MORPHOLOGY CHANGE MODELING FOR CRAB BANK, SOUTH CAROLINA, USING THE COASTAL MODELING SYSTEM (CMS)

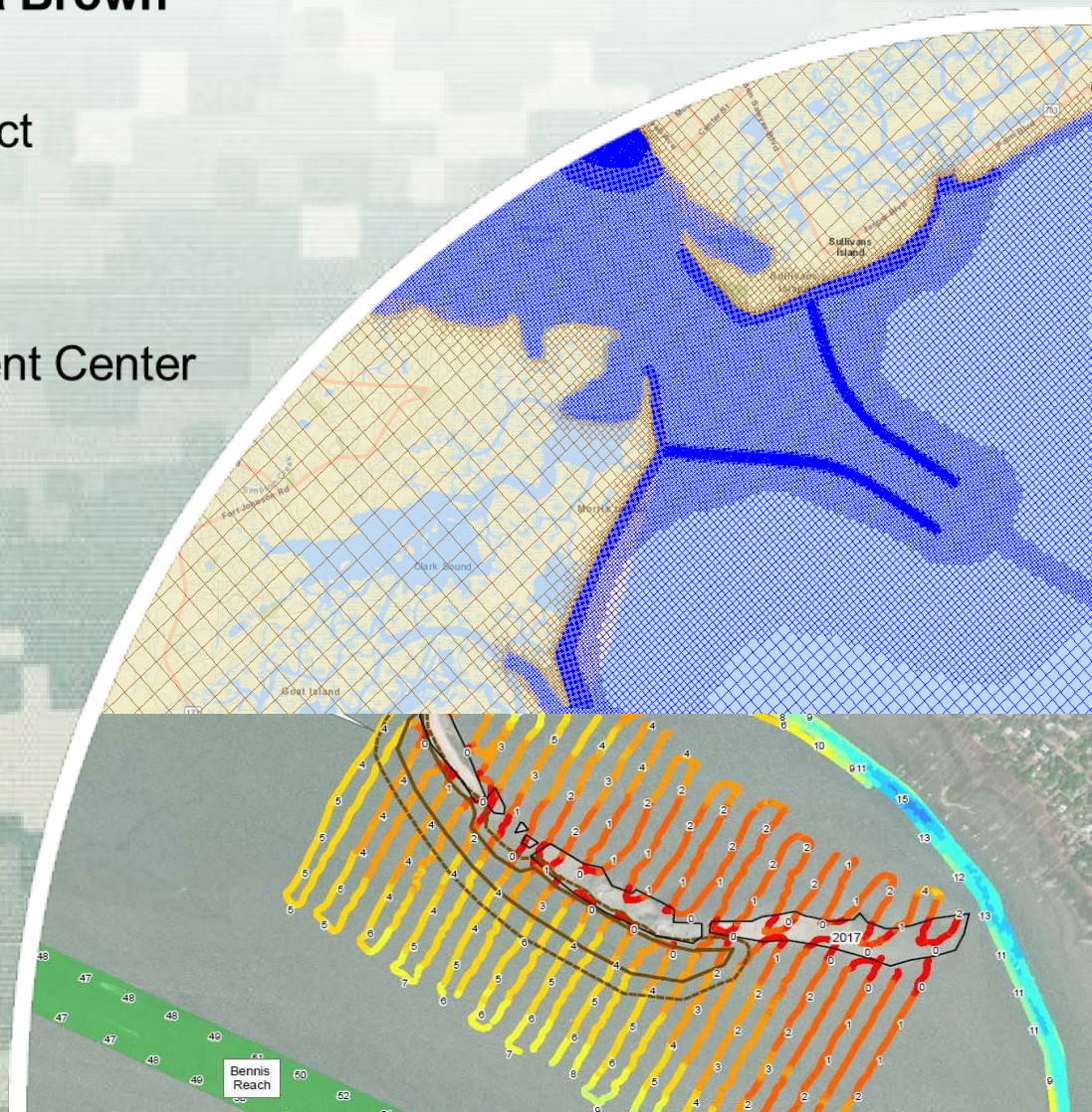
Alison Sleath Grzegorzewski; Sara Brown

U.S. Army Corps of Engineers
Charleston District; Wilmington District

Honghai Li

Coastal and Hydraulics Laboratory
U.S. Army Research and Development Center

CIRP Technical Discussion
30 July 2019
ERDC-CHL

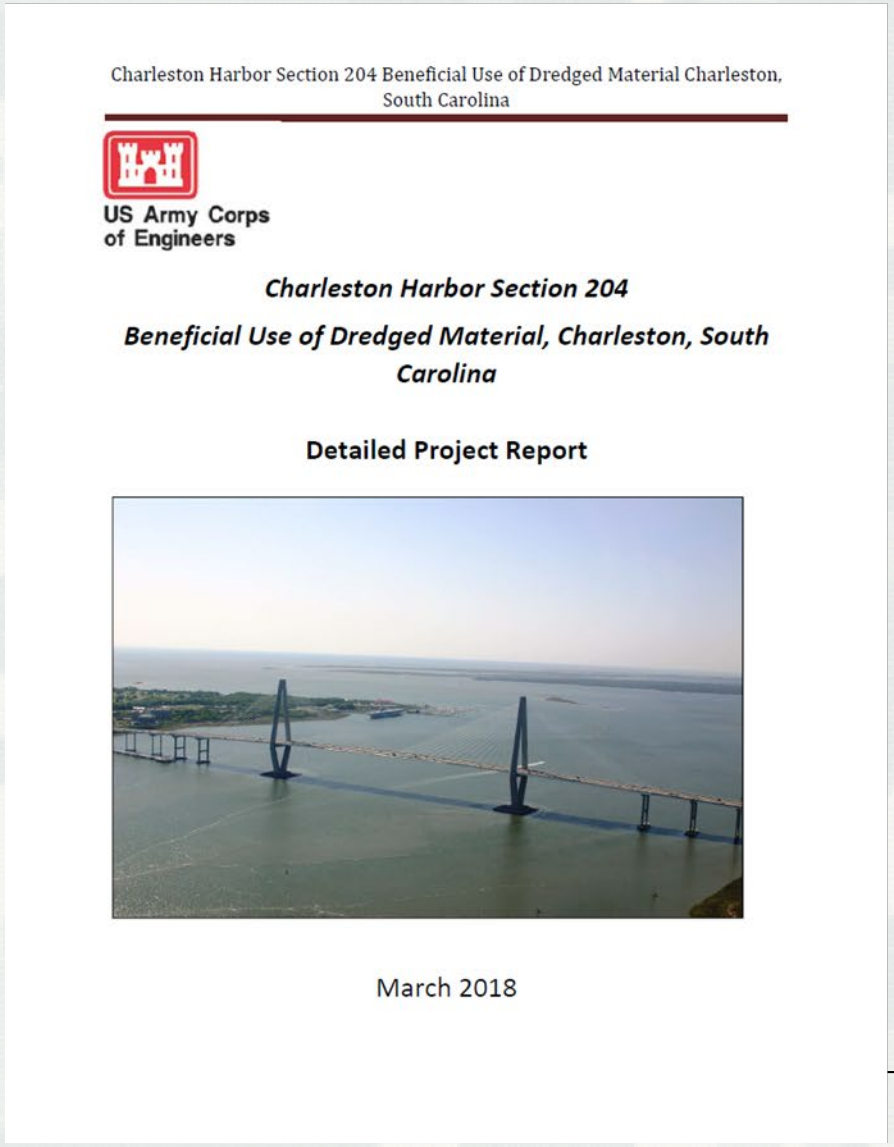


US Army Corps of Engineers
BUILDING STRONG®

Outline

- Background
- Charleston Harbor Section 204 CAP Study
  - ✓ USACE Plan
- Historical Trends
- Long-Term Migration and Concerns
- Numerical Modeling Method (CMS)
- Results – Morphology Changes
- Summary

Background


Charleston Harbor Section 204 Beneficial Use of Dredged Material Charleston, South Carolina

US Army Corps of Engineers

Charleston Harbor Section 204

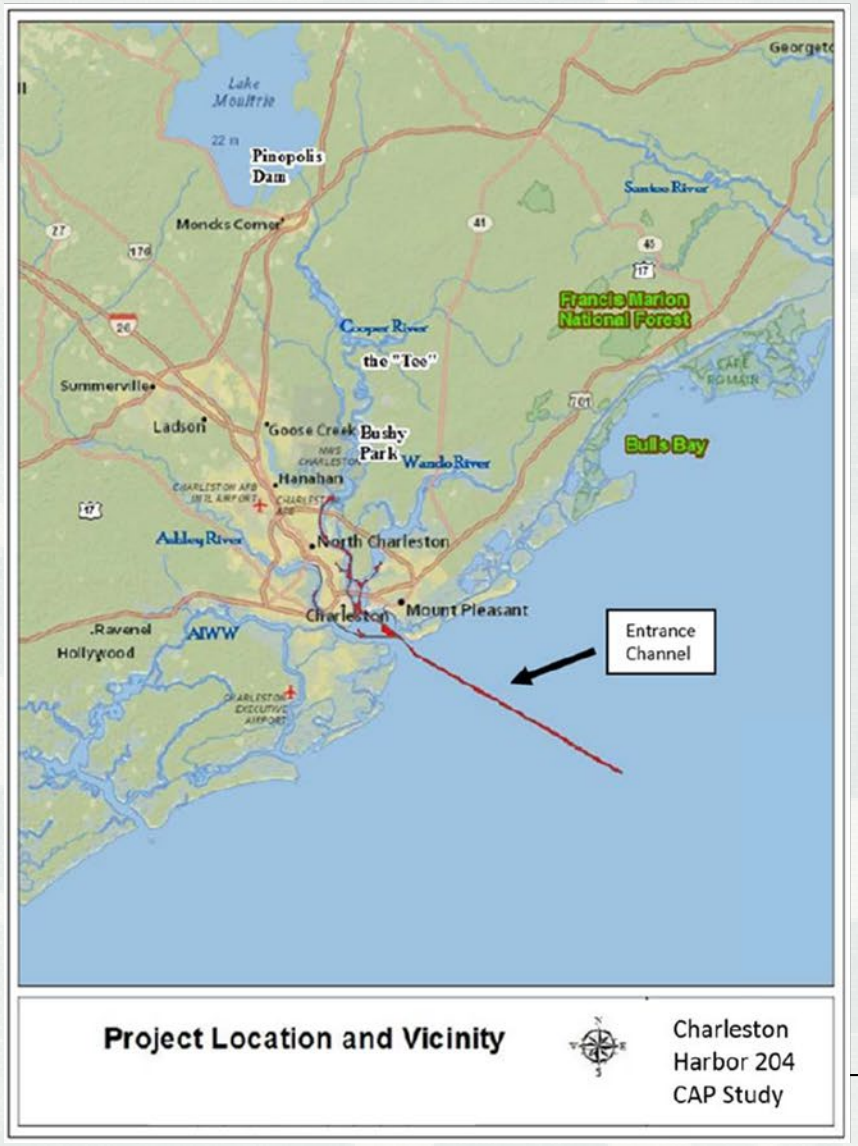
Beneficial Use of Dredged Material, Charleston, South Carolina

Detailed Project Report

March 2018

- Section 204 Detailed Project report presents the evaluation of beneficial uses for dredged material resulting from the planned deepening of the federal channel in Charleston Harbor.
- Normal Operations & Maintenance (O&M) annually removes ~1 Million CY material in the lower reaches of the harbors; predicted 50% increase in the O&M material that will be dredged.
- Over 30 measures initially screened and eliminated; 25 measures were evaluated as part of this study.
- Result: The most cost effective beneficial use of the new material is to enlarge Crab Bank and provide new avian habitat.

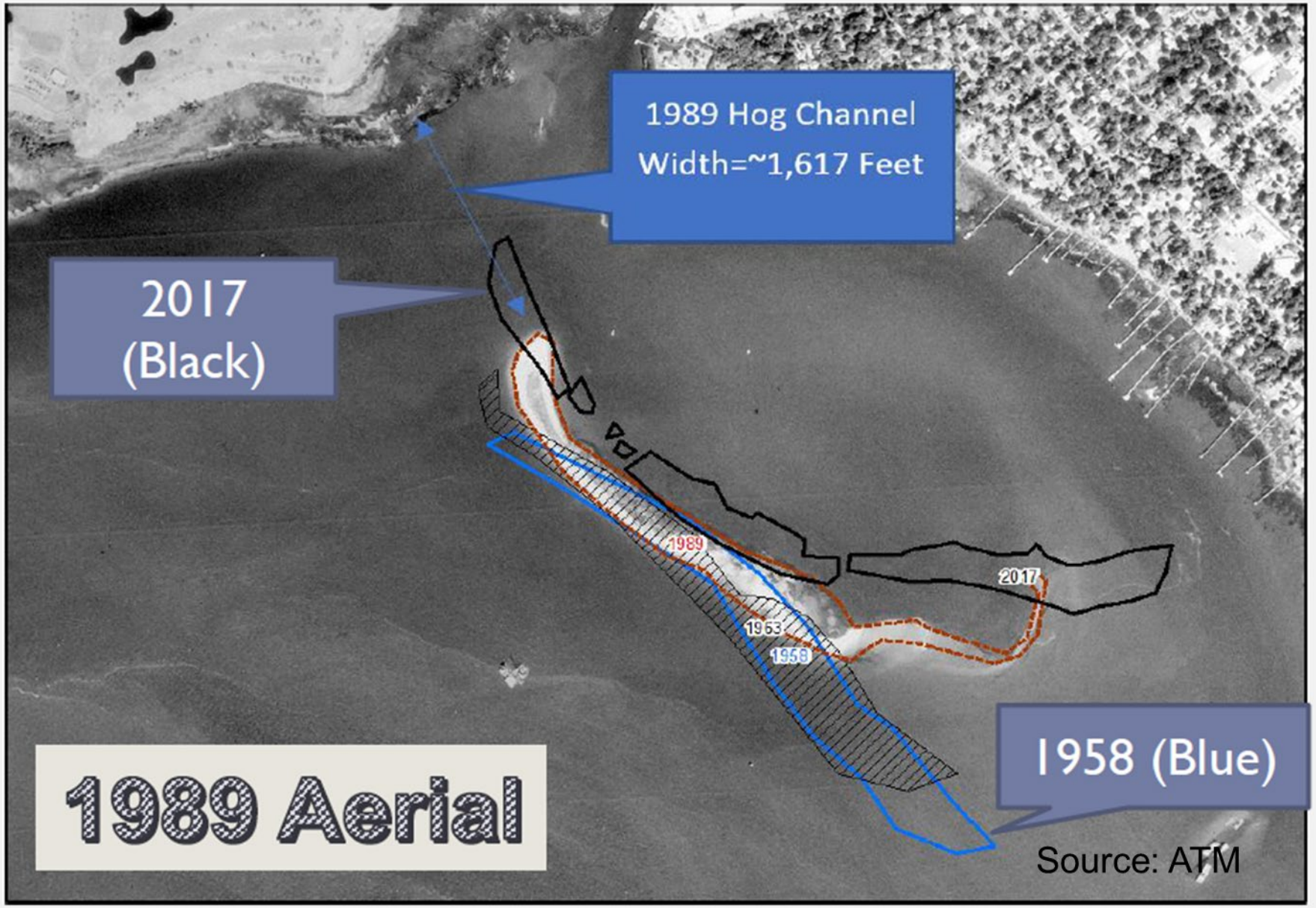
Charleston Harbor Section 204 CAP



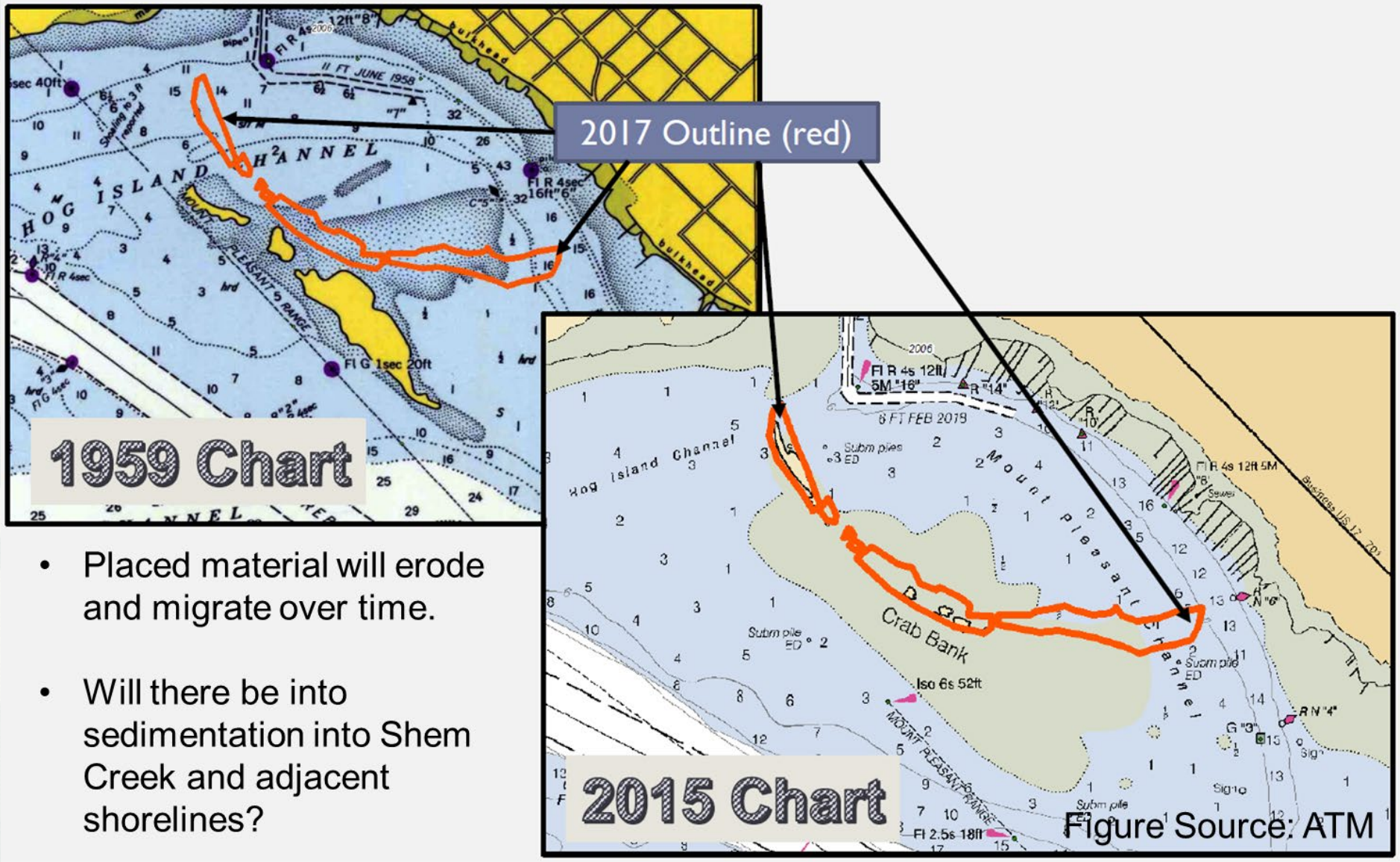
USACE Plan

- ~825,000 CY total added material
- 660,000 CY of sandy material to enhance Crab Bank
- Dredged from Federal Navigation Channel (Post-45 Project)

Historical Trends



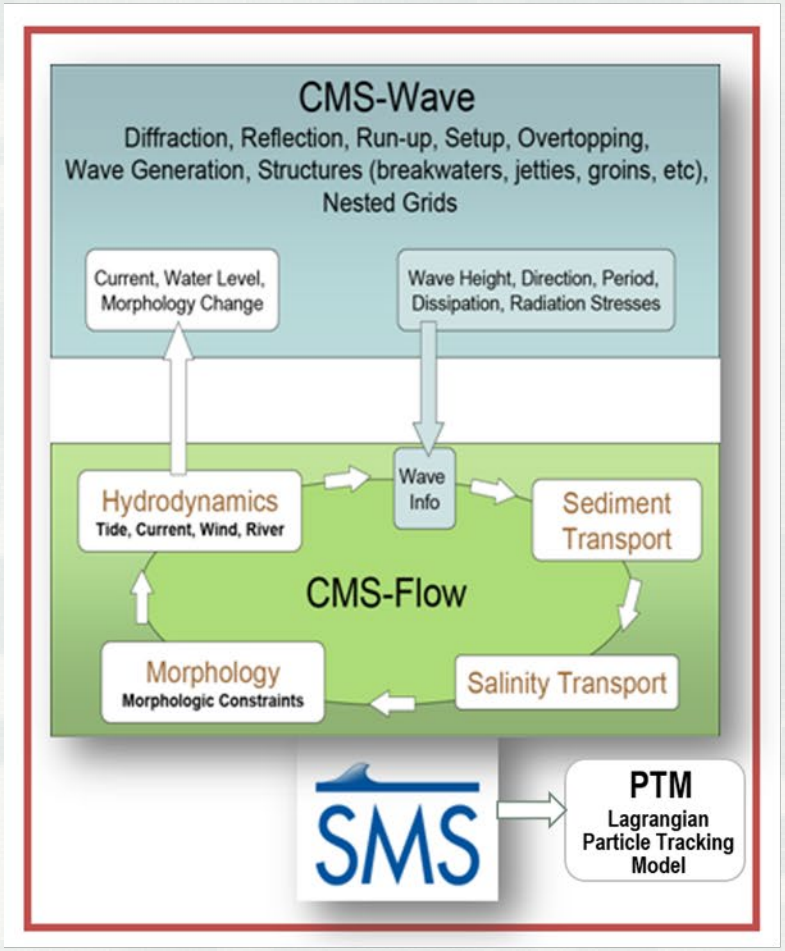
Long-Term Migration and Concerns



- Placed material will erode and migrate over time.
- Will there be into sedimentation into Shem Creek and adjacent shorelines?

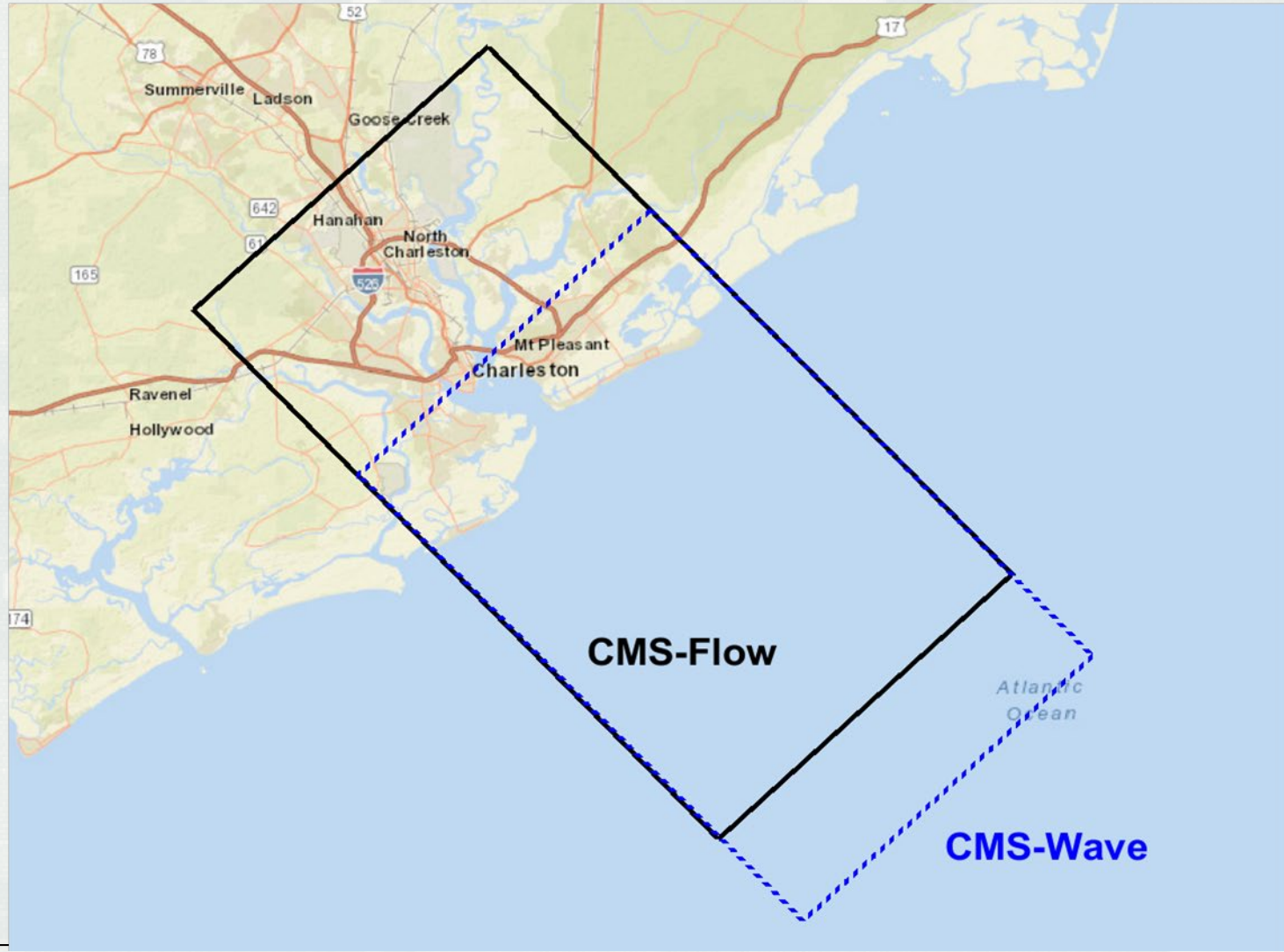
Figure Source: ATM

Numerical Modeling Method (CMS)

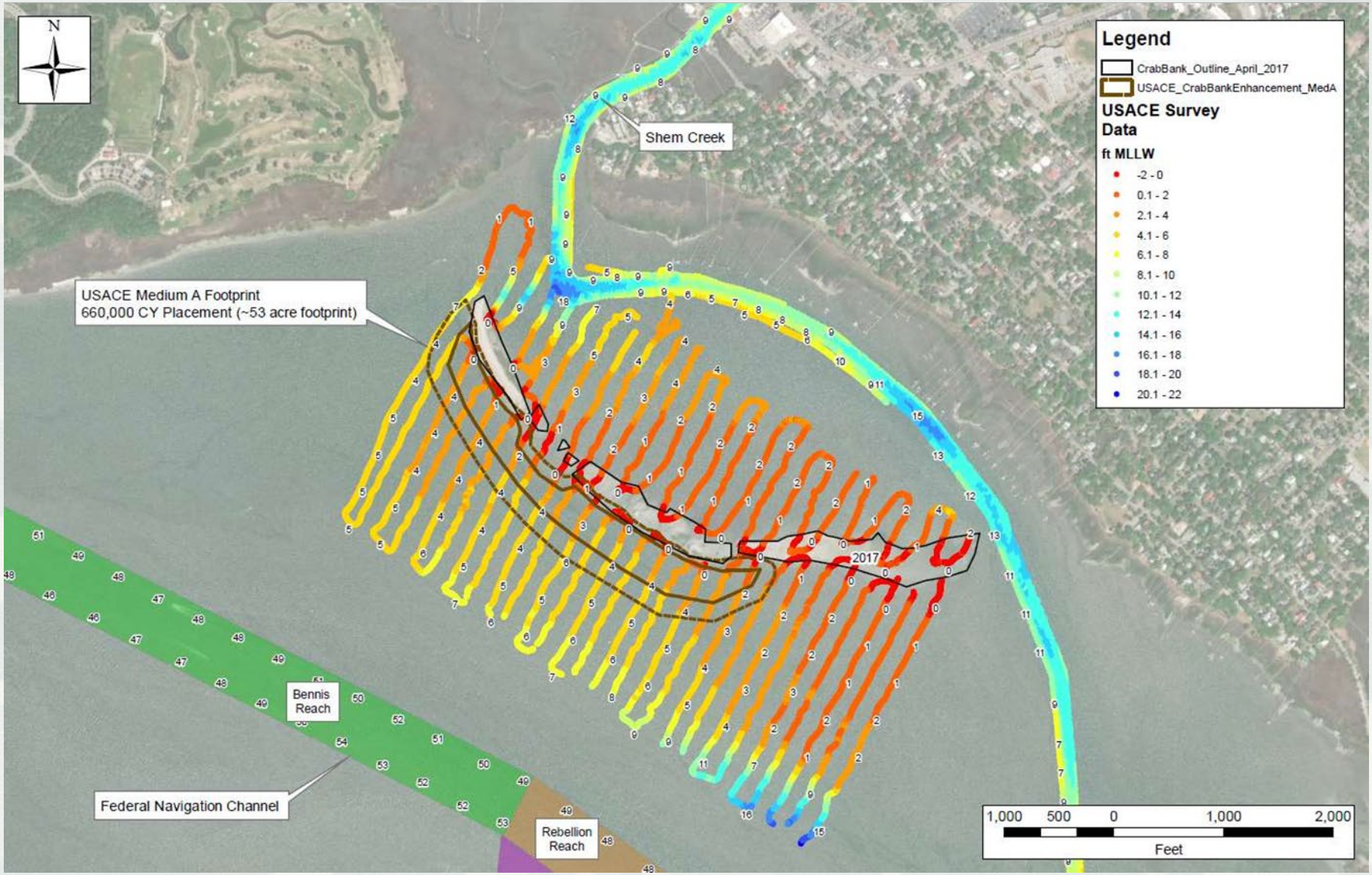


- CMS-Flow: Two-dimensional (2D) finite-volume model and calculate hydrodynamics, sediment transport.
- CMS-Wave: 2D spectral wave transformation model, simulate important wave processes, including diffraction, refraction, reflection, wave breaking and dissipation mechanisms.
- Coupled system for waves, flows, and sediment transport and morphology change.
- Primary objective of this study: Evaluate the potential impacts of increasing the footprint of Crab Bank on the morphology changes within Shem Creek entrance area and/or adjacent shorelines.
- Present study used field data collected during previous USACE studies (bathy, current, wave measurements) and astronomical tide, measured river flows, and wave data (USACE, 2013).

Spatial Extent of Model Domains

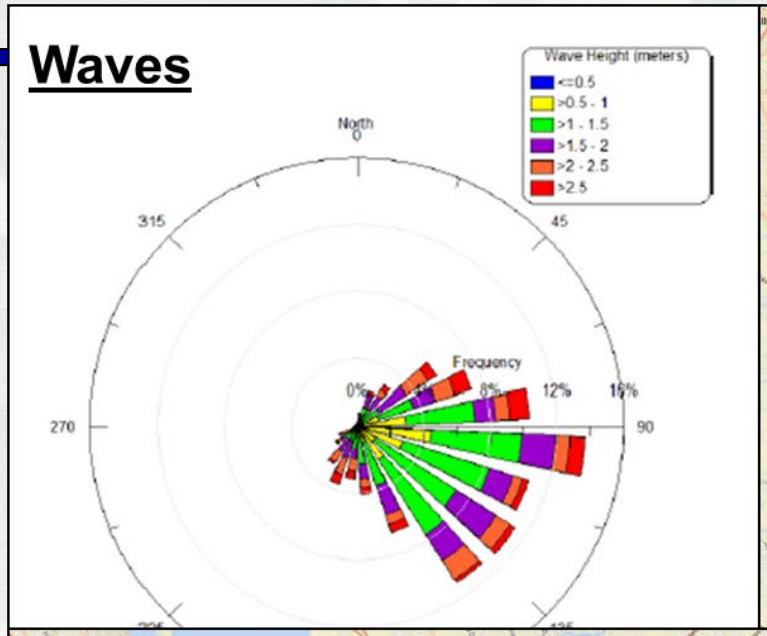


Bathymetry Data

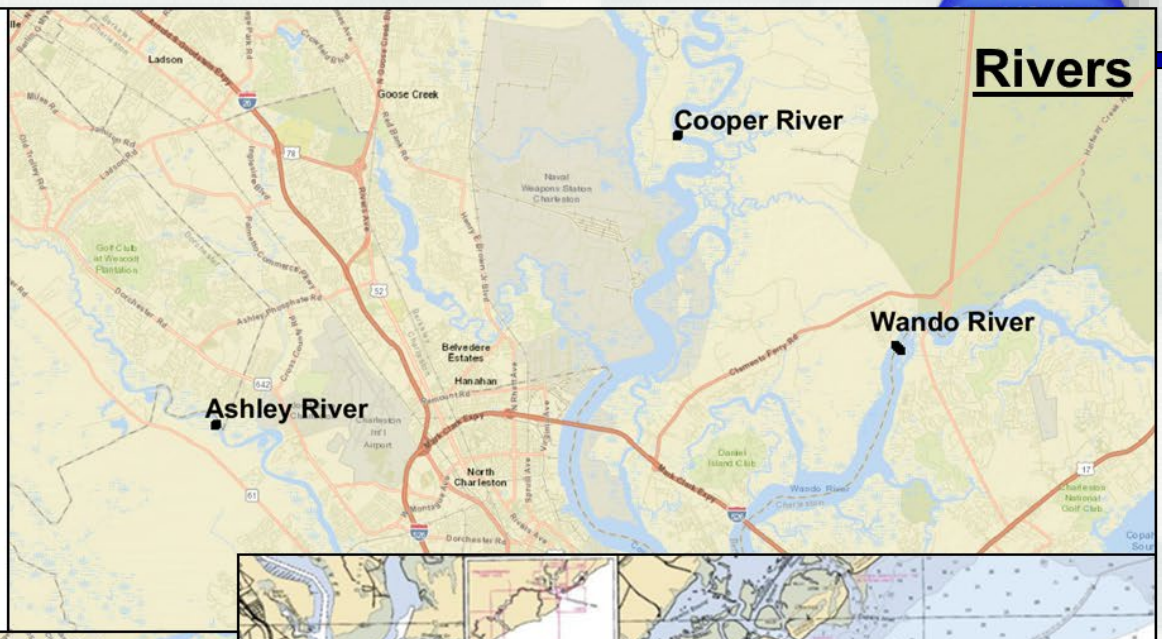


Other Data

Waves

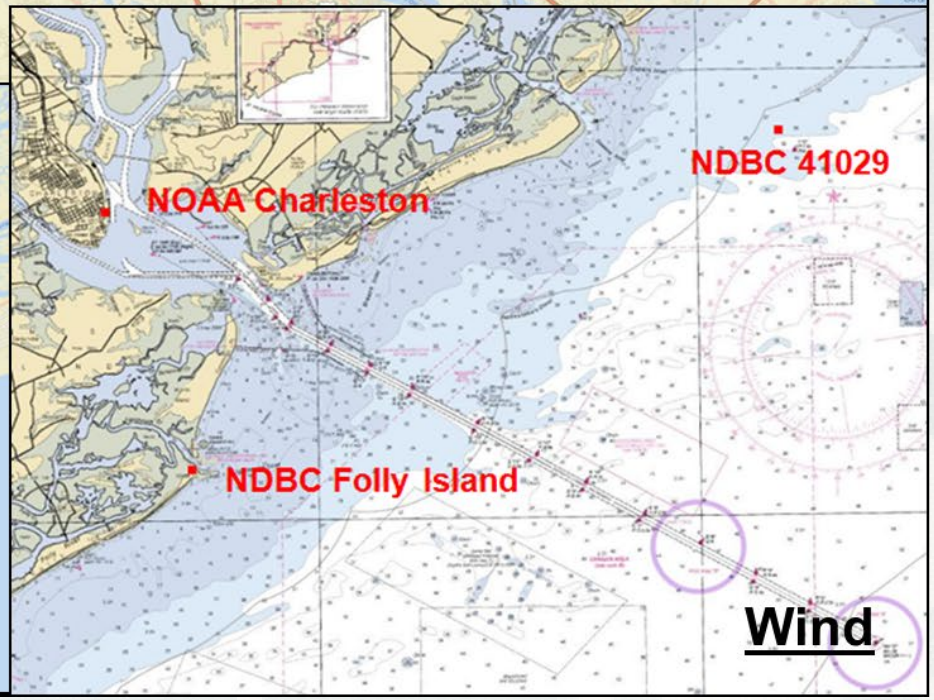


Rivers

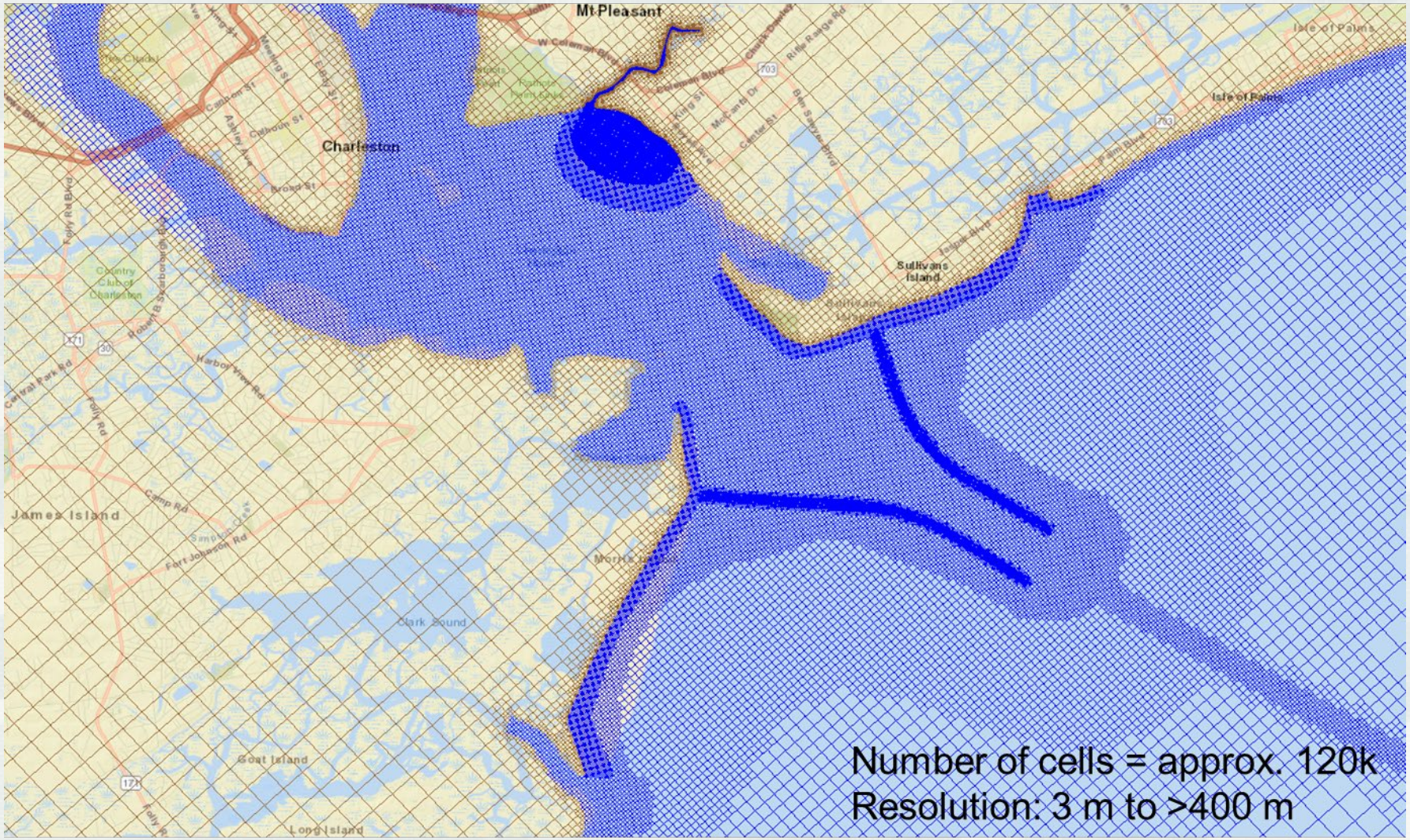


Tide

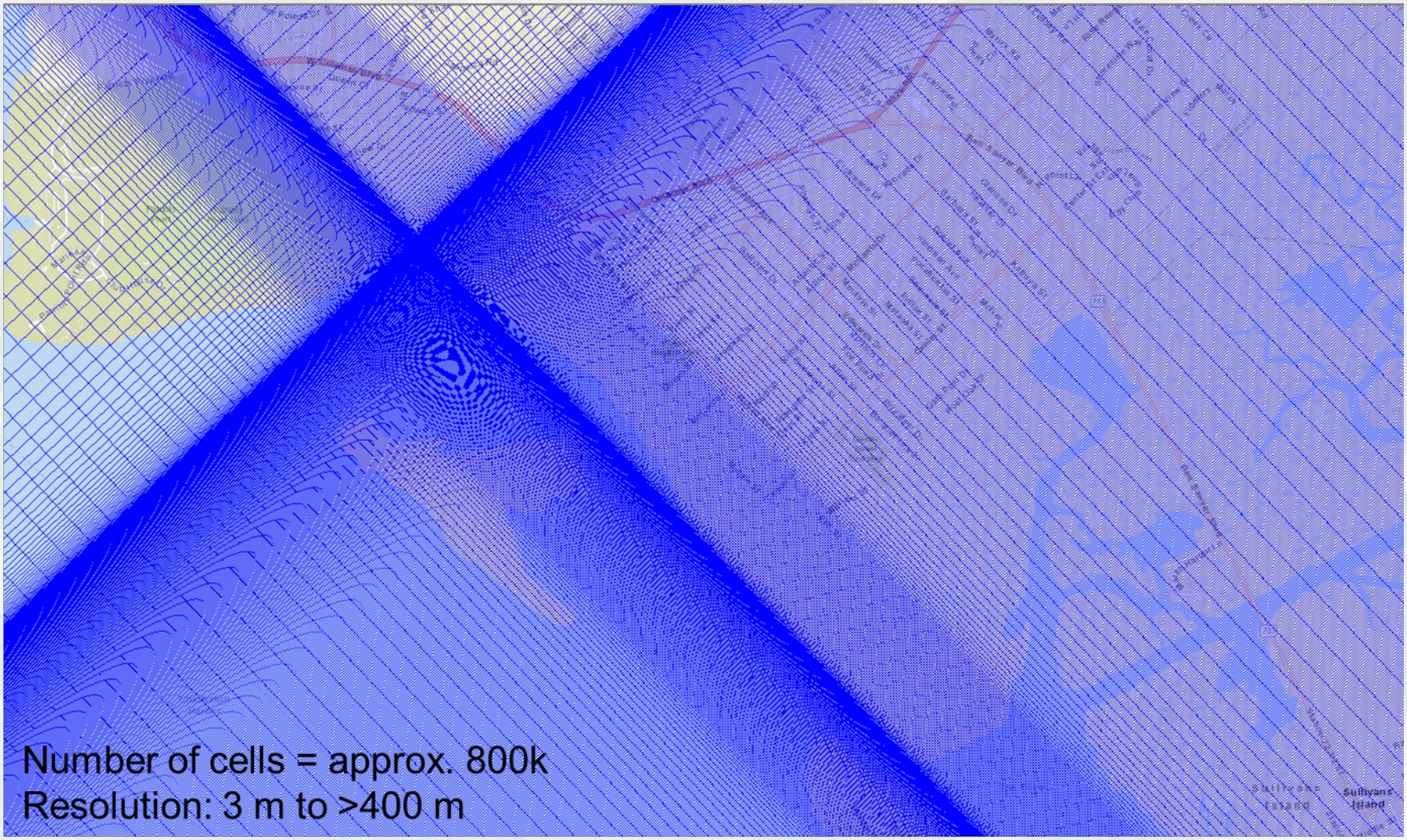
Wind



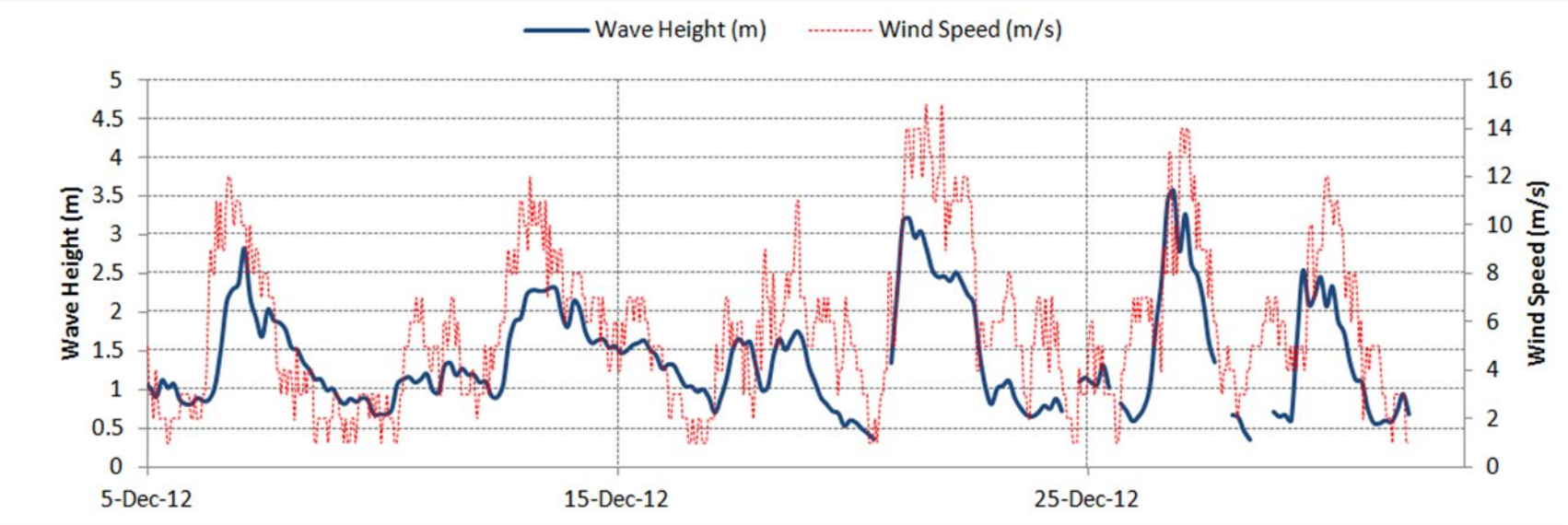
CMS-Flow Grid



CMS-Wave Grid

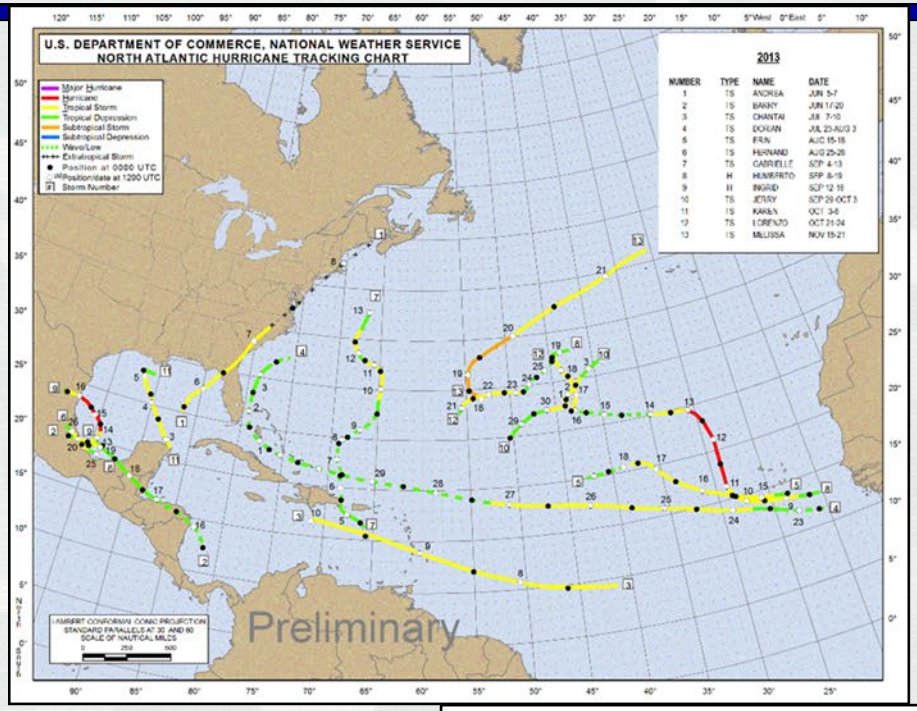


Model Simulation Periods

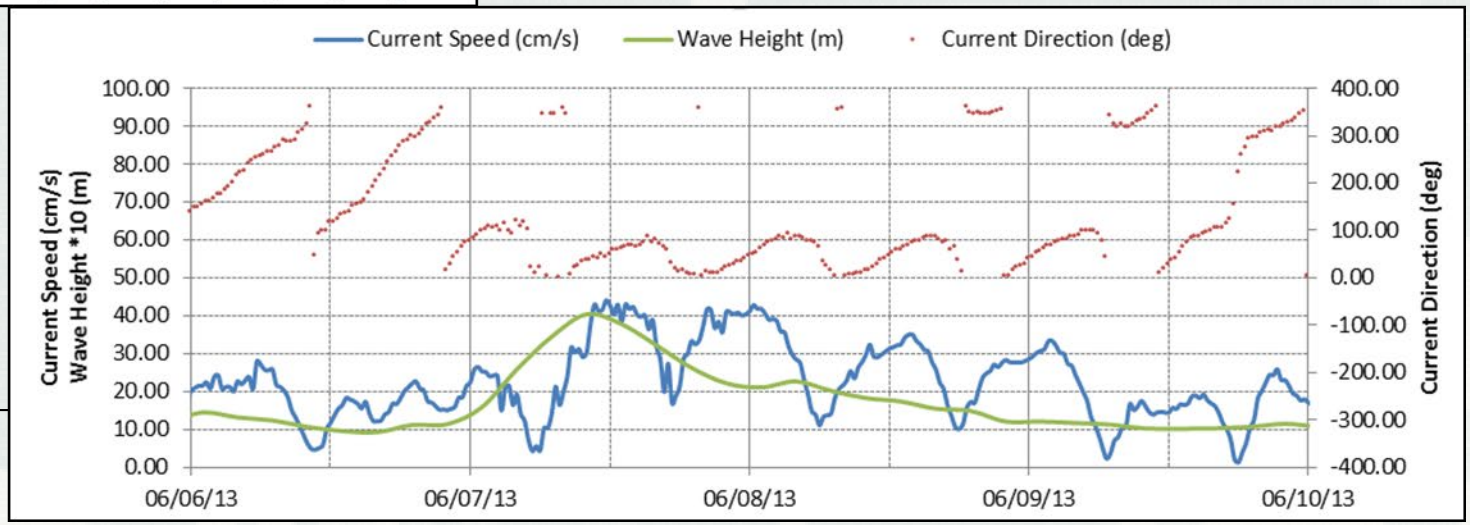


- December 2012 was an active winter month; selected to represent the longer-term period.
- Data was collected in 2012-2013 as part of a study to designate a new Charleston Harbor Ocean Dredged Material Disposal Site (ODMDS) and involved the deployment of multiple Acoustic Doppler Current Profilers (EPA, 2014).

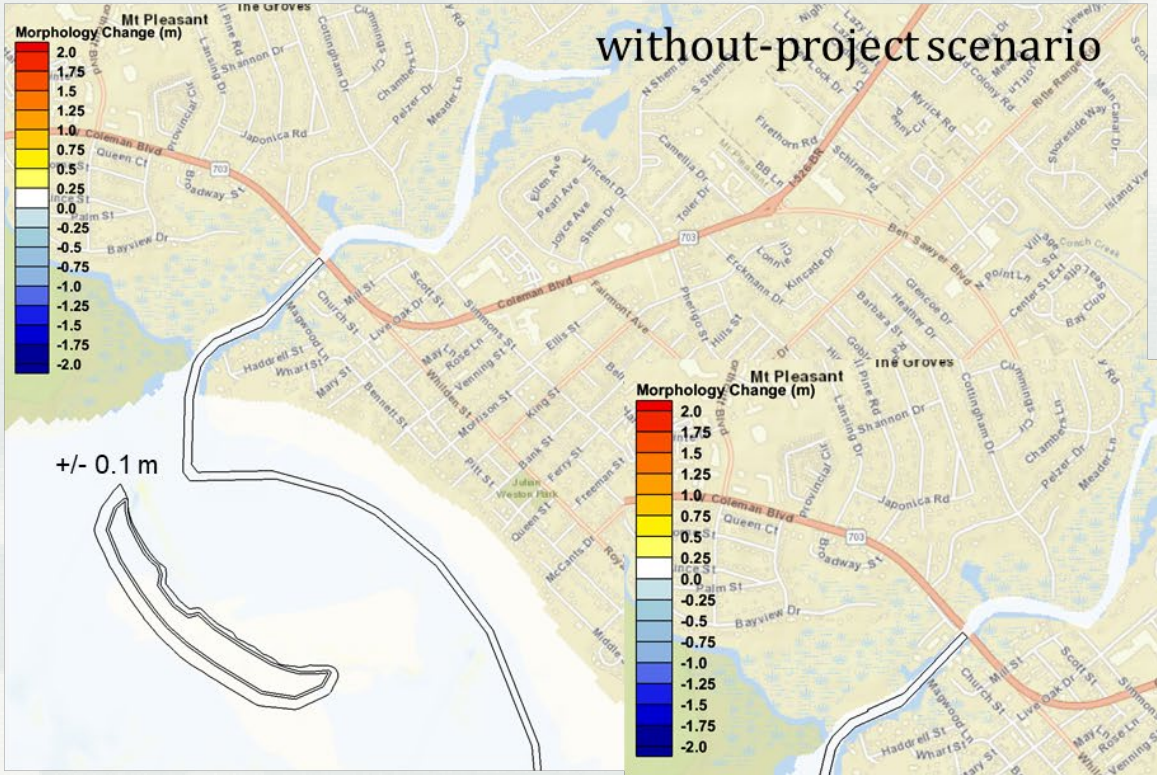
Model Simulation Periods



- Tropical Storm Andrea 2013
- Only storm observed during 2013 season
- Selected to represent the extreme shorter-term simulation period due to availability of previous data measurements (EPA 2015) and existing calibrated numerical models.



Morphology Changes



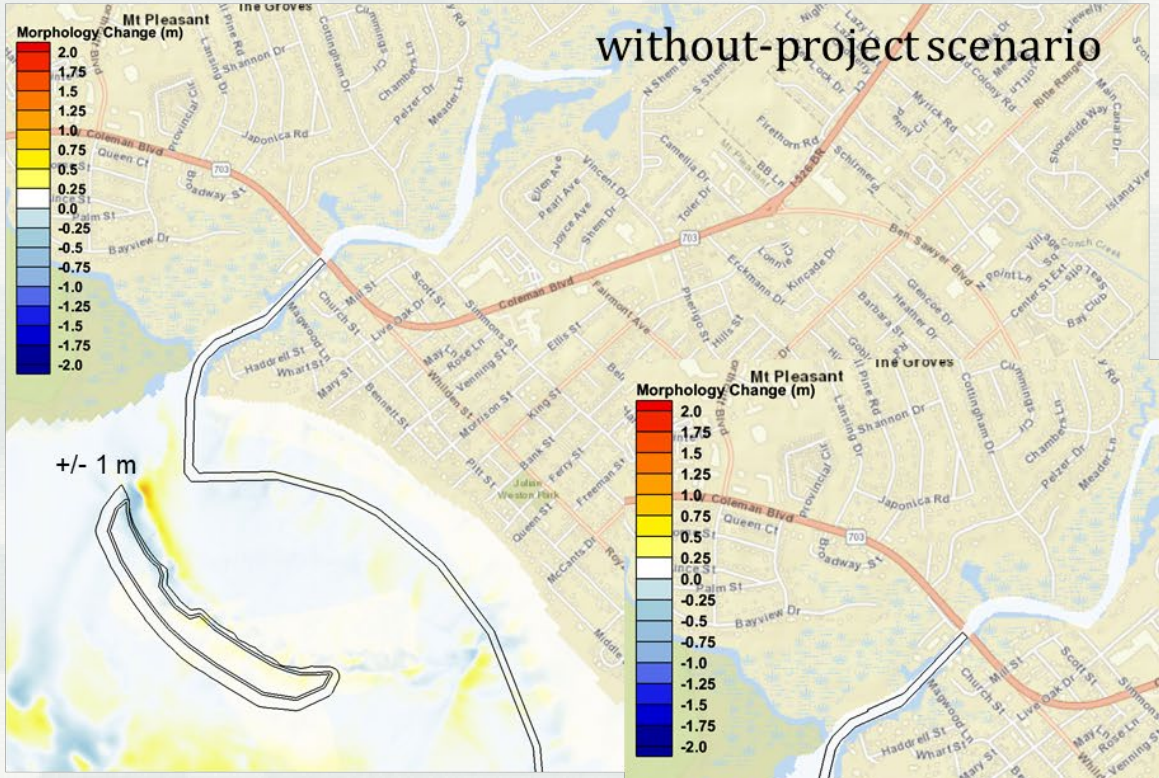
without-project scenario

Morphology changes calculated at the end of the Tropical Storm Andrea June 2013 simulation event

Warm colors (red) = accretion
Cool colors (blue) = erosion

with-project scenario

Morphology Changes



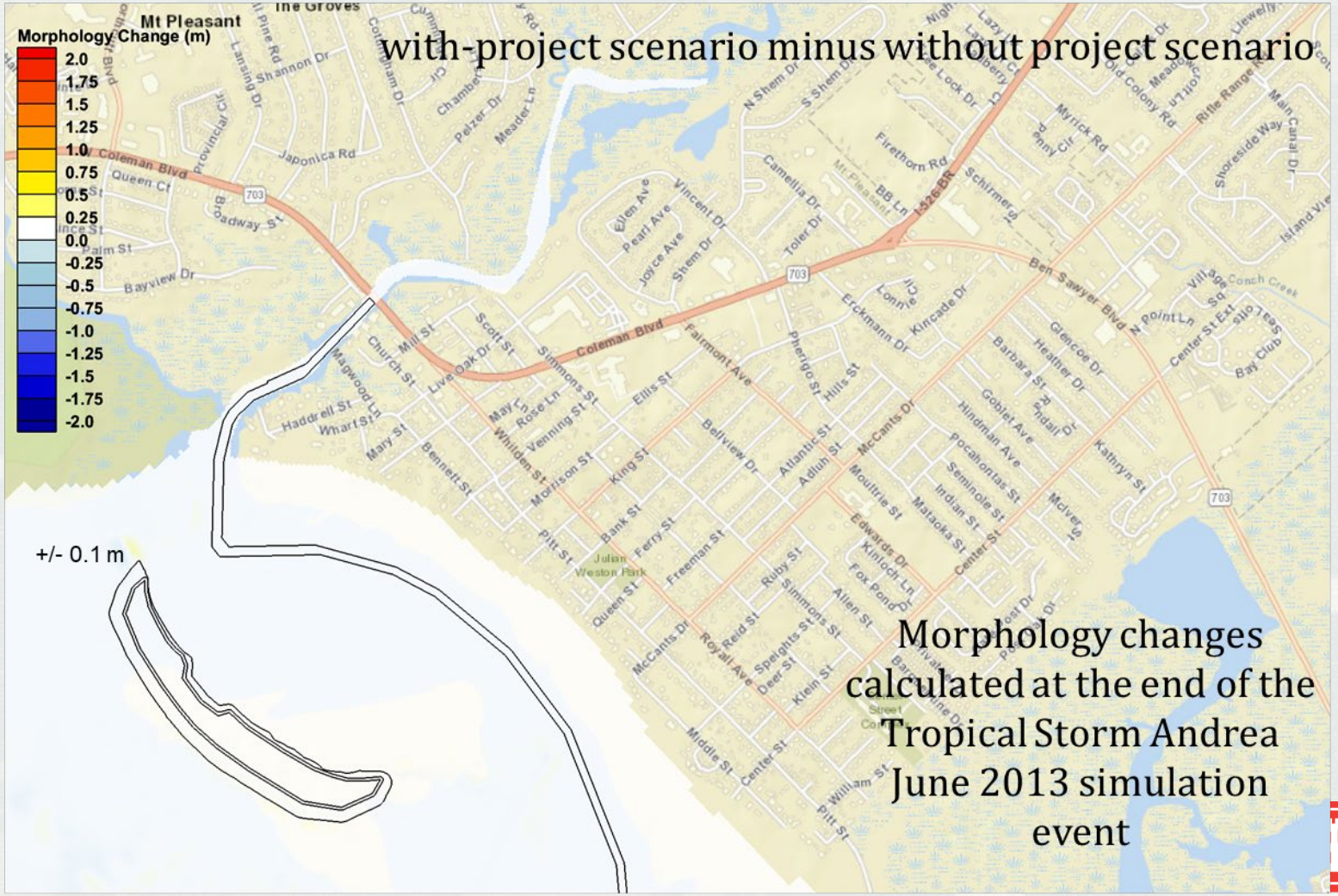
without-project scenario

Morphology changes calculated at the end of the December 2012 simulation event

Warm colors (red) = accretion
Cool colors (blue) = erosion

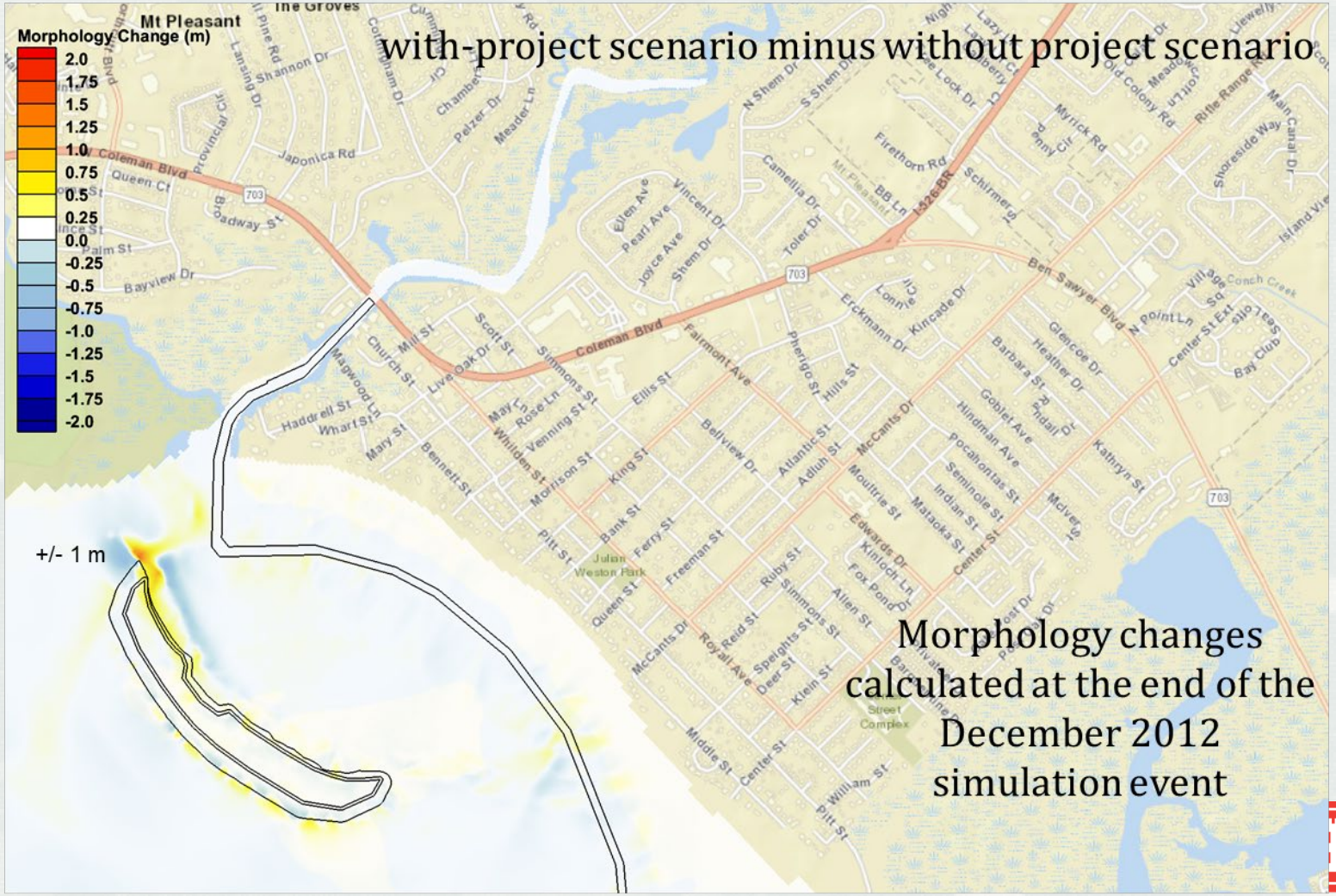
with-project scenario

Morphology Changes



Warm colors (red) = accretion
Cool colors (blue) = erosion

Morphology Changes



Warm colors (red) = accretion
Cool colors (blue) = erosion

BUILDING STRONG®

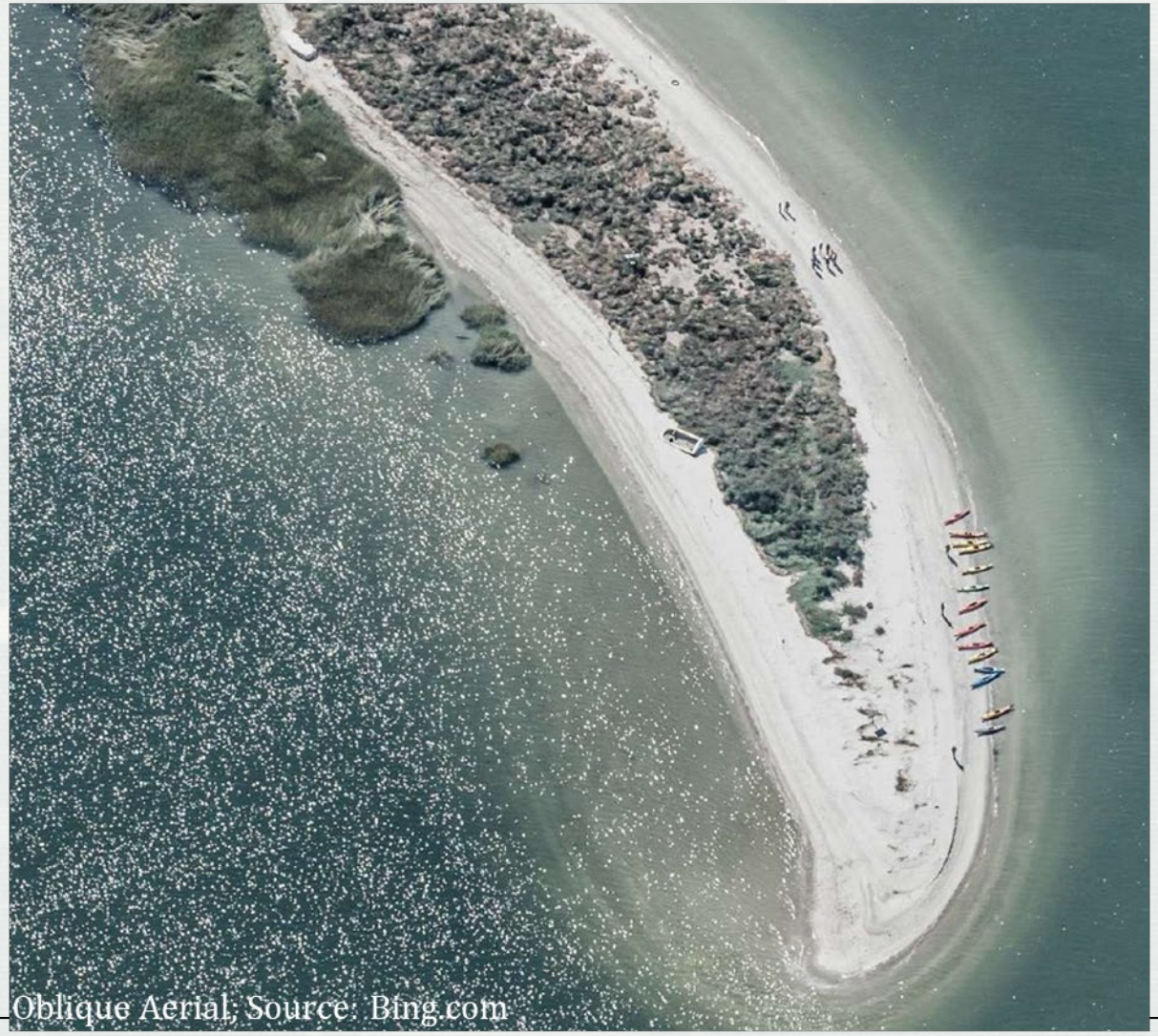
Summary

- In general, the patterns of morphology distribution at the end of the simulation periods showed negligible changes in Shem Creek or at adjacent shorelines.
- The largest morphology changes were observed in the immediate vicinity of Crab Bank, which were on the order of +/- 0.1 m for the extreme storm event, Tropical Storm Andrea June 2013, and were generally on the order of +/- 1 m for the active longer-term event, December 2012.
- The Coastal Modeling System showed negligible changes in Shem Creek or at adjacent shorelines as a result of increasing the footprint of Crab Bank at the end of either simulation time period modeled in this study.
- According to USACE (2018), overtopping is a primary transport mechanism of Crab Bank, and the associated sediment transport to the leeward side of the island has resulted in migration of the island to the north.

Summary (continued)

- Using available Lidar, the northern and leeward migration of Crab Bank was examined by USACE (2018). Larger erosion rates were indicated in areas that experienced frequent overwash; similarly, lower erosion rates were indicated in areas that did not experience frequent overwash.
- The Crab Bank footprint modeled in this study takes into account the past migration patterns of the island and historical sediment transport trends. Once Crab Bank is elevated with the proposed USACE federal project footprint, the sediment transport dynamics of the island will change with a reduced overwash impact. However, the Coastal Modeling System showed negligible changes in Shem Creek or at adjacent shorelines as a result of increasing the footprint of Crab Bank at the end of either simulation time period modeled in this study.

Thank you!!! Questions?



Oblique Aerial; Source: Bing.com

BUILDING STRONG®