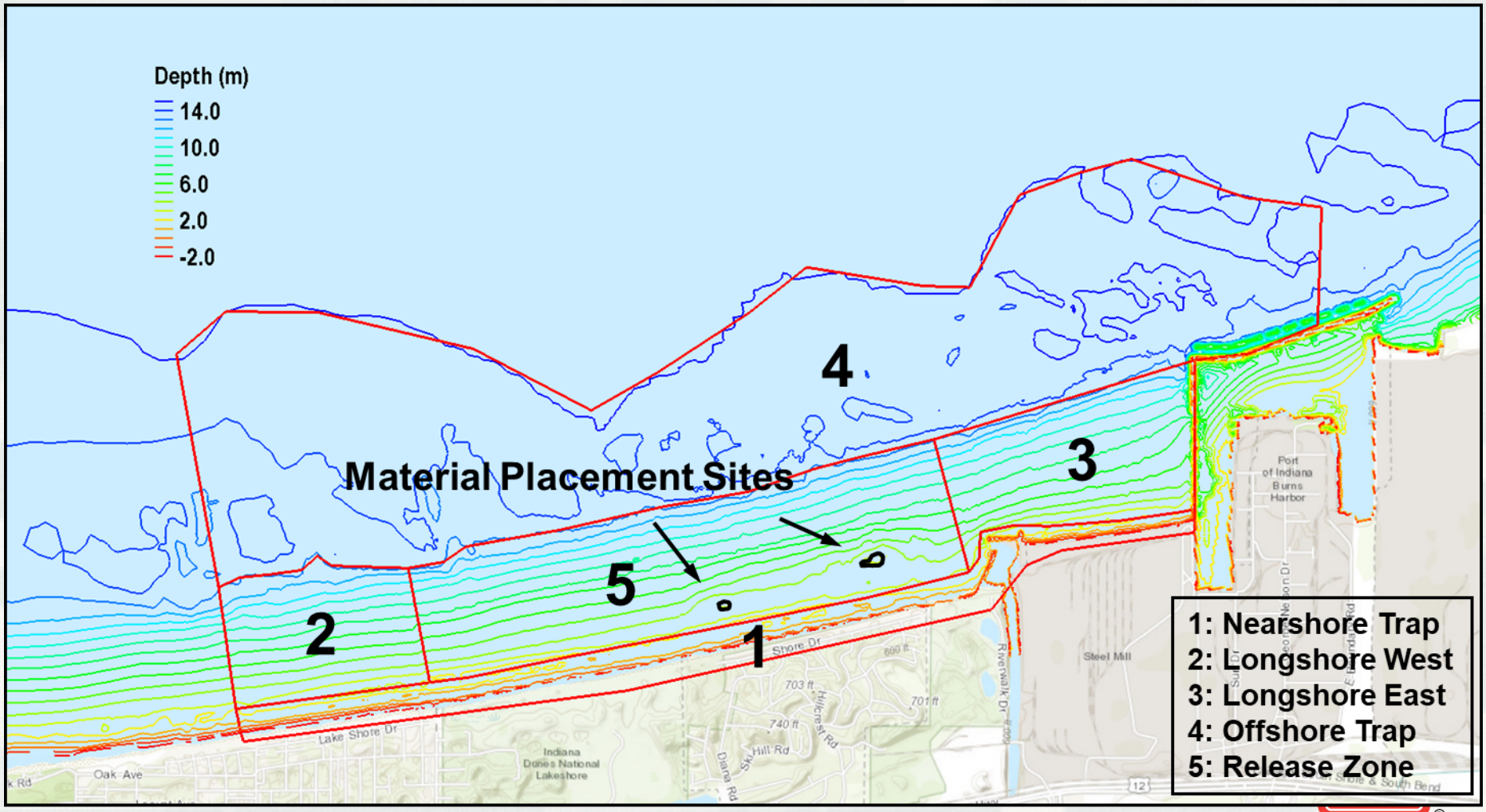
Sediment Volume Change



- Bed erosion (sediment dissipation) around dredge material placement sites

Area	Volume Change (m^3)	
	ADCP Survey	CMS
A1	-13032	-20436
A2	-367	-847
A3	-1738	-2827

Sediment Tracking



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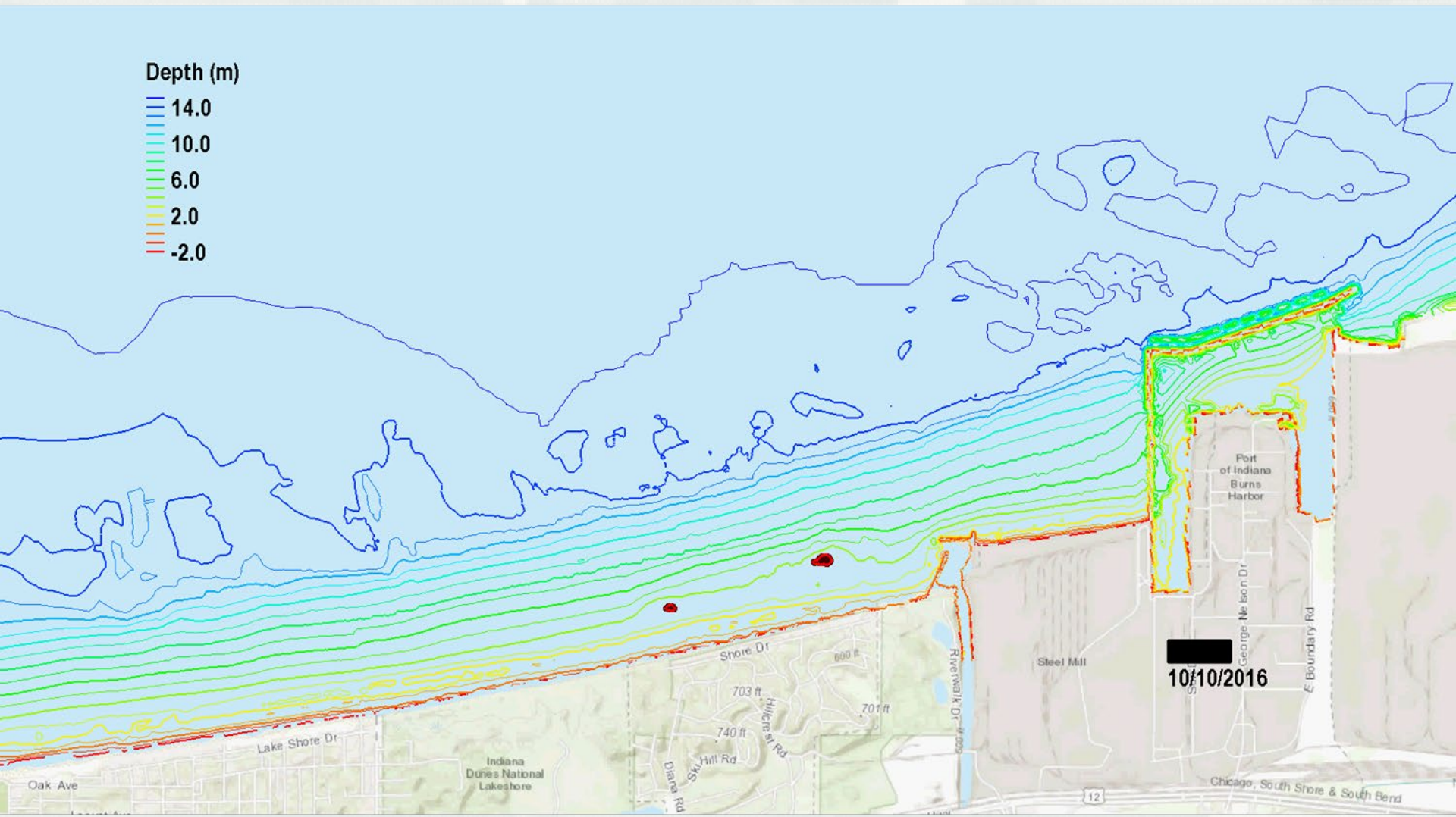
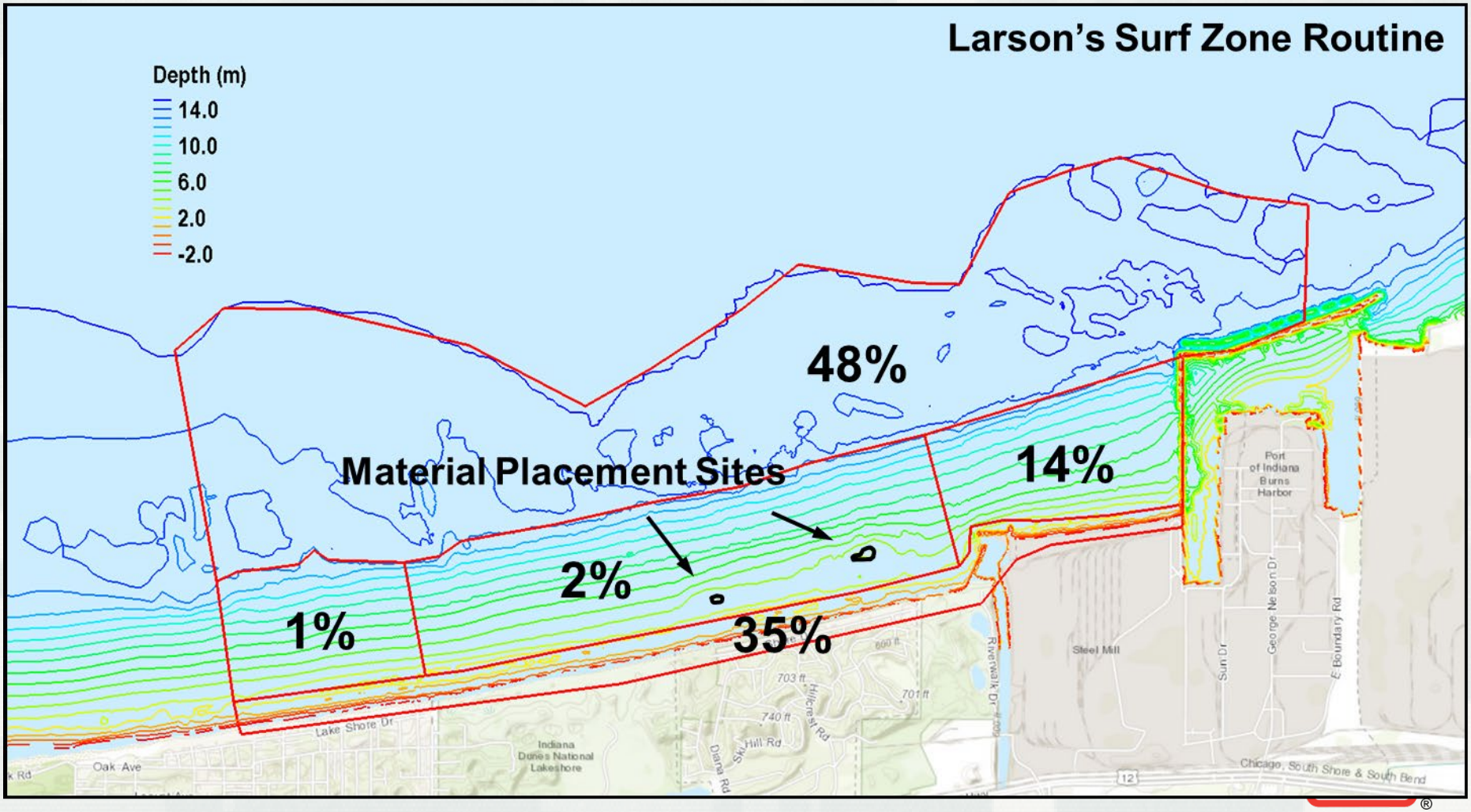


Sediment Transport



Summary

- Mean current vectors display dominant, south-southwestward longshore flows and the maximum current speed was approximately 0.1 m/sec in the surf zone area.
- Mean sediment transport pattern corresponded closely with the mean current pattern. Coastal sediments were dominantly transported alongshore towards the south-southwest and no apparent sediment movement was identified in deeper lake area.
- During the simulation period, mean longshore current and sediment movement were driven by dominant, northerly directed storm waves.
- About 25-35% of placed material move to nearshore zone and 50-65% are within the offshore zone.
- Longer term simulations need to be conducted to further investigate sediment transport pathways.

Thank You!