Nearshore Placement Techniques in Southern Lake Michigan

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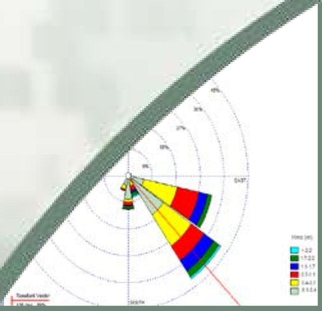
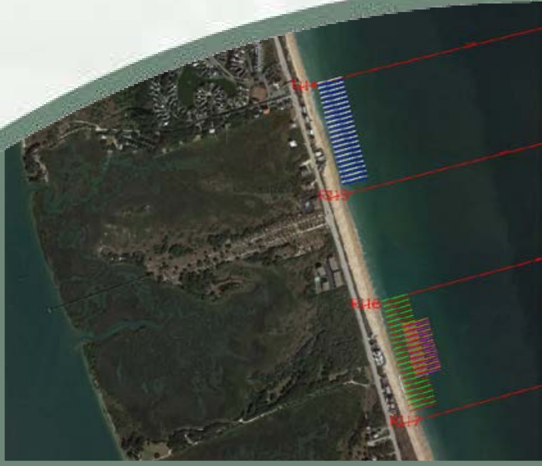


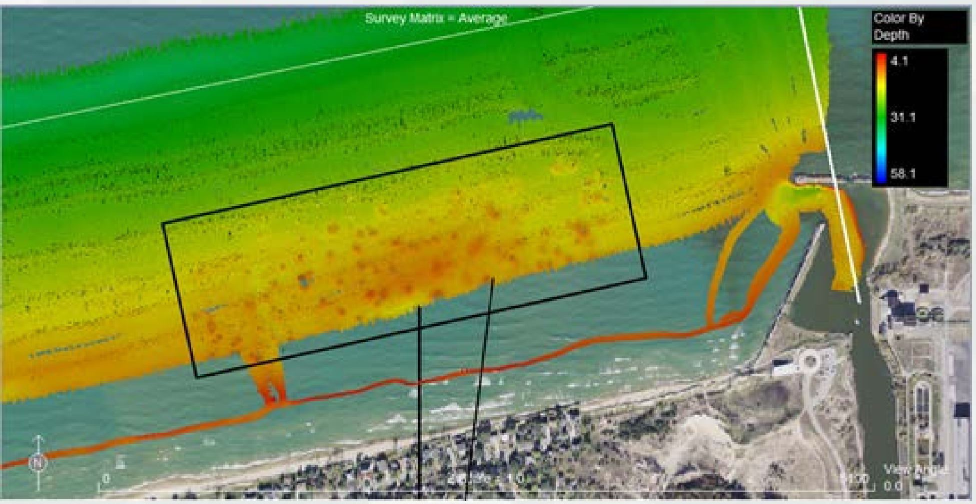


Nearshore Placement

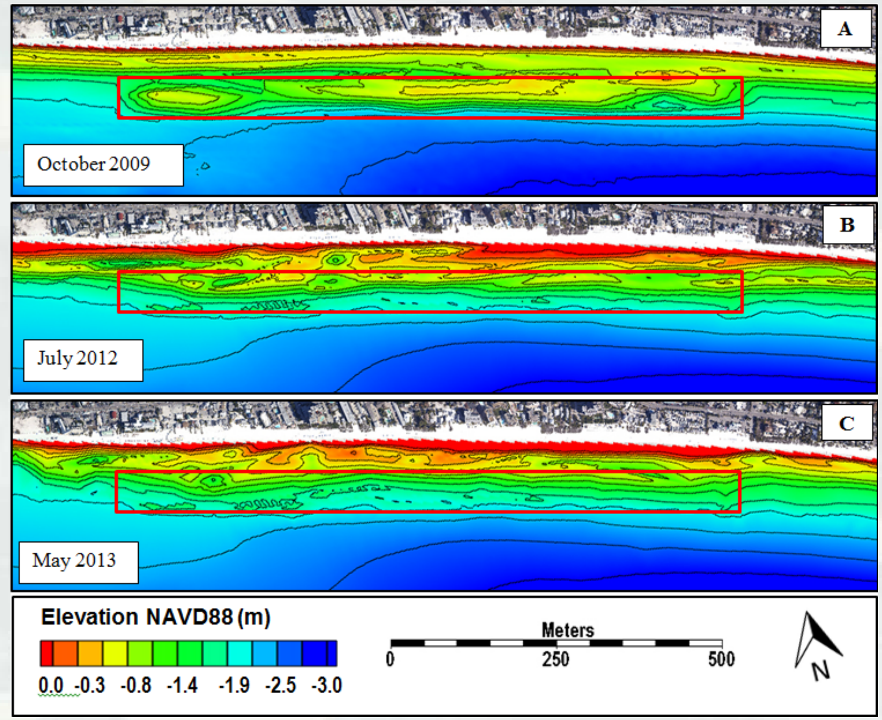
- Dredged material placement in the nearshore in a manner and at locations that permits natural forces to disperse the dredged material toward other locations where it can deliver benefits
  - Maximize benefits
  - Minimize rehandling
  - Minimize negative environmental impacts
  - Reduced cost (vs. direct placement)
  - Increase beneficial use applications
- Typically consist of dredged sediment from navigation projects that is incompatible with natural beach sediment
- Nearshore berms are a specific example of nearshore placement

Terminology

Nearshore Placement vs. Nearshore Berm



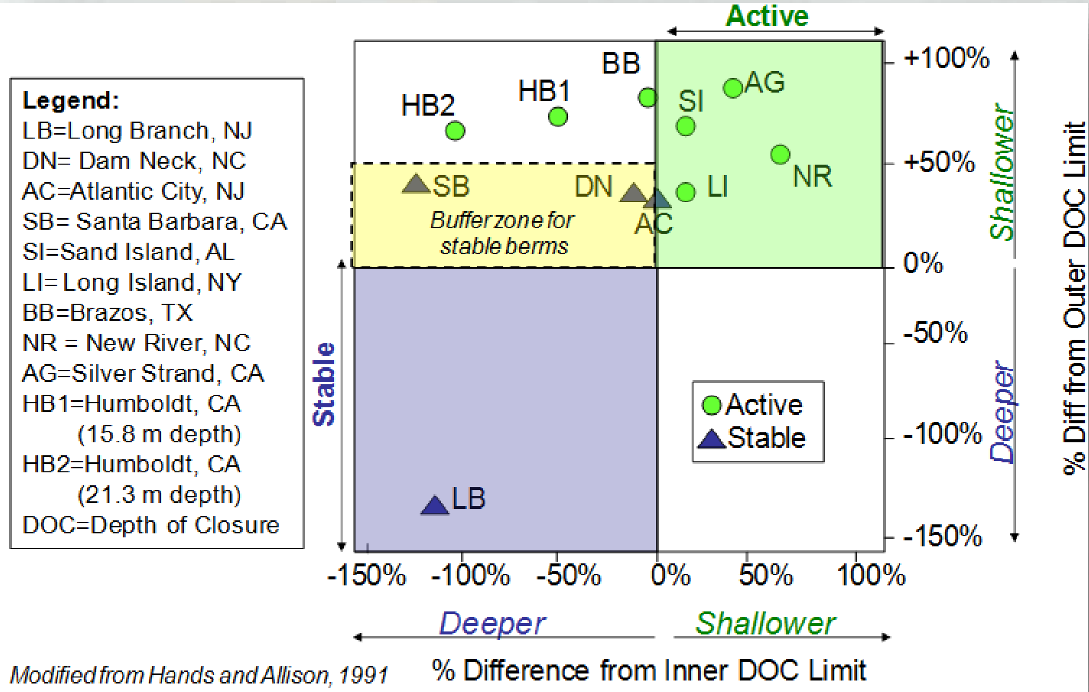
- Discrete mounds placed within a project design template



- Intentional placement of material in an elongate bar or mound feature

Nearshore Berms

- Sediment placed in the nearshore in either an elongate (bar-like) feature or a mound
  - Stable berms- remain stationary for years
  - Active/Feeder berms- sediment dispersed by waves and currents



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Nearshore Placement

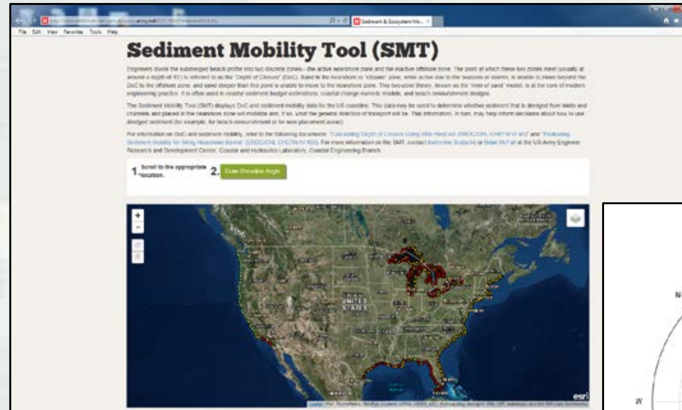
- Nearshore placement is becoming an increasingly utilized method for beneficial use of dredged material
  - Less costly than beach nourishment, fewer restrictions, fewer environmental concerns
- Important to have a better understanding of what happens once the sediment is placed
- Update to current design guidance to answer key regulatory questions
- Need to quantify benefits of nearshore placement

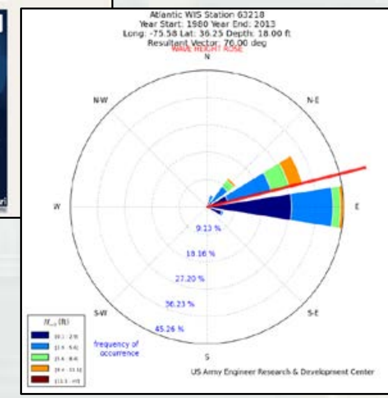
Important Questions

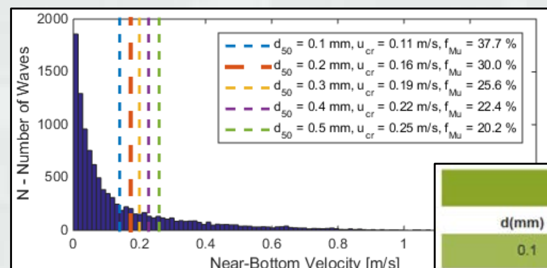
- Will sediment move once it is placed in the nearshore?
- Where will the sediment move?
- How much sediment will move?
- How long will it take for the sediment to move?

Sediment Mobility Tool

- Sediment Mobility Tool (SMT) is a web tool that predicts:
  - Frequency of sediment mobilization at nearshore placement sites
  - Cross-shore sediment migration direction
  - Axis of wave dominated sediment transport
- WIS data are downloaded from server in real-time to calculate SMT predictions







WIS Station 63218, 155° Shoreline Angle, Nearshore Placement Depth: 18 ft

d(mm)	Predicted Sediment Migration
0.1	53% offshore
0.2	95% onshore
0.3	100% onshore
0.4	100% onshore
0.5	100% onshore

Sediment Mobility Tool

http://sam-ap-map2moba.sam.ds.usace.army.mil/portal/rest/directories/arcgisjobs/doc/depthofclosure_gpserver/jc721aebc574347fc9f1cf2e76b2be97b/

Sediment & Ecosystem Manag... | sam-ap-map2moba.sam.ds...

File Edit Go to Favorites Help

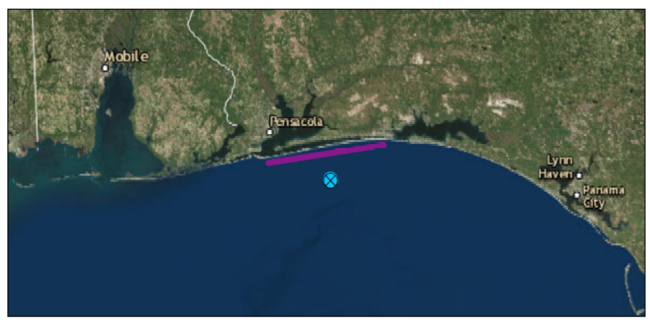
Sediment Mobility Tool

http://navigation.usace.army.mil/SEM/SedimentMobility

9/19/2016

The Sediment Mobility Tool is a scoping level tool for siting nearshore placement areas of dredged material. The tool uses Snell's Law to transform WIS hindcast wave data to the nearshore site. The depth of closure, which is a specified depth along a beach profile where net sediment transport is very small or nonexistent, is calculated using several commonly used empirical equations which are described by Brutsché et al. (2016). The frequency of sediment mobility is calculated using both linear and nonlinear stream-function wave theories using procedures described by McFall et al. (2016). The cross-shore sediment migration is calculated using an empirical relationship described by Larson and Kraus (1992). The wave rose provides the axis of wave dominated transport at the nearshore site.

User Input:	
Shoreline Angle	263°
Placement Site Latitude	30.22° N
Placement Site Longitude	-86.91° W
WIS Station	73171
Years of WIS Data	1980 - 2015
d_{50}	0.26 mm
Nearshore Placement Depth	8.00 ft
Current 3 ft Above the Bed	0.33 ft/s
Water Temperature	68.00 °F
Water Salinity	35.00 psu



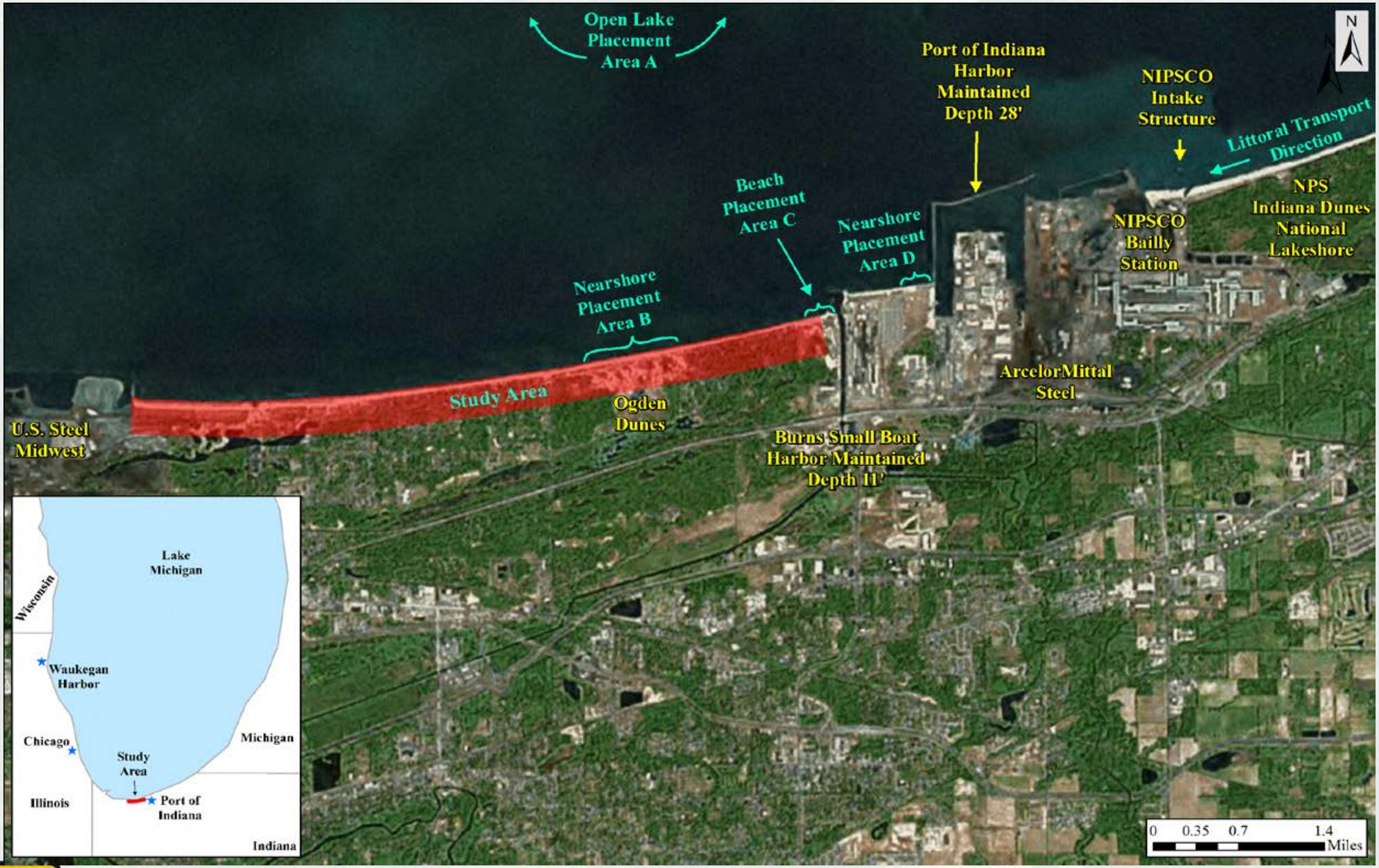
Southern Lake Michigan

- USACE Chicago District routinely places sediment dredged from Burns Waterway Harbor in places in the nearshore of Ogden Dunes, Indiana
  - Nearshore placement is least cost alternative over direct placement
- Area is critically eroding despite nearshore placement
- Determine effectiveness of nearshore placement

Study Area

- Approximately 6 miles of coastline in Southern Lake Michigan
- Bounded on the east by Burns Small Boat Harbor jetty
- Bounded on the west by eastern bulkhead of U.S. Steel landfill
- Net transport from east to west
- Harbor and Northern Indiana Public Service Company (NIPSCO) water intake dredged frequently

Study Area



Open Lake
Placement
Area A
Port of Indiana
Harbor
Maintained
Depth 28'
NIPSCO
Intake
Structure
Littoral Transport
Direction
N
Beach
Placement
Area C
Nearshore
Placement
Area D
NIPSCO
Bailly
Station
NPS
Indiana Dunes
National
Lakeshore
Nearshore
Placement
Area B
ArcelorMittal
Steel
Study Area
Ogden
Dunes
U.S. Steel
Midwest
Burns Small Boat
Harbor Maintained
Depth 11'
Lake
Michigan
Wisconsin
Waukegan
Harbor
Chicago
Study
Area
Michigan
Illinois
Port of
Indiana
Indiana
0 0.35 0.7 1.4
Miles

Research Tasks

- Determine effects of existing placement practices
  - Historical shoreline change analysis
- Develop innovative strategies for placing material in the nearshore more effectively
  - Run SMT
- Develop a monitoring plan
- Use strategies and monitoring plan to optimize placement in 2016
- Collect and analyze field data
- Numerical modeling effort

Historical Shoreline Analysis

- Aerial imagery prior to 1998 was digitized and georeferenced using UTM Zone 16
- Due to water level fluctuations in the lake, the date of the imagery was used in conjunction with NOAA Tides and Currents database
- Net shoreline change was determined between each successive photo
- Digital Shoreline Analysis Tool (DSAS) was used to determine net shoreline change statistics
  - Transects were created every 50 m using DSAS
- Compare shoreline analysis to dredging record

Data Acquisition

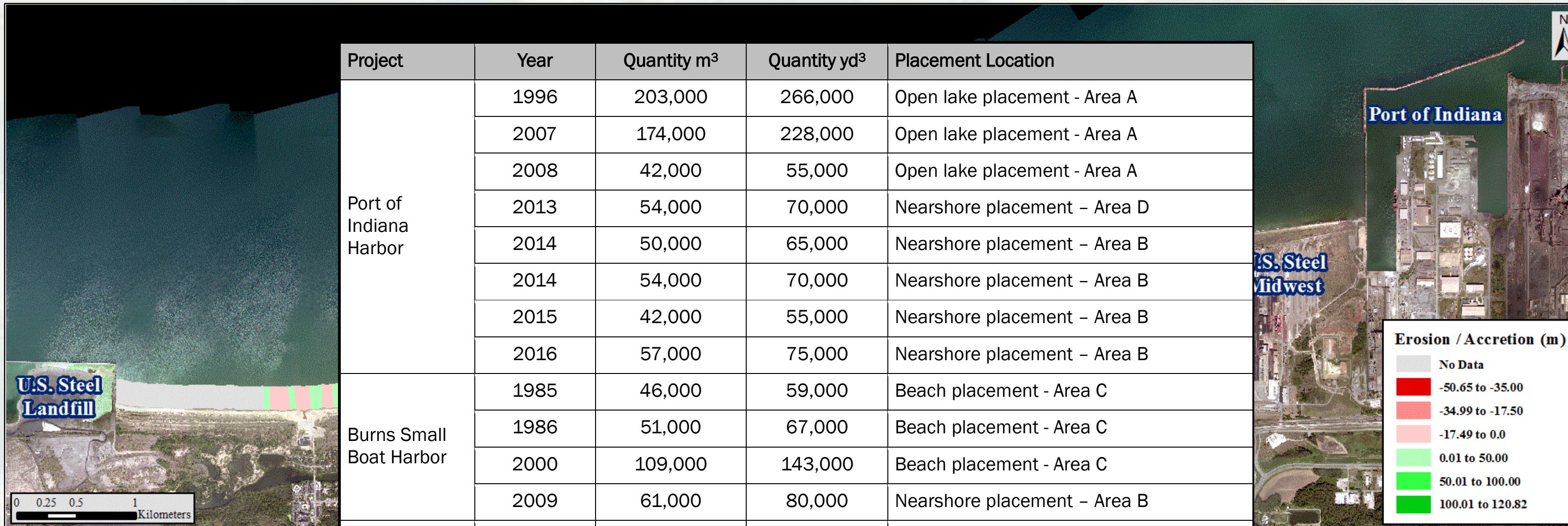
- Aerial imagery from 1969-2014
- Dredging and placement records from both Burns Waterway Harbor and NIPSCO water intake 1996-2015

Project	Year	Quantity m³	Quantity yd³	Placement Location
Port of Indiana Harbor	1996	203,000	266,000	Open lake placement - Area A
	2007	174,000	228,000	Open lake placement - Area A
	2008	42,000	55,000	Open lake placement - Area A
	2013	54,000	70,000	Nearshore placement – Area D
	2014	50,000	65,000	Nearshore placement – Area B
	2014	54,000	70,000	Nearshore placement – Area B
	2015	42,000	55,000	Nearshore placement – Area B
	2016	57,000	75,000	Nearshore placement – Area B
Burns Small Boat Harbor	1985	46,000	59,000	Beach placement - Area C
	1986	51,000	67,000	Beach placement - Area C
	2000	109,000	143,000	Beach placement - Area C
	2009	61,000	80,000	Nearshore placement – Area B
NIPSCO Intake (NIPSCO Dredged)	1980	210,000	275,000	Unspecified open lake placement
	1982	167,000	218,000	Shoreline at BGS
	1986	245,000	320,000	Nearshore placement – Area B *
	1989	220,000	288,000	Nearshore placement – Area B *
	1992	160,000	209,000	Nearshore placement – Area B *
	1995	90,000	118,000	Nearshore placement – Area B *
	1997	112,000	146,000	Nearshore placement – Area B *
	1999	126,000	165,000	Nearshore placement – Area B *
	2016	50,000	65,000	Nearshore placement – Area B
NIPSCO Intake (USACE Dredged)	2006	23,000	30,000	Nearshore placement – Area B
	2007	174,000	228,000	Nearshore placement – Area B
	2008	80,000	105,000	Nearshore placement – Area B
	2009	84,000	110,000	Nearshore placement – Area B

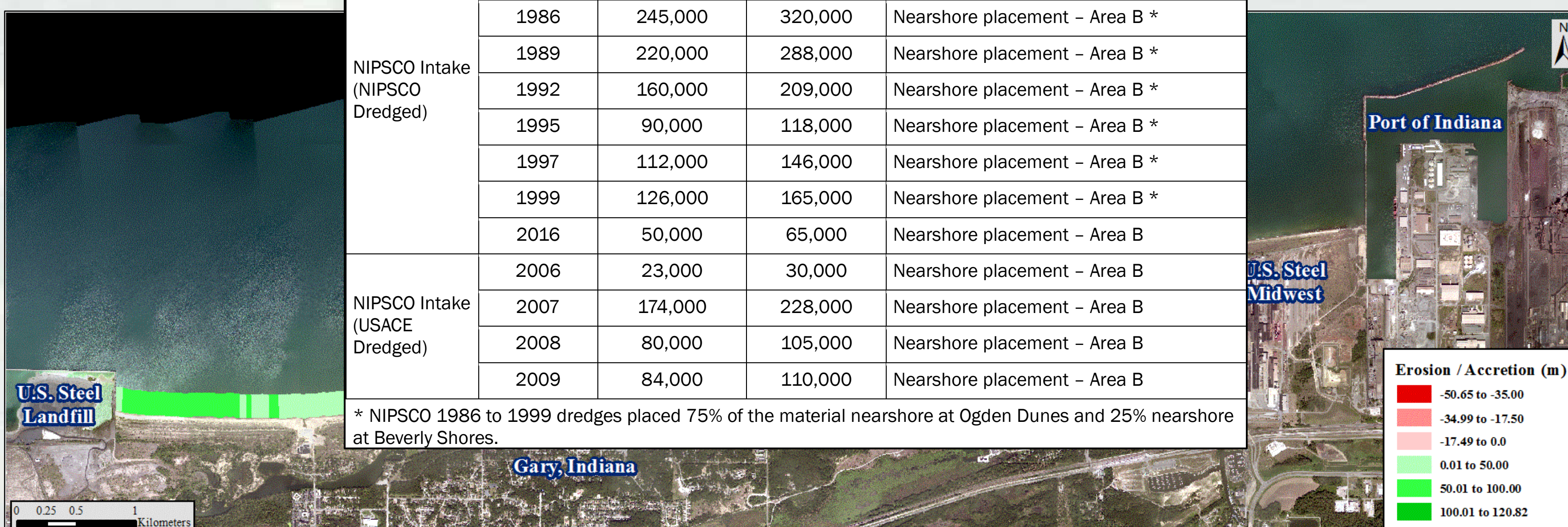
* NIPSCO 1986 to 1999 dredges placed 75% of the material nearshore at Ogden Dunes and 25% nearshore at Beverly Shores.

Shoreline Change

1969-1973



1973-1998



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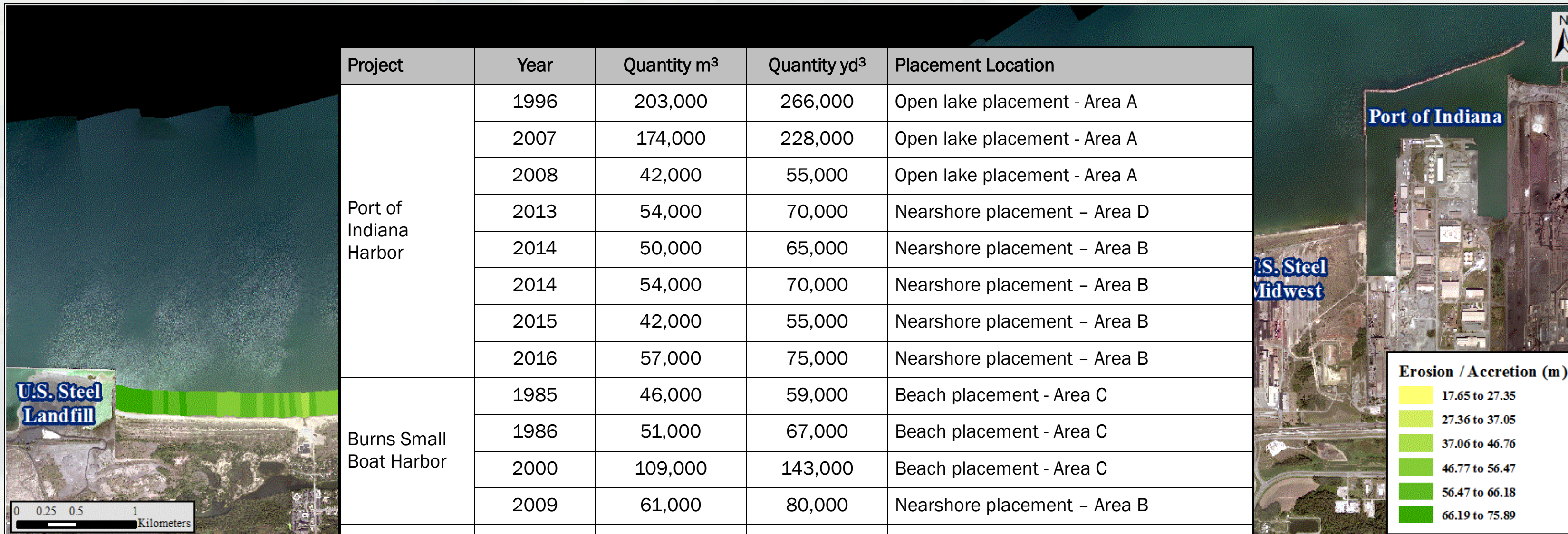
Shoreline Change

1998-2005



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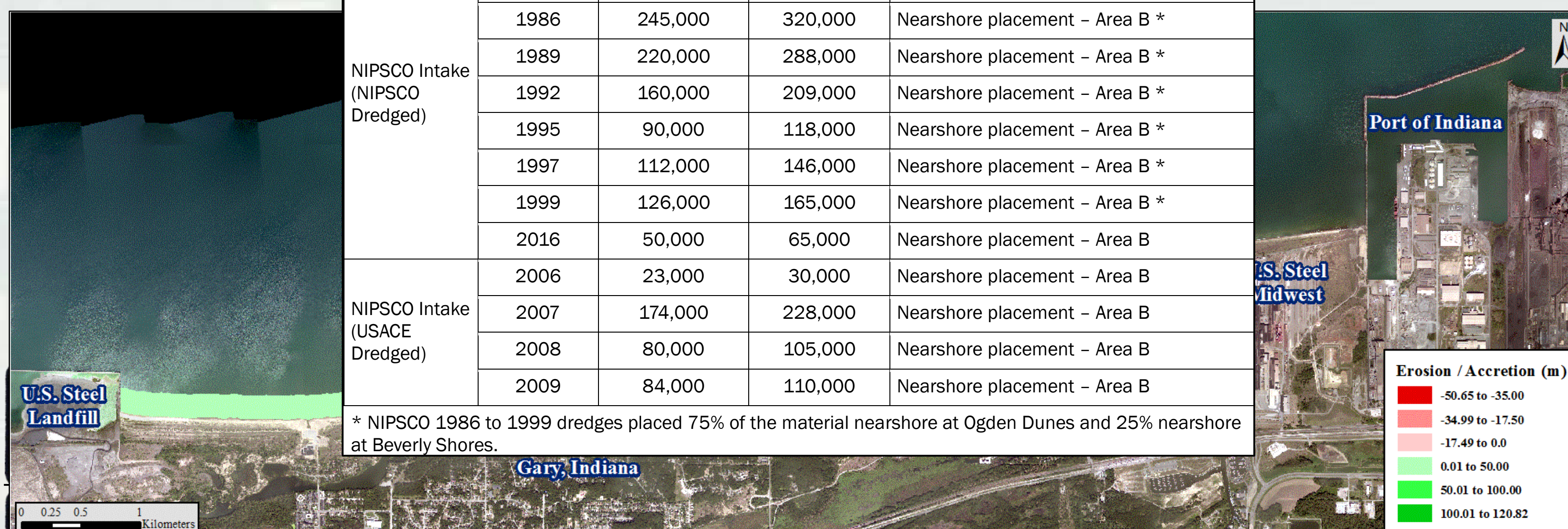
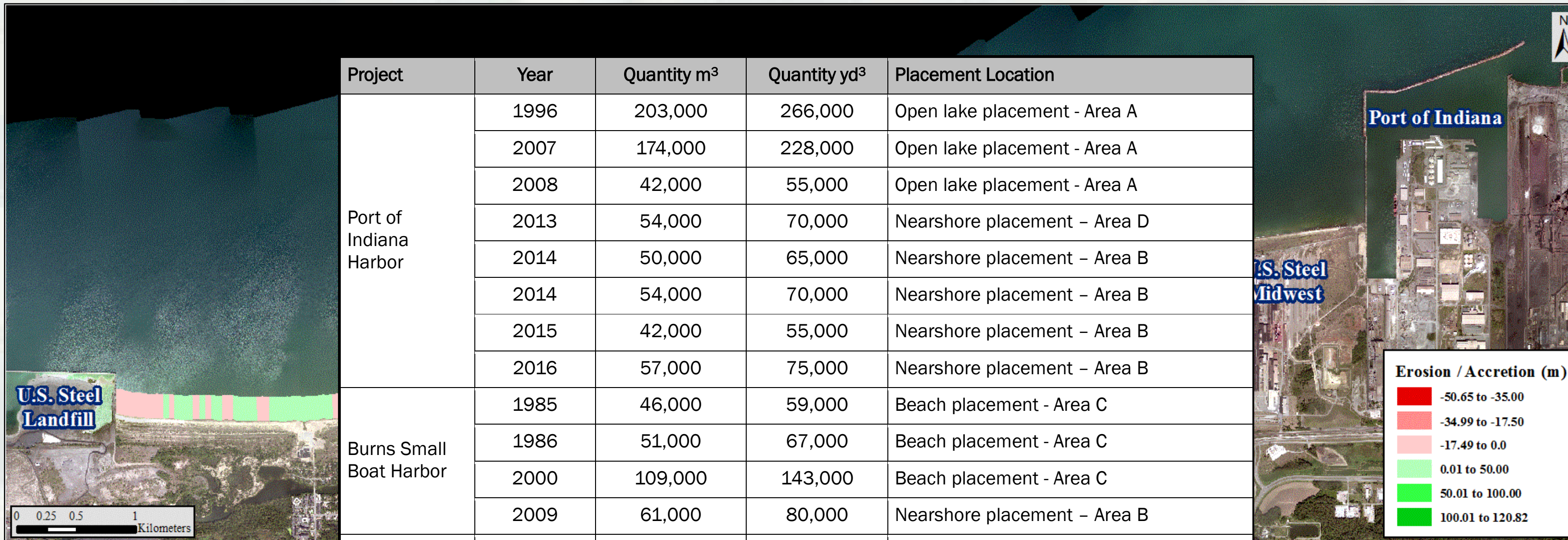
2005-2010

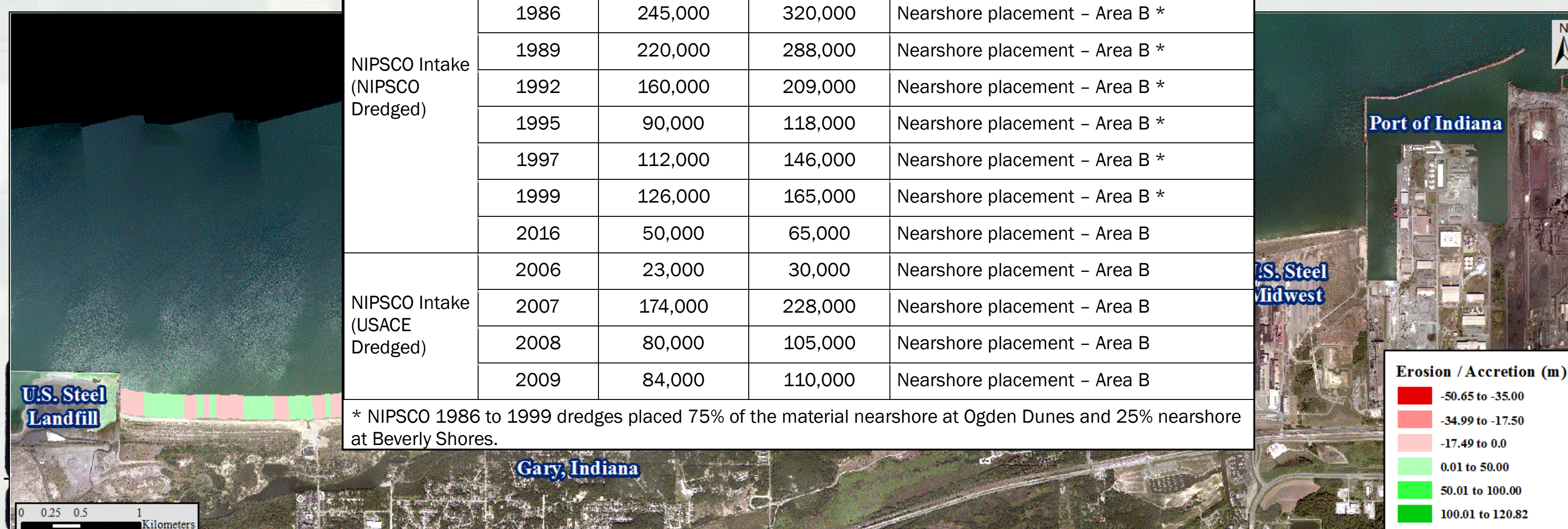


Shoreline Change

2010-2012



2012-2014



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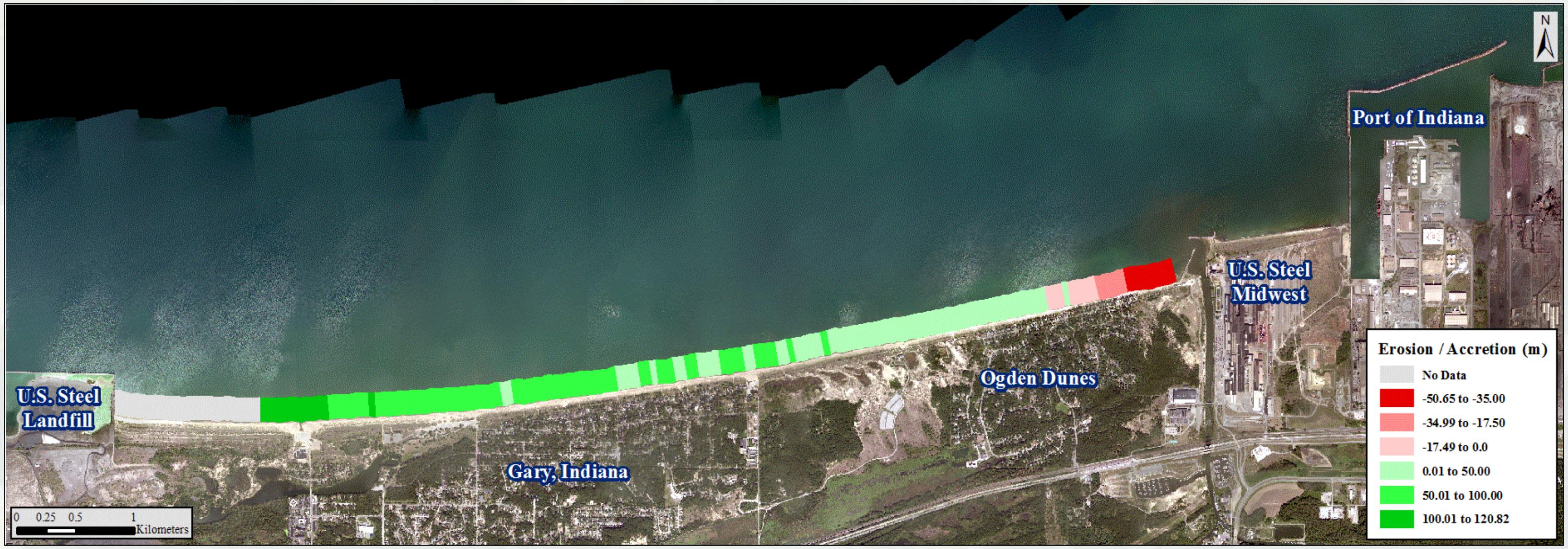
Overall Shoreline Change

1969-2014



Date Range	Range Low (m)	Range High (m)	Range Average (m)
1969 to 1973	-29.79	12.73	-2.57
1973 to 1998	-66.55	78.98	10.88
1998 to 2005	17.65	75.89	42.34
2005 to 2010	-14.28	32.90	6.83
2010 to 2012	-14.74	16.68	2.09
2012 to 2014	-21.67	14.22	-0.92
1969 to 2014	-50.65	120.82	45.37

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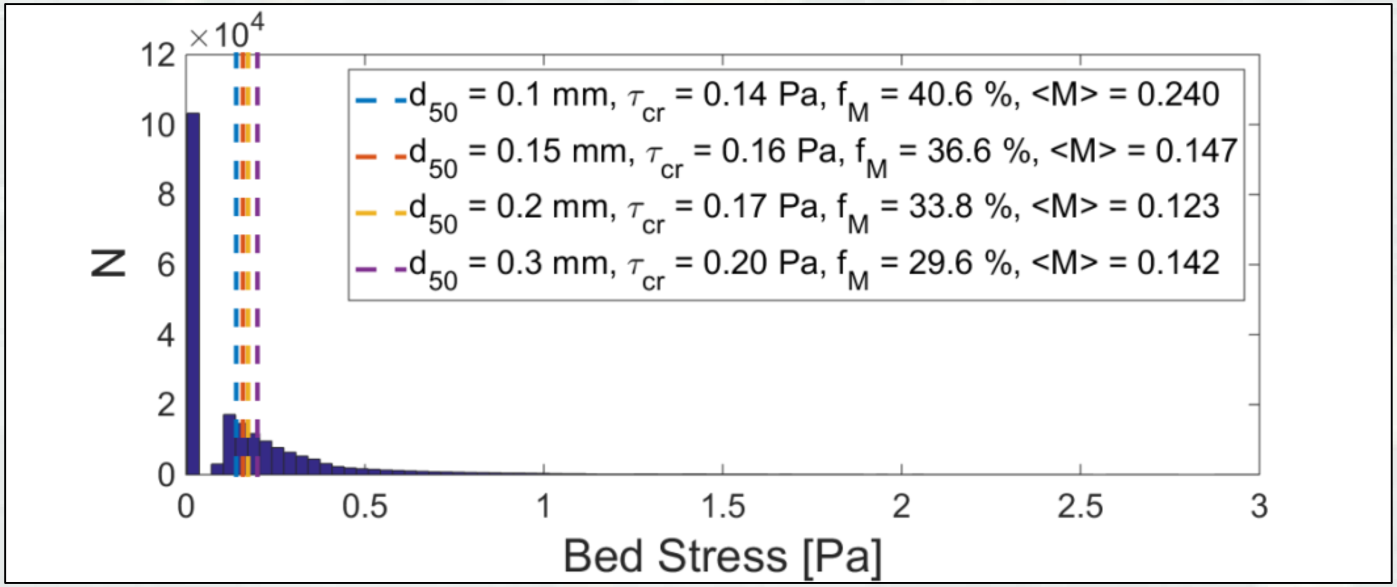
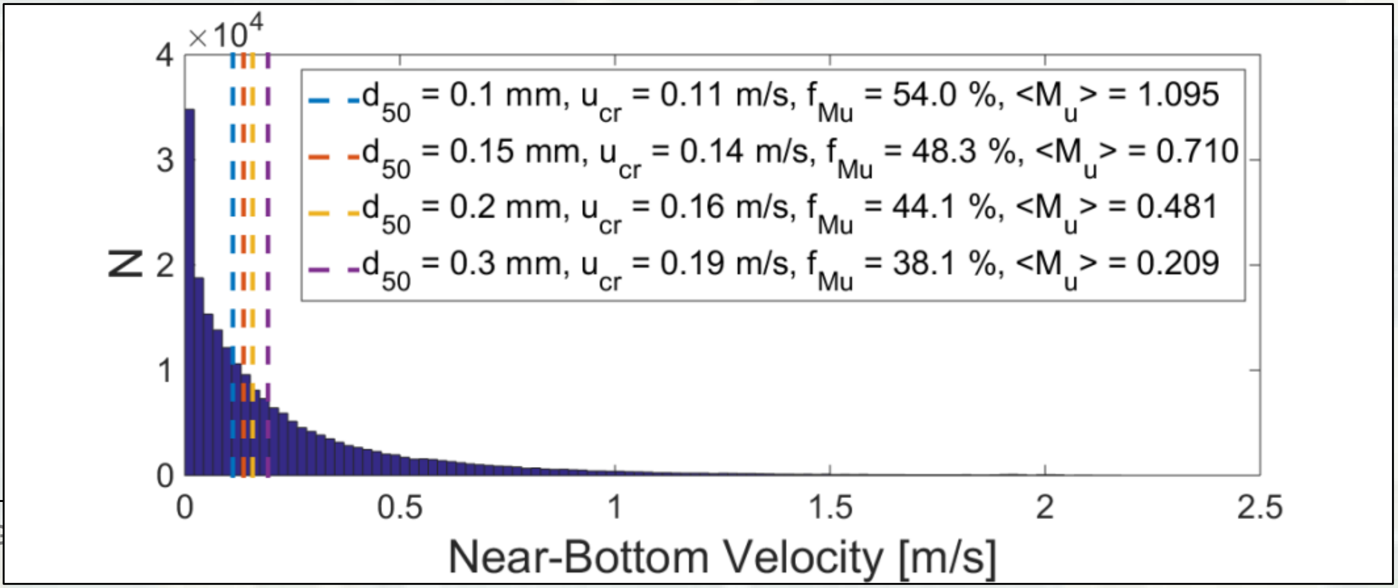
Sediment Mobility Tool

- WIS waves used from 1976 to 2014
- 18 ft placement depth
- 0.15 mm grain size

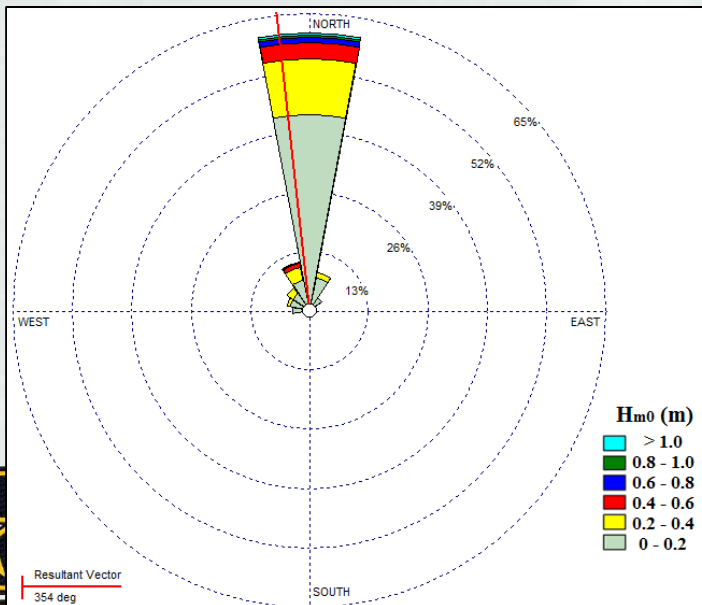




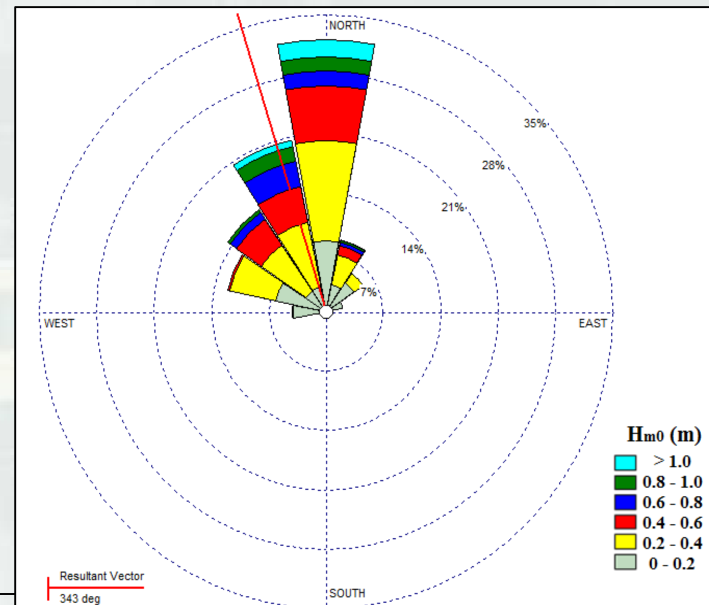
Sediment Mobility Tool

d_{50} (mm)	Typical Waves		Storm Events	
	Frequency of Mobilization	Sediment Migration	Frequency of Mobilization	Sediment Migration
0.1	41% - 54%	68% Onshore	79% - 87%	51% Offshore
0.15	37% - 48%	91% Onshore	76% - 84%	72% Offshore
0.2	34% - 44%	97% Onshore	73% - 81%	85% Onshore
0.3	30% - 38%	99% Onshore	68% - 76%	96% Onshore

Typical Waves



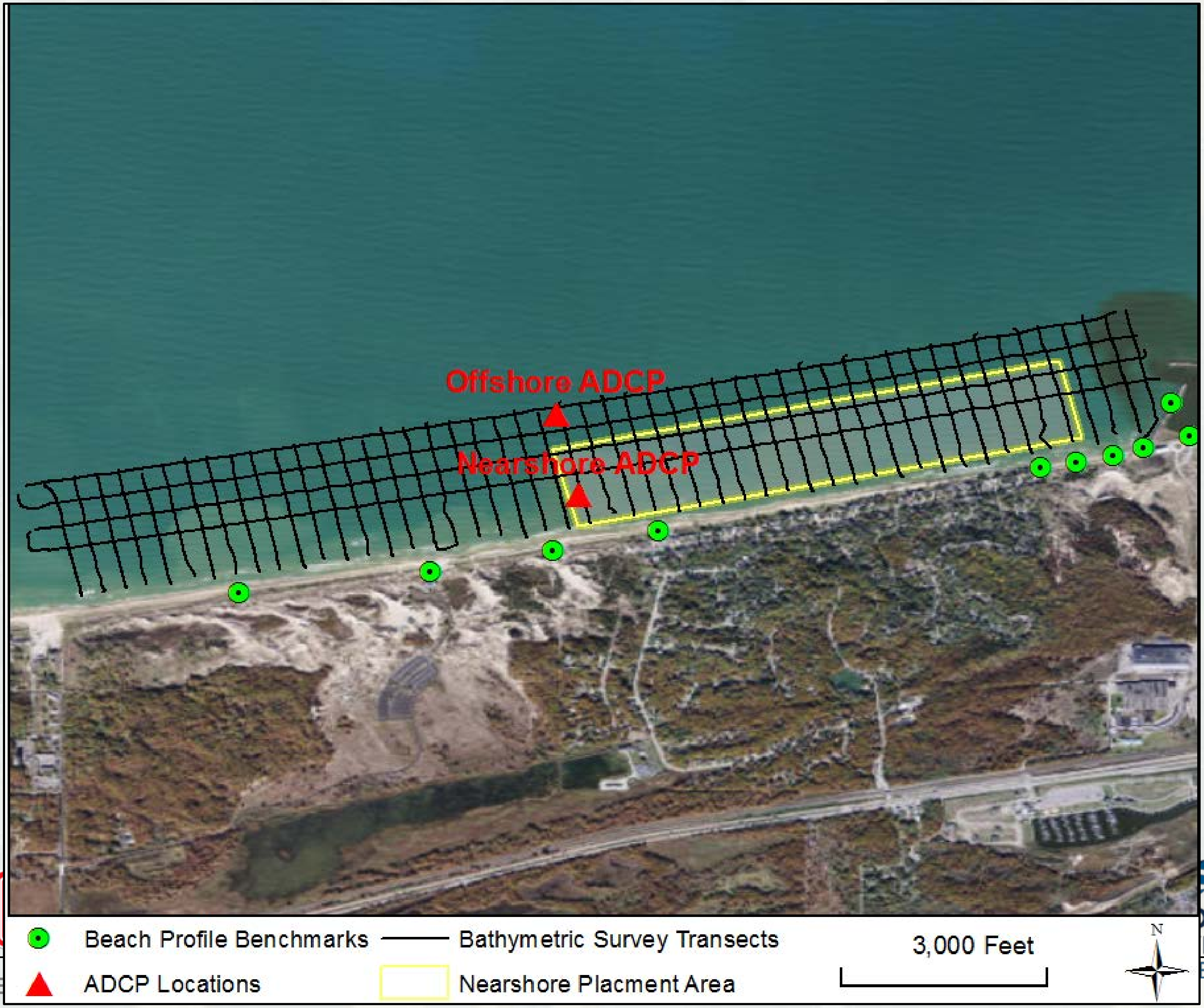
Storm Waves



Shoreline Analysis and Nearshore Placement Techniques

- Overall, accretion along the shoreline due to nearshore placement of sediment is seen
- Exception is immediately adjacent to harbor, likely due to breakwaters
- SMT predicts sediment will move onshore, except during storm events
- Recommendation: place material as shallow as possible in berm like feature

Monitoring Plan



Monitoring Plan

Timeline of data collection

JUNE
June 2: 1st **ADCP** Survey
June 15: Start dredging

JULY
July 15: End dredge placement
July 20: 2nd **ADCP** Survey
July 25: 1st **MBES** Survey

AUGUST - NOVEMBER
Aug 9: Beach Survey
Sept 8: 3rd **ADCP** Survey, 2nd **MBES** Survey**
Oct 11-12: 4th **ADCP** + Beach Survey
Nov 15: 5th **ADCP** Survey

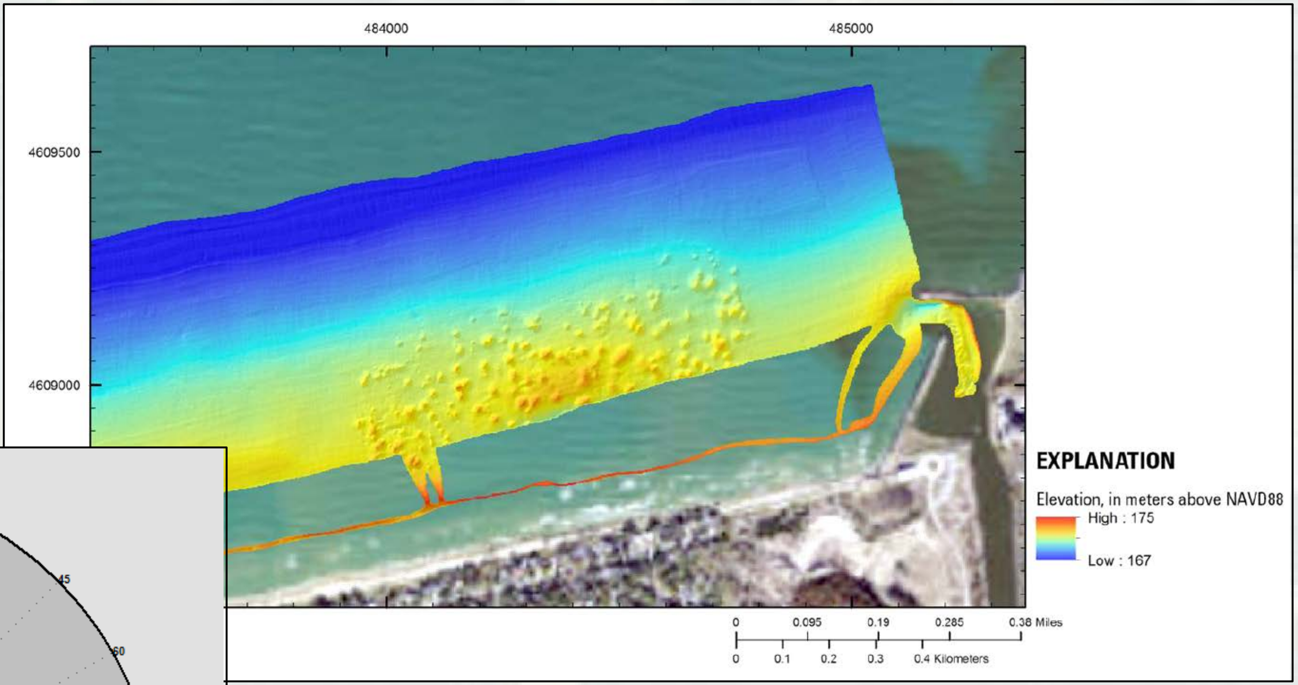
**NIPSCO dredge placement observed

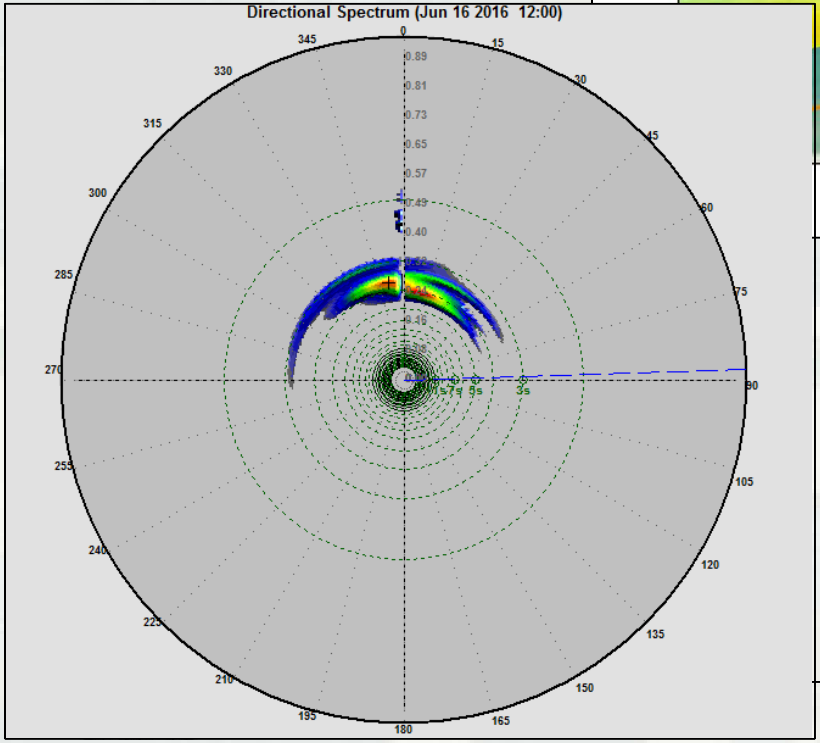
Wave/Current Data: 06/02 – 10/28
2 Uplooking ADCPs measuring waves/currents…only the one in shallower water was recovered


RTK-dGPS beach survey


NIPSCO dredge placement

Initial Data





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Ongoing Research

- Continued processing of data
- Numerical modeling
  - CMS Wave and Flow
  - Particle Tracking Model
- Beach profile changes to calculate shoreline and volume changes
- Calculate wave dissipation across the berm

Questions?