ERDC

Engineer Research and Development Center

Strategic Placement of Dredged Material

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US Army Corps of Engineers®

Outline

- Strategic Placement definition
- Examples of strategic placement practiced by USACE (coastal, riverine, in-bay)
- Examples of strategic placement outside US (coastal, estuarine)
- Example field/laboratory/modeling study for strategic placement site optimization

Strategic Placement

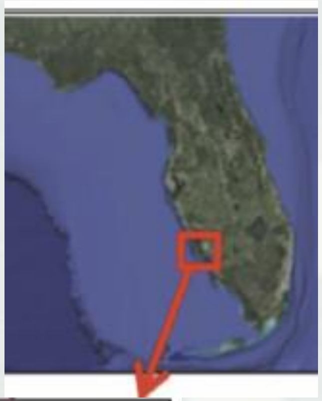
- Direct placement of dredged sediment is used to construct beaches, wetlands, berms, etc.
  - Cost can be high
  - Available dredged sediment may not be compatible
  - Environmental or resource impacts may be high
- Strategic placement is the practice of placing at one location in a water body with the expectation that some fraction of sediment will transport to nearby resources
  - Often lower cost than direct placement
  - Permits natural sorting of sediments
  - Desired sediments transported toward the resource of interest
  - Undesired sediments are moved away from the resource of interest
  - Slower rates of accumulation permit habitat recovery
  - Improved RSM

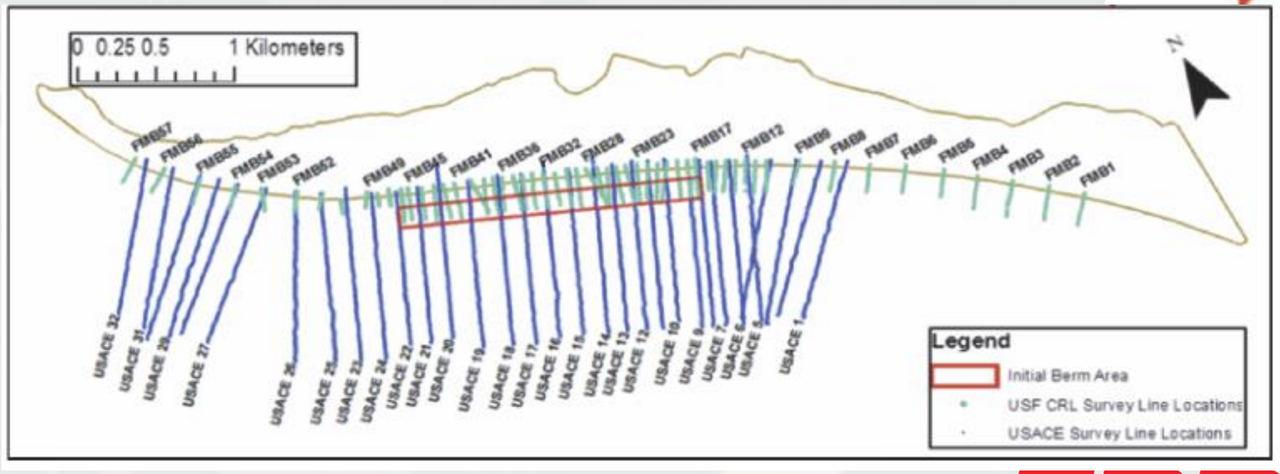
Strategic Placement Examples by USACE

- Fort Myers Beach
- Horseshoe Bend, Atchafalaya River
- Mobile Bay

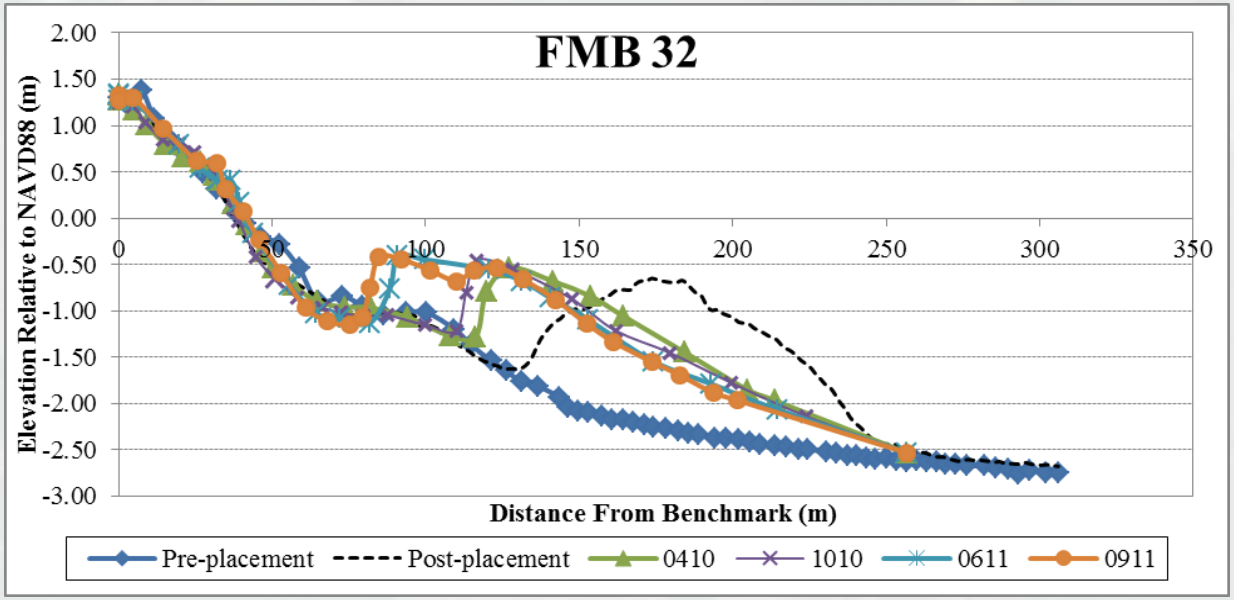
Fort Myers Beach, Florida

- Dredged sediment from nearby Matanzas Pass is not beach quality (16% fines)
- Nearshore placement permits winnowing of fines prior to deposition on the beach
- Placement as an elongated bar in 2009.
- Four year monitoring program (USF)





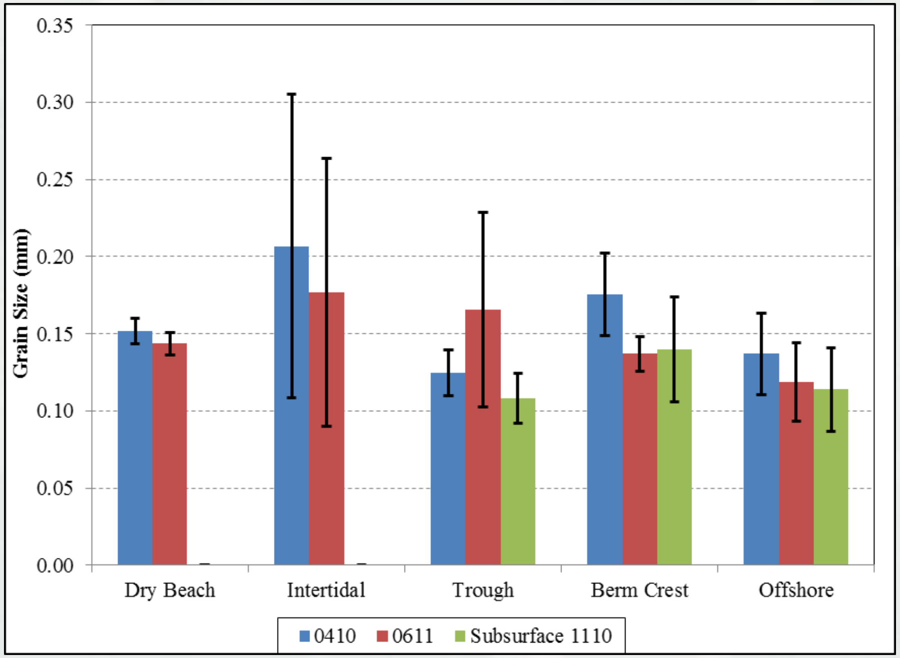
Fort Myers Beach, Florida



Profile during first two years after placement (Brutsche et al, 2014)

- Pre-placement: relatively small dynamic natural bar ~ 150 ft offshore
- Dredged sediment berm 600 ft offshore, 3 ft high, 400 ft wide, 6000 ft long
- Volume of 230,000 cy
- Berm migrated onshore during entire 4-year monitoring period
- Onshore movement more rapid during high-energy winter months
- Berm project area experienced less erosion than control area during storms

Fort Myers Beach, Florida



Spatially averaged cross-shore GSD (Brutsche et al, 2014)

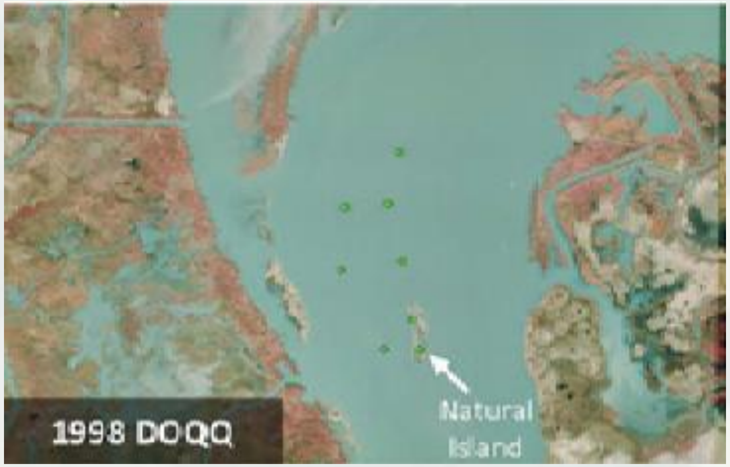
- April 2010: finest material in offshore and trough
- June 2011: trough sediment had coarsened and offshore had become finer, indicating transport of FGS away from beach
- Control area samples indicate that FGS occurs naturally in this region
- GSD of dry beach remained constant during study period

Fort Myers Beach, Florida

- RSM and EWN strategic placement practices (from Brutsché and Pollock 2015)
  - Mixed sediment winnowed by waves and currents to reduce the percent fine content such that it complied with regulatory requirements for beach compatibility
  - The compliant sediment migrated onshore
  - Fine-grained sediment dispersed
  - Future design of nearshore placements can be improved using information gained during this monitoring
  - Nearshore berms provide shore protection from large waves breaking on the berm
  - Sustainable dredged sediment management solution

Horseshoe Bend, Louisiana History

- 1990s: Placement at wetland development sites
- Site capacity filled by 1999
- Alternative placements
  - ► Convert wetland to upland
  - ► Long-distance pipeline to Atchafalaya Bay
  - ► Mounding of material mid-river
- Mid-river placement selected to investigate downriver shoaling
- Began mid-river placement in 2002
- Monitor island development (acreage, habitat, soils, etc…)
- USACE EWN Project, certified by PIANC as a WwN project



From Berkowitz et al, 2015

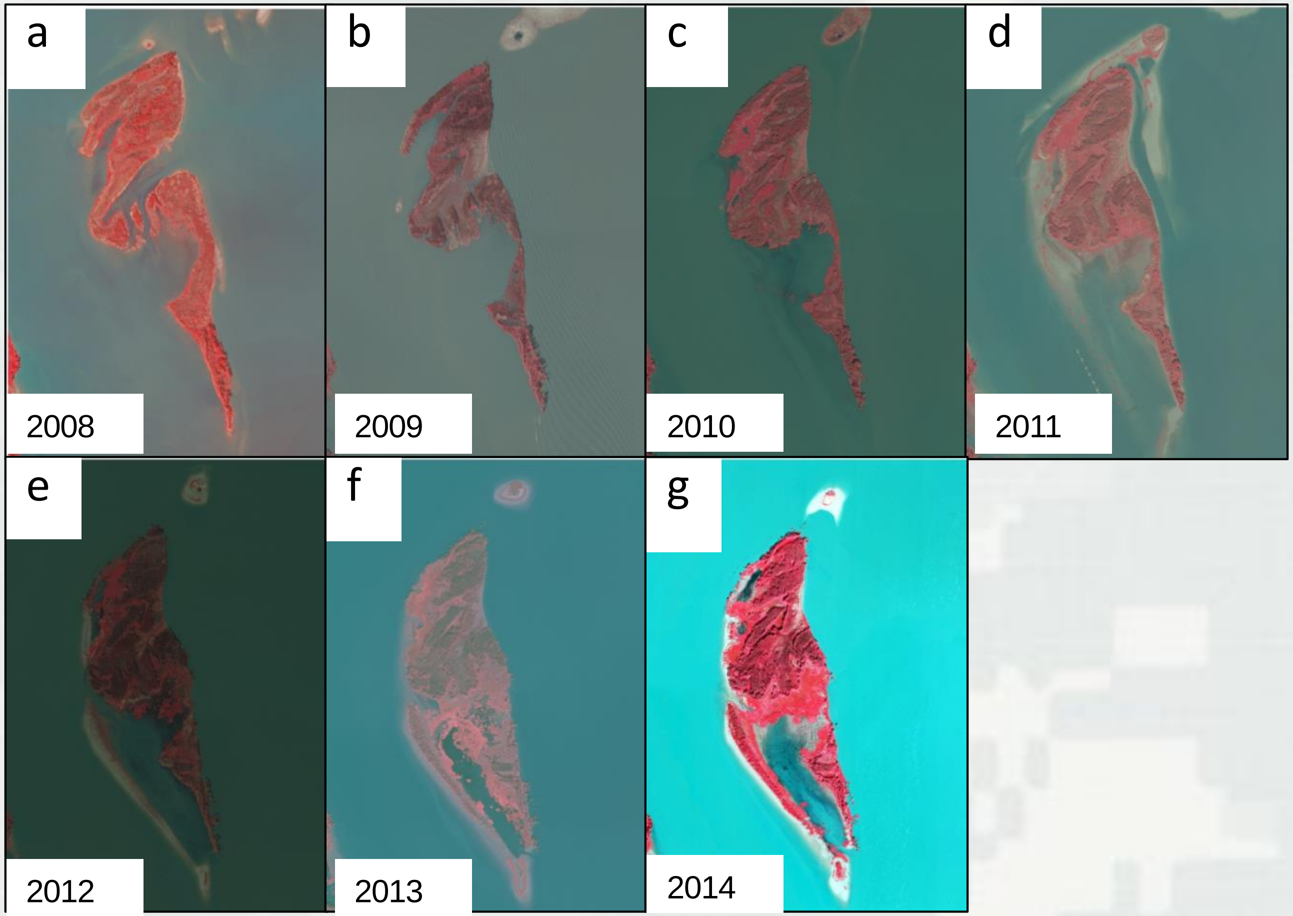
Horseshoe Bend Goals and Objectives

- Understand how and why the island formed
  - ► Hydrology of the river (modeling)
  - ► Island geomorphology
  - ► Sediment transport from placement site to island
  - ► Soil and biogeochemical activity
  - ► Habitat diversity
  - ► Flora and fauna composition
  - ► Aerial photography
  - ► Economic value of strategic placement (future study)
  - ► Suedel et al 2015 Terra et Aqua (140) Sept 2015

Suedel et al, 2015

Horseshoe Bend Goals and Objectives

Evolution of Horseshoe Bend Island



From Suedel et al, 2015

Horseshoe Bend Modeling

Suspended solids transport 01-03 2012 (m^3/m/s)

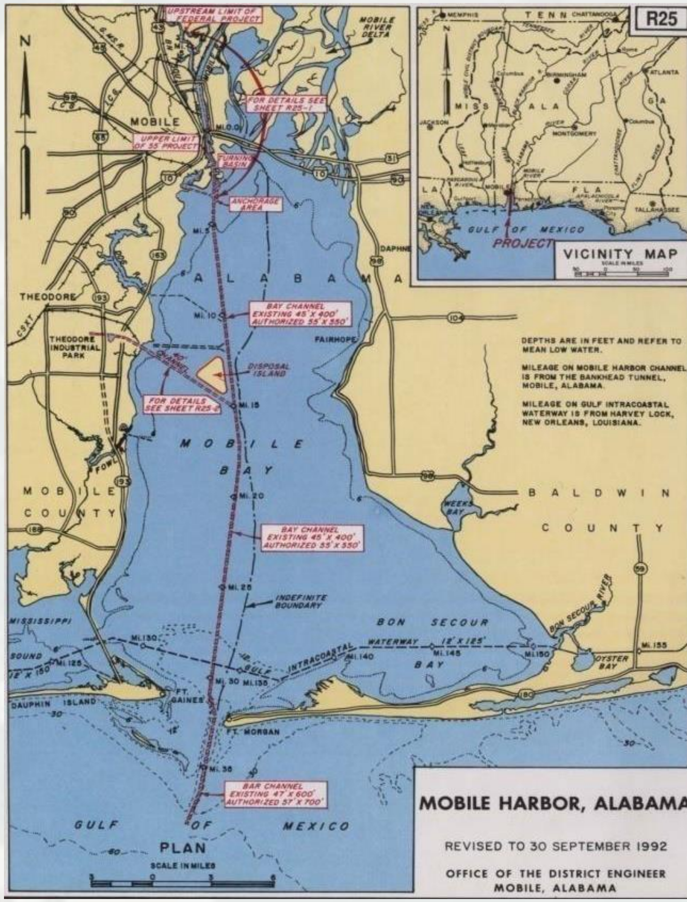
Bedload transport 01-03 2012

From Suedel et al, 2015

- Understand hydrodynamics in channel, at placement site, and at island
- Quantify potential for transport from placement site to island
- Quantify stresses that move sand in the channels
- Evaluate changes to channel infilling

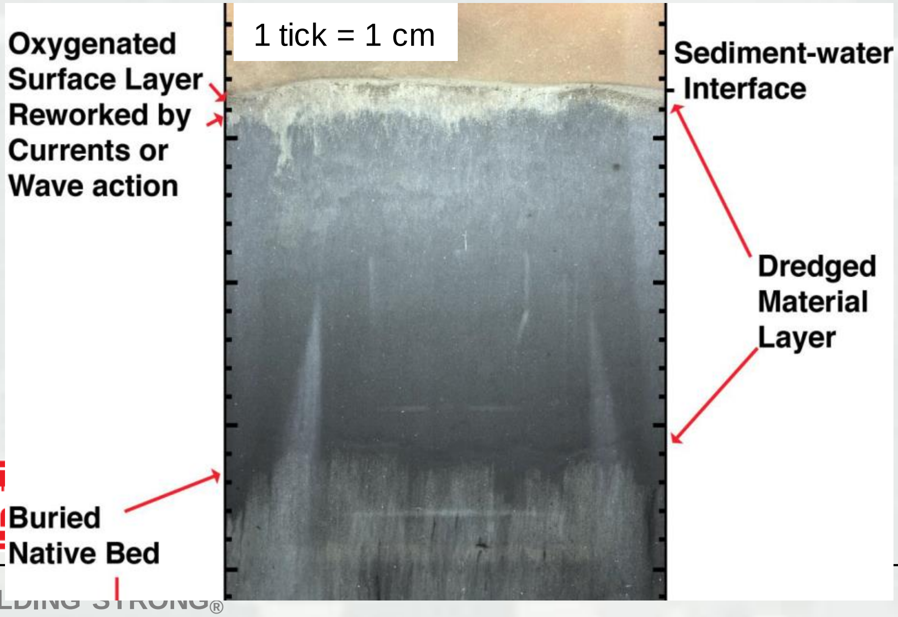
Mobile Bay, Alabama History

- Mobile-Tensaw system is 6th largest river system in US
- Majority of dredged sediment placed in Bay until WRDA 1986
- Post-WRDA, all sediment placed in Gulf to improve Bay "environmental quality"
- ~ 4 Mcy annually transported up to 40 miles to ODMDS
- It has been recognized that the Bay is losing sediment ~ 1.6 Mcy/year (Byrnes et al, 2013)
- 2012 permission for emergency in-bay placement
- 2014 permission for long-term in-bay placement approved



Mobile Bay, Alabama TLP Practice

- Channel-Adjacent thin layer placement only in 2012
- <1 ft placement to permit re-establishment of benthic organisms
- Sediment placement, process and transport studies applied to evaluate placement options



Mobile Bay, Alabama TLP Practice

Average Channel Sedimentation Rates (cy/day)*

Scenario Number	1	2	3	4
	TLP	Sensitivity Sim. 1	Sensitivity Sim. 2	Base Case (No-action)
Typical month	18	46	33	42
Active month	25	61	40	56
Hurricane Gustav	33	75	55	69
Hurricane Ida	30	70	52	64

* Infilling over 80,000 ft of channel

- Fine-grained sediment – model incorporated site-specific data collected for erosion potential
- Model indicates 35% of transported sediment re-enters channel
- Remainder dispersed throughout the bay
- Less channel infilling for placement further from channel

Strategic Placement Examples Outside of US

- Delfland Sand Motor, the Netherlands
- Harwich Haven, England

Delfland Sand Motor History

- Dutch coast is receding
- Dutch government committed to sustaining present coastline
- Addressed with standard beach nourishments every 3-5 years – use offshore borrow sites
- 2011: New strategic placement method tested
- 21.5 Mm^3 parabolic peninsula constructed
  - 2 km wide, protrudes 1 km into ocean
  - Reduce frequency of interruption to habitat caused by 3-5 year cycle of nourishment
- European initiative: Building with Nature

Delfland Sand Motor Objectives

- Feed adjacent beaches for 20 years (approximately 12.4 miles)
- Wind action, wave action and littoral current transport
- Foster natural dune growth
- Knowledge development
- Create habitat and leisure areas

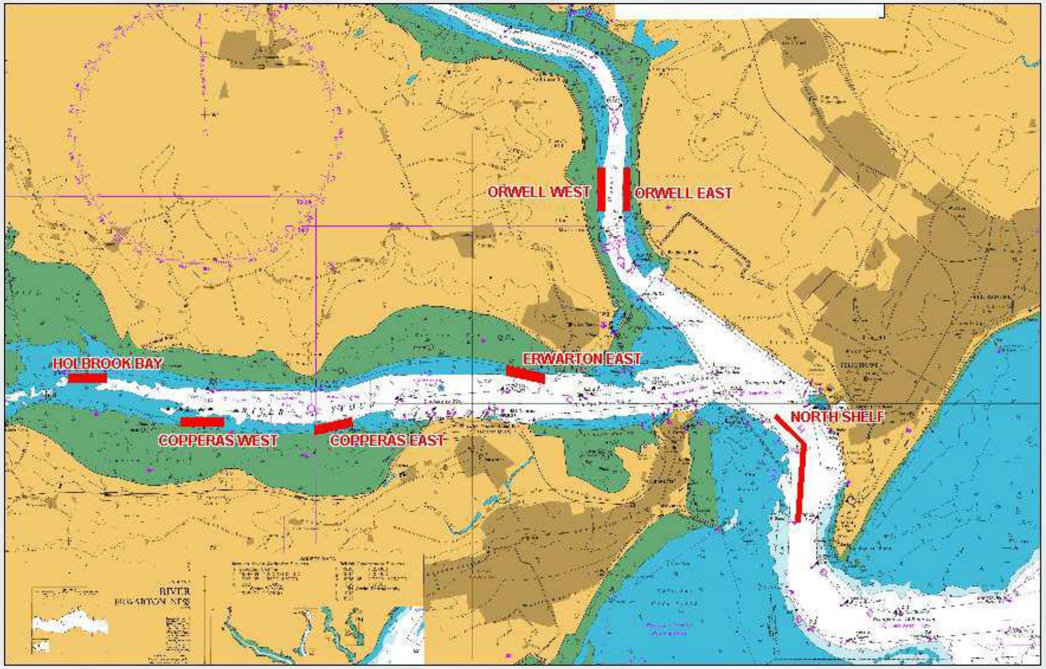
Delfland Sand Motor Monitoring

- Monitor hydrodynamics, waves, morphology, ecology of beach and foreshore, geomorphology of dunes, dune habitat, leisure visitors, and groundwater
- 2013 monitoring
  - 95% of the sand remained in the monitoring area
  - 80% of the sand remained within the original design footprint
- Monitoring supports pre-construction model predictions of 20-year lifespan
- Storms are the major driver of transport
- Habitat recovery (compared to typical beach fill) is inconclusive to date

Harwich Haven, England History

- Harwich Haven on east coast of England
- Tidal range up to 3.5 m
- Channel infilling dominated by fine-grained sediment
- Wetlands adjacent to entrance channel
- 1998 channel deepening predicted to increase wetland recession ~ 2.5 ha/yr
- A combination of wetland construction and innovative strategic placement beneficial use methods applied

Harwich Haven, England Methods



- Direct placement to construct 16.5 ha of wetland
- 8 mm thin layer placement on some saltmarsh
- Strategic placement or “bypassing” of DM
  - ► Subtidal placement of fine-grained DM near wetlands
  - ► Water column recharge nearshore during flood tide
  - ► Increase overflow during flood tide

Harwich Haven, England Methods

- Understand that fine-grained sediment is a resource
- Partially lost to a system by channel infilling
- Appropriate dredge practice can re-introduce some portion of this fine-grained sediment to the sediment starved system
- Dredge practices must reintroduce sediment in a manner where dosing will not overwhelm surrounding resources.

Harwich Haven, England Monitoring

- Fate of fine-grained sediment difficult to monitor
- Estuary wide monitoring program includes:
  - bathymetry
  - benthic invertebrate community
  - saltmarsh vegetation
  - bird count
  - fisheries
  - suspended sediment concentrations and intertidal deposition
- Modeling exercises applied to assess remediation options
- Adaptive management plan enacted
- Advisory group developed which can modify strategies

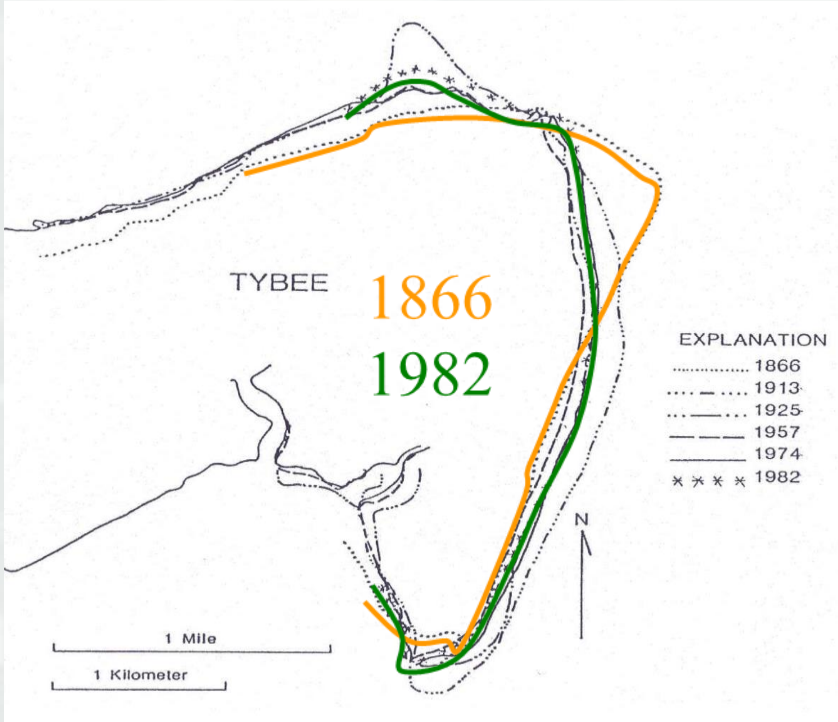
Example Field/Laboratory/Modeling Study for Site Optimization

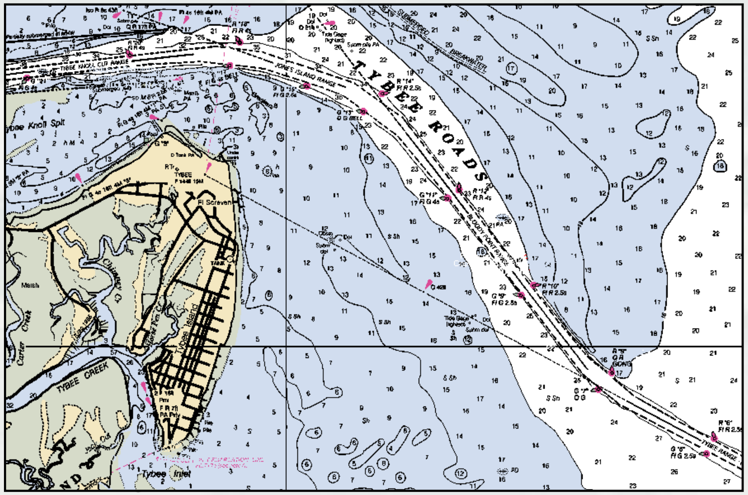
Shrestha et al (2014)

Strategic Placement at Savannah River/Tybee Island:

Example Field/Laboratory/Modeling Study

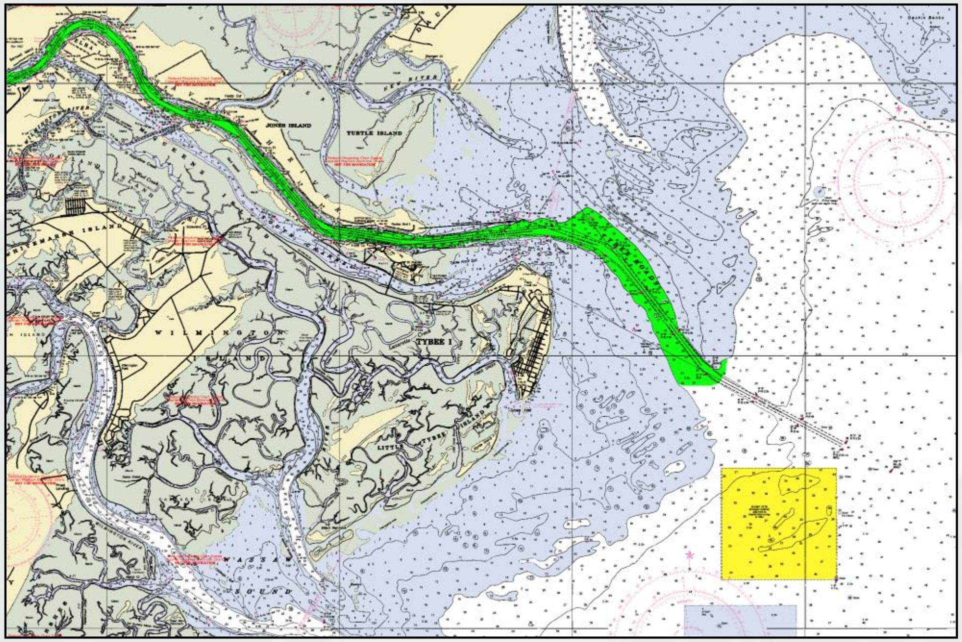
- Evolving ebb shoal complex and beach erosion problem downdrift of the entrance (on Tybee Island)
- Shore protection projects to address the recession
- High sand loss rate on north Tybee, adjacent to the inlet





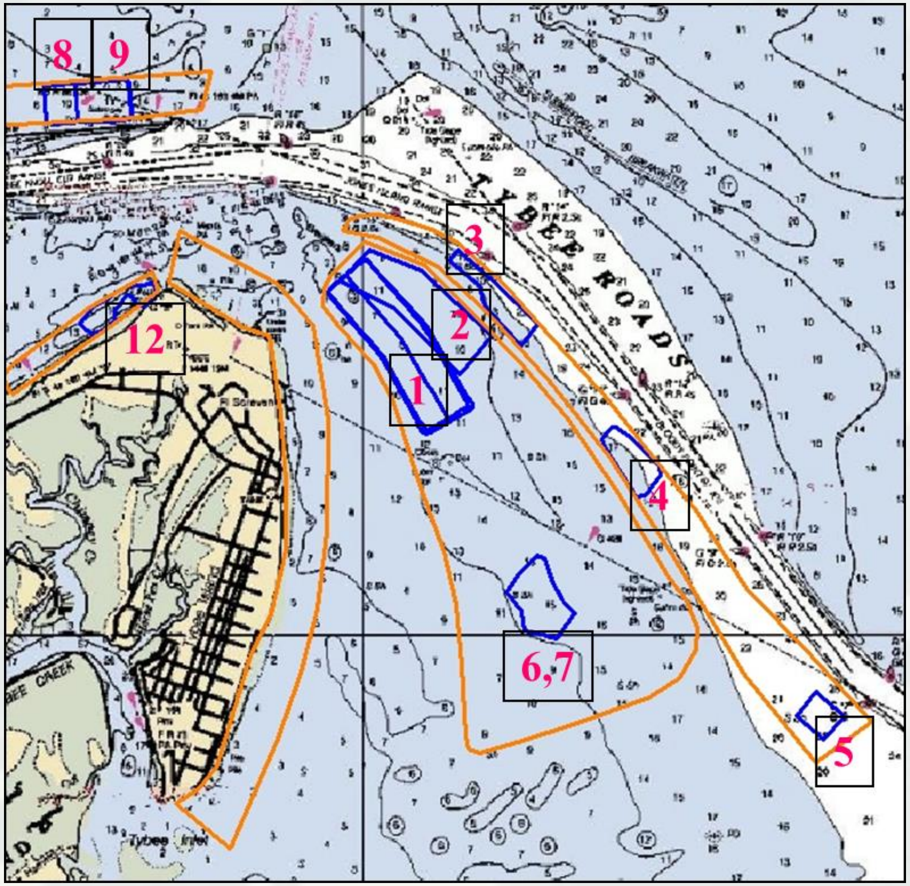
Strategic Placement Issues

- **Benefits to Tybee Island littoral system?**
- **Any negative impacts to Tybee Island shoreline?**
- **Minimize sediment rehandling**
- **Nearshore turbidity**
- **Identify optimal placement locations and orientation**



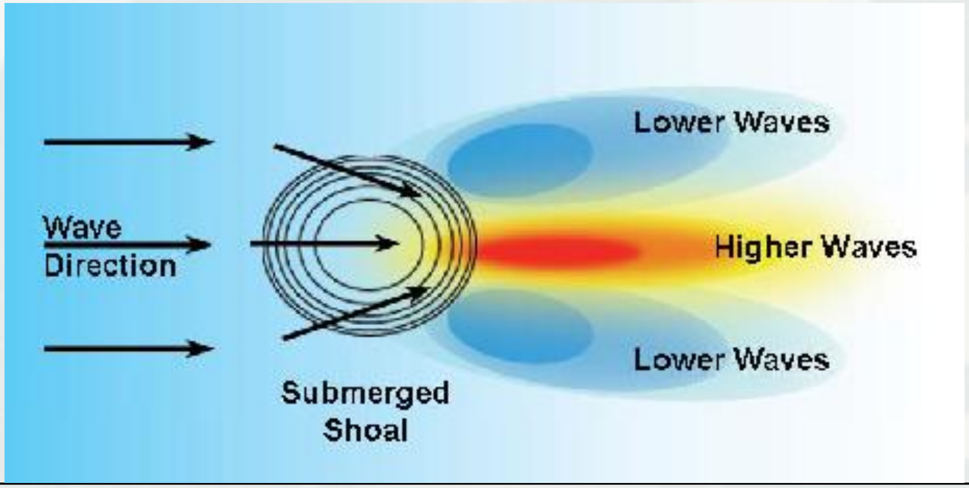
Strategic Placement Study Process

- Coordinate field, laboratory and modeling studies
- Evaluate hydrodynamic and wave conditions for both storms and tides
- Evaluate sediment transport pathways
- Develop alternatives
- Assess benefits and impacts of each alternative



Strategic Placement Modeling

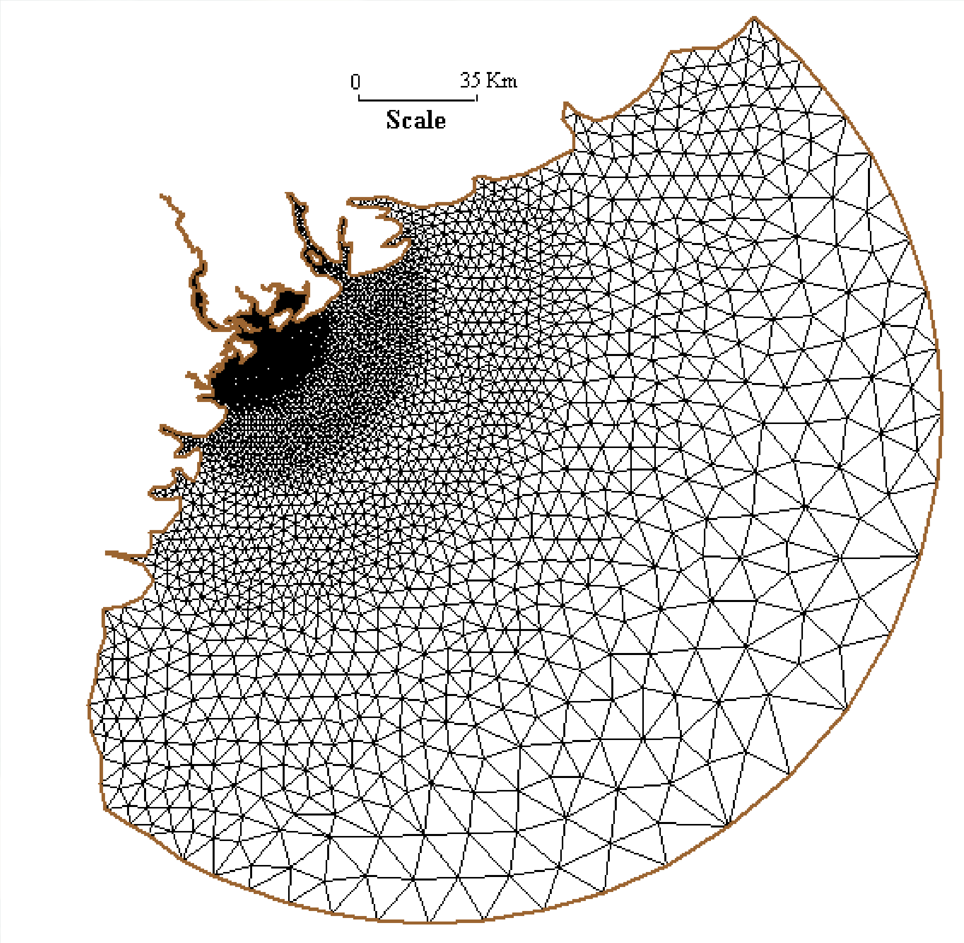
- **Must assess multiple placement options –need strategy for rapid evaluation of alternatives**
- **Models applied**
  - **Circulation (ADCIRC)**
  - **Wave Transformation (STWAVE)**
  - **Sediment transport pathways (GTRAN)**
  - **Shoreline evolution (GENESIS)**



Strategic Placement Modeling

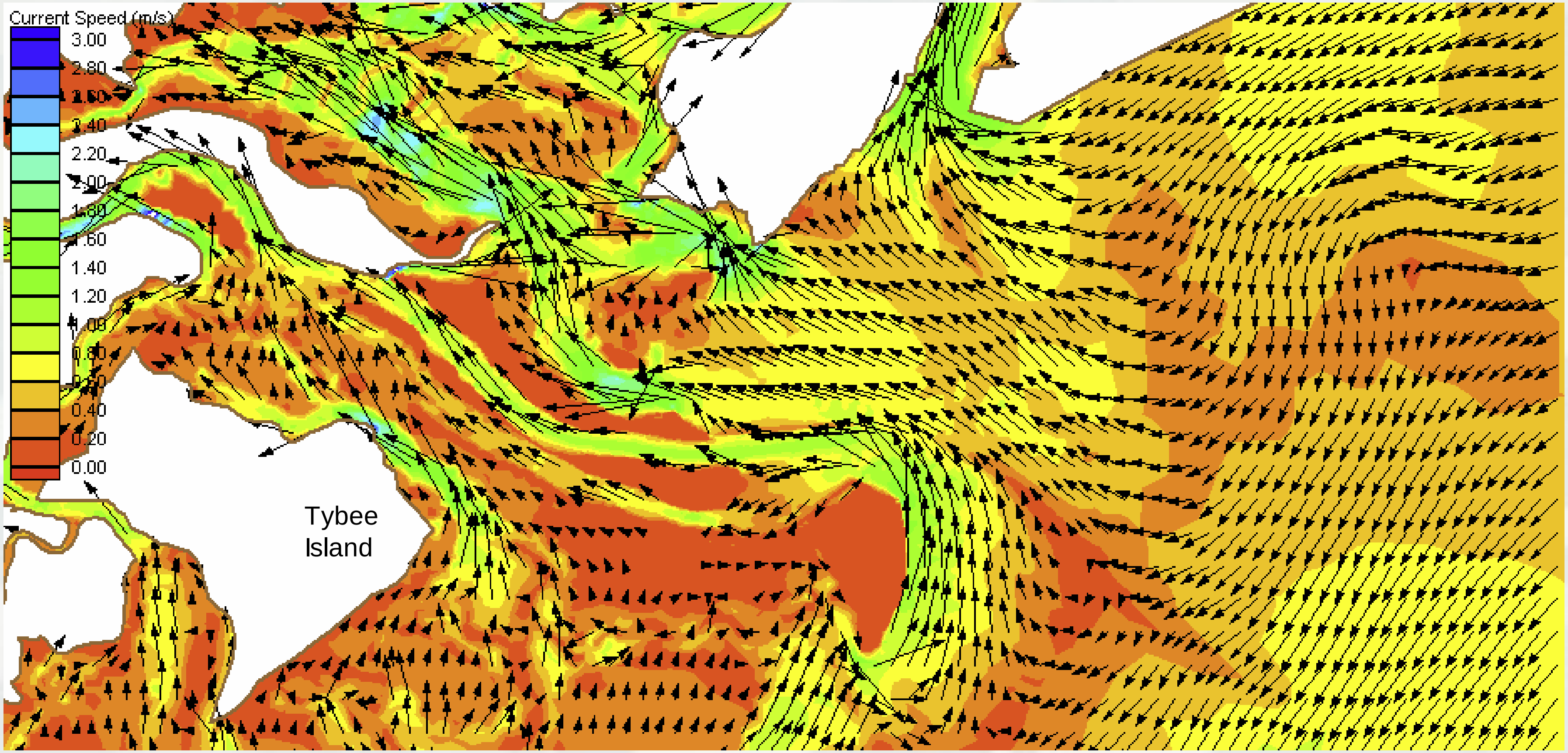
Circulation

- **Regional ADCIRC Model refined for entrance channel**
- **Model tides and storms**
- **2-D model for currents and water levels**
- **Compare to hydro data where possible (currents, elevation)**



Strategic Placement Modeling

Circulation

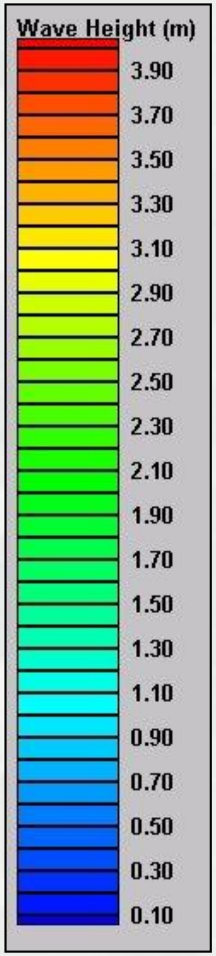


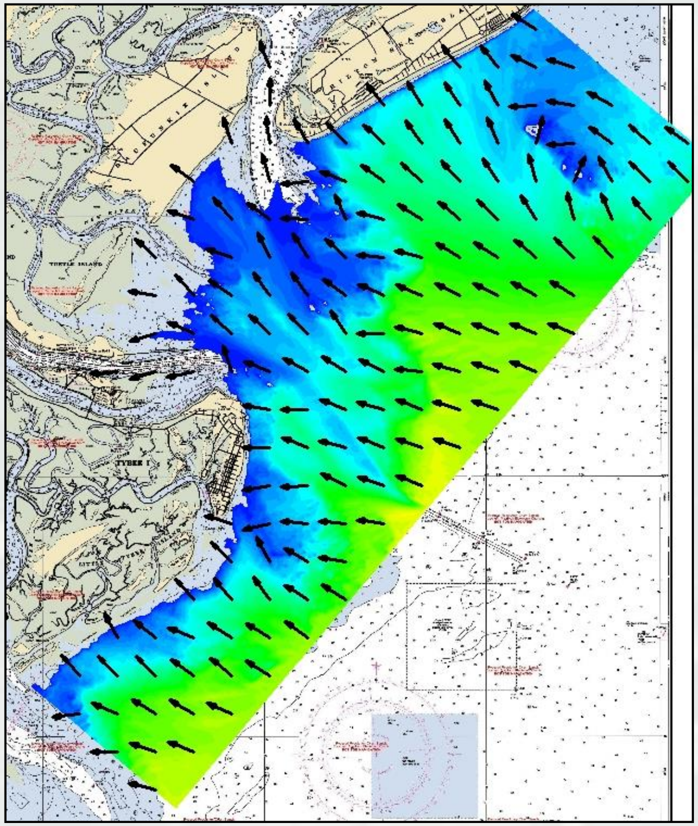
Circulation pattern during peak water level

Strategic Placement Modeling

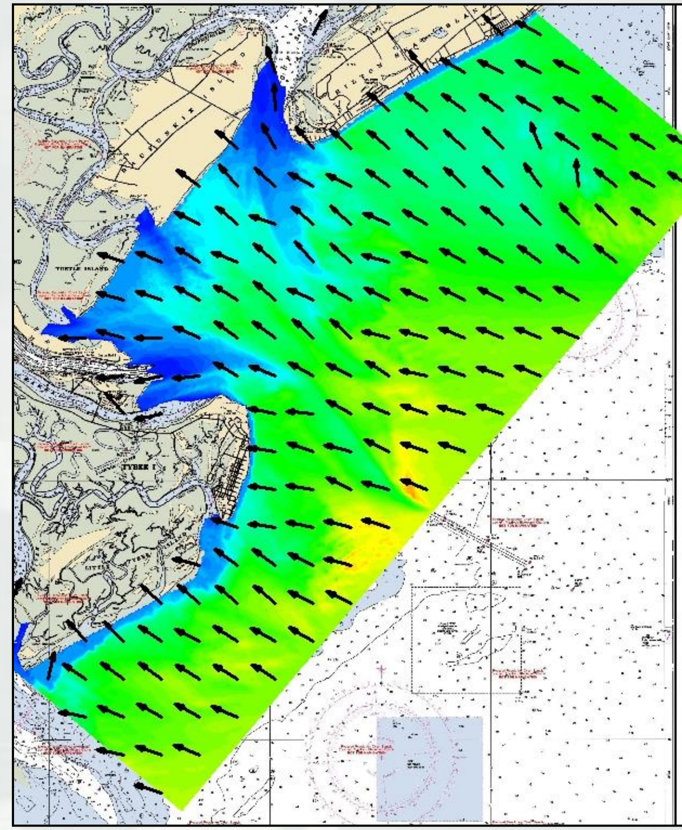
Waves

Large tide range has an pronounced effect on nearshore wave conditions at a particular placement site





Low Tide



High Tide

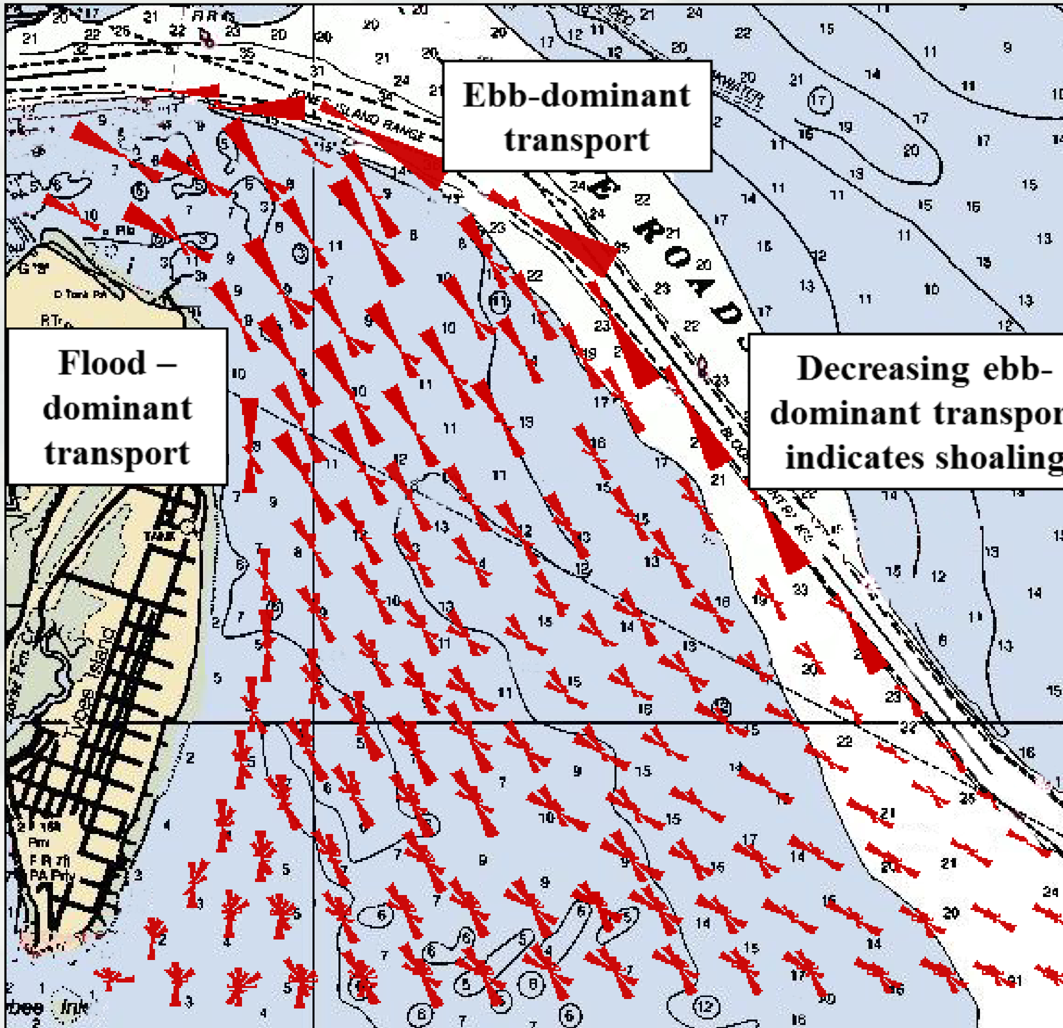
Strategic Placement Modeling

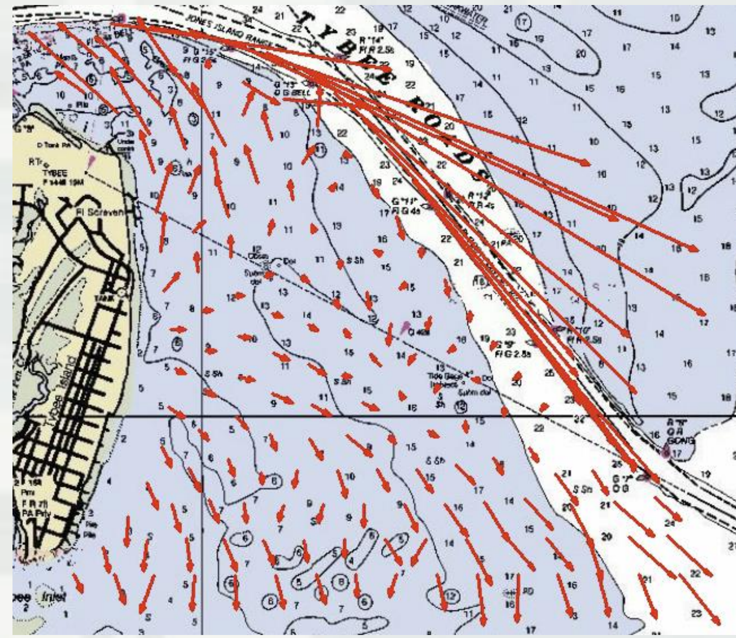
Sediment Transport Pathways

- GTRAN is a numerical tool to estimate sand transport potential under combined waves and currents
- Not a morphologic sediment transport model
- Applied over a distribution of points in a region
- GTRAN indicates sediment pathways and trends
- User input includes hydrodynamic solution (waves and currents) and grain size data
- Computationally efficient: long-term simulations feasible for multiple scenarios
- Applied to base case and each mound scenario

Strategic Placement Modeling

Sediment Transport Pathways



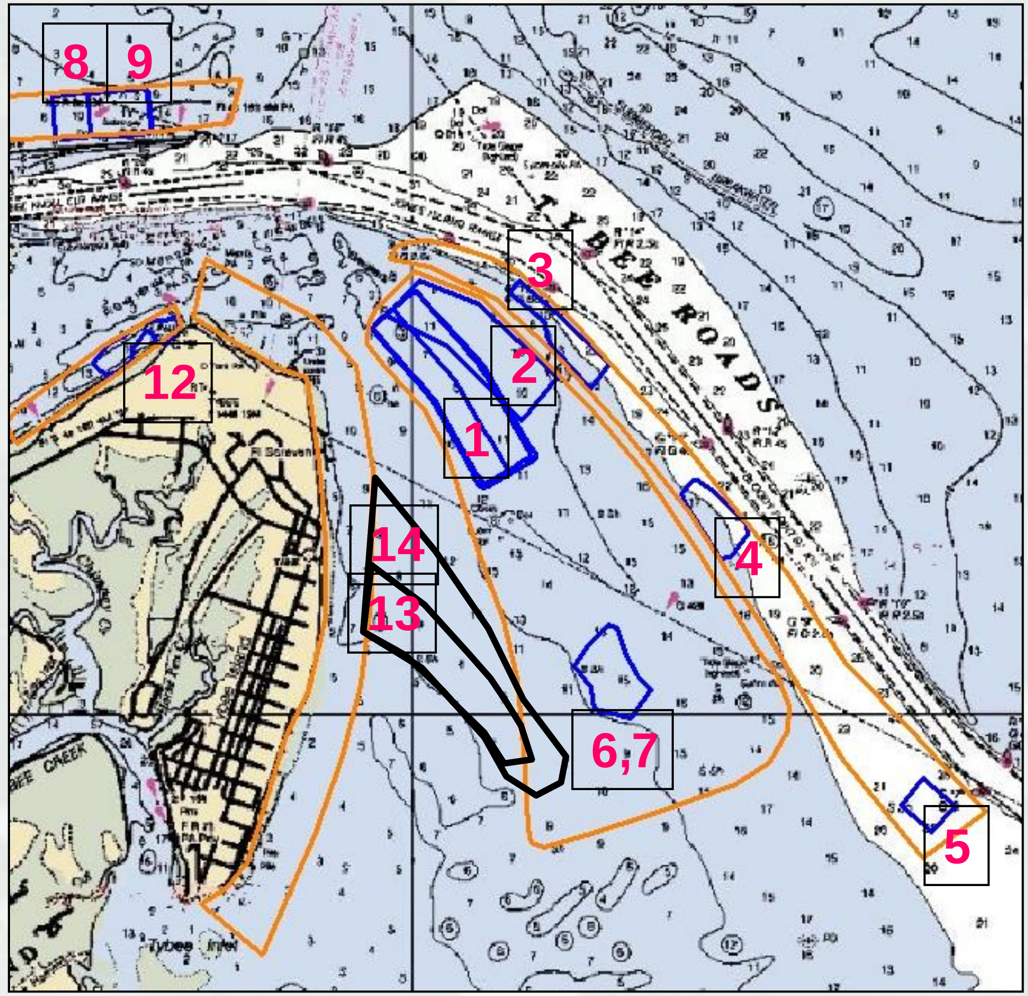


Strategic Placement Modeling

Sediment Transport Pathways

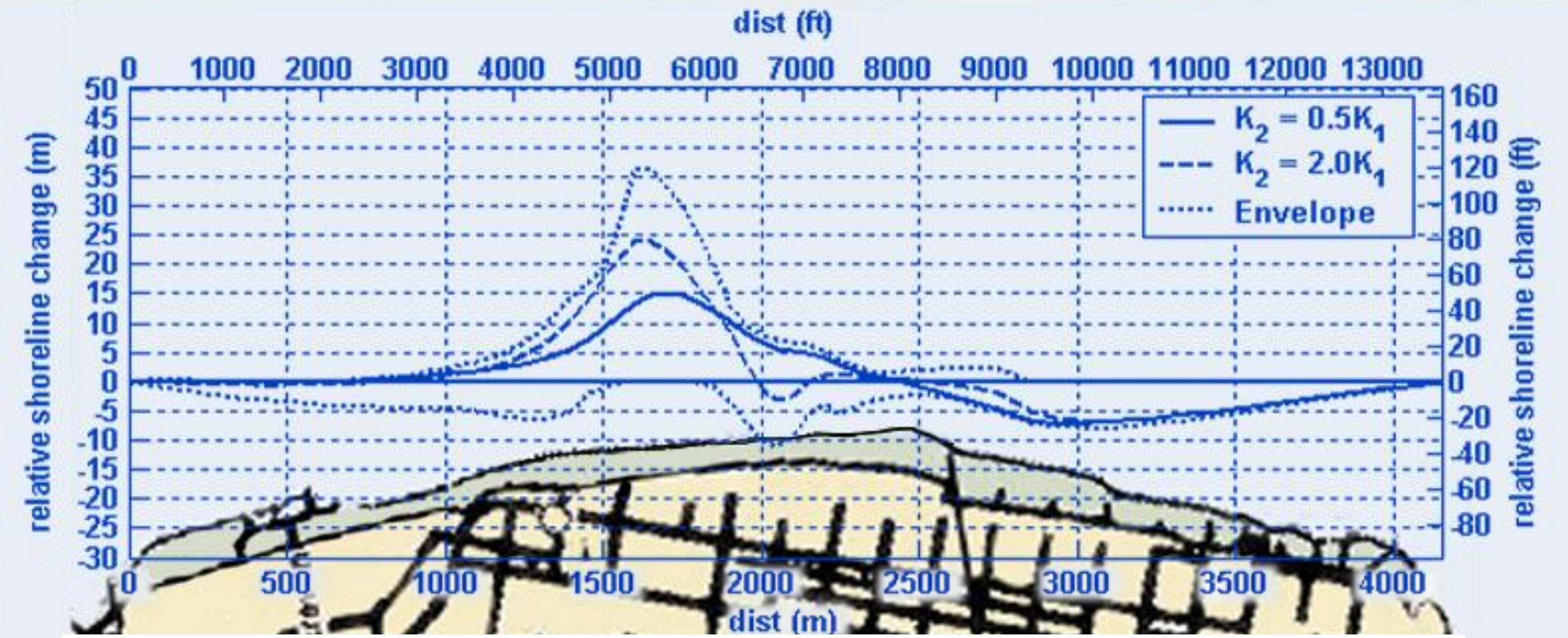
Crest Elevation (MLLW)

Berm 01: -2.1 m
Berm 02: -2.1 m
Berm 03: -3.0 m
Berm 04: -4.0 m
Berm 05: -4.0 m
Berm 06: -3.5 m
Berm 07: -2.5 m
Berm 08: -1.5 m
Berm 09: -2.5 m
Berm 12: -3.0 m
Berm 13: -2.0 m
Berm 14: -2.0 m



Strategic Placement Modeling

Shoreline Evolution Modeling

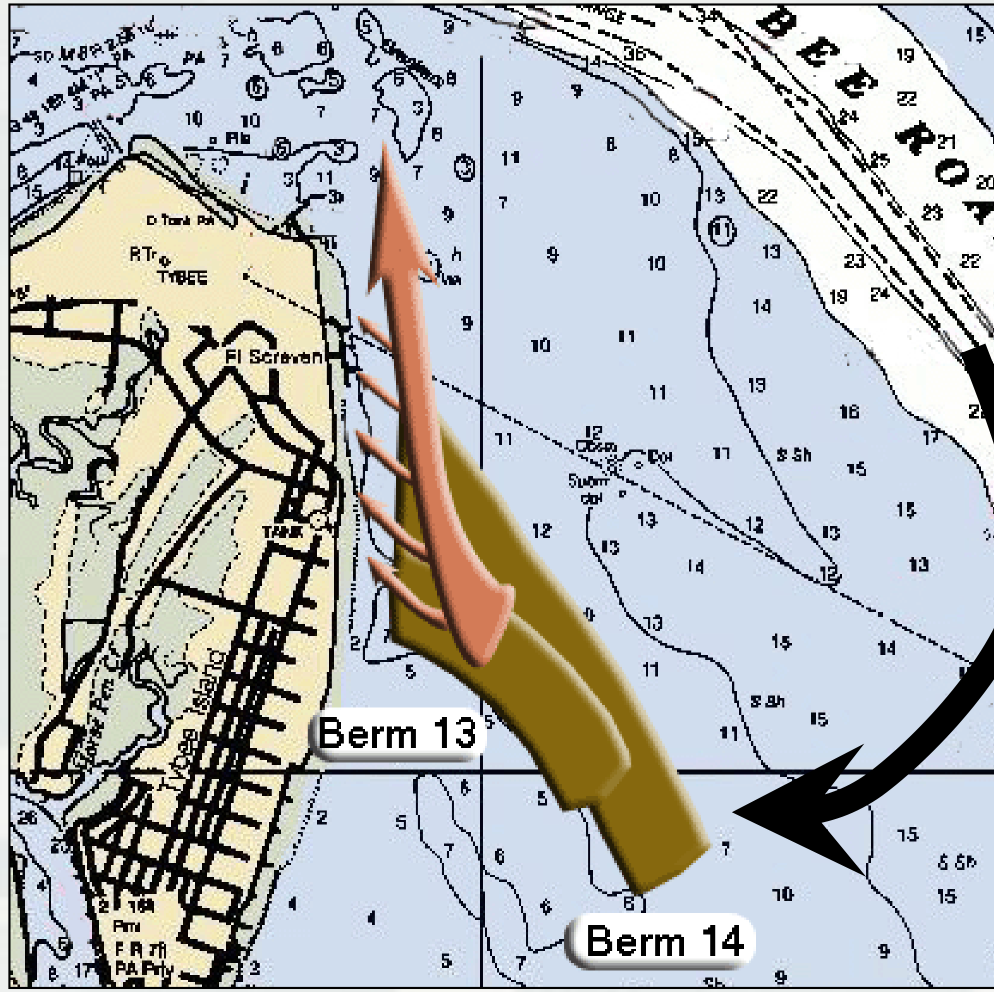


- GENESIS: Evaluate the impact of mounds on wave refraction, longshore transport, and shoreline change
- 20 year simulation (4150 m total length, 50 m resolution)
- Relative change in shoreline between base case and Mound 13

Strategic Placement Modeling

Sediment Transport Pathways

- **Place mixed sediment into berms 13/14**
- **Allow natural winnowing to remove FGS**
- **Longshore transport patterns will move sediment to north Tybee littoral zone**



Strategic Placement Conclusions

- Placement studies for mixed-sediments require interconnected laboratory, field, and numerical analysis
- Offshore or along-channel adjacent placement will not benefit Tybee shoreline
- Berms placed closer to shore more likely to provide sand to Tybee shoreline and nearshore platform
- Nearshore berm location is critical in maximizing nourishment and minimizing rehandling
- Berm location may affect shoreline evolution
- Strategic placement supports broader USACE RSM/EWN goals

Questions?

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