

2017 National Conference on
Beach Preservation Technology
Hutchinson Island, Florida

An Inland Perspective on Hurricane Impacts and the 2016 Storm Season

February, 2017

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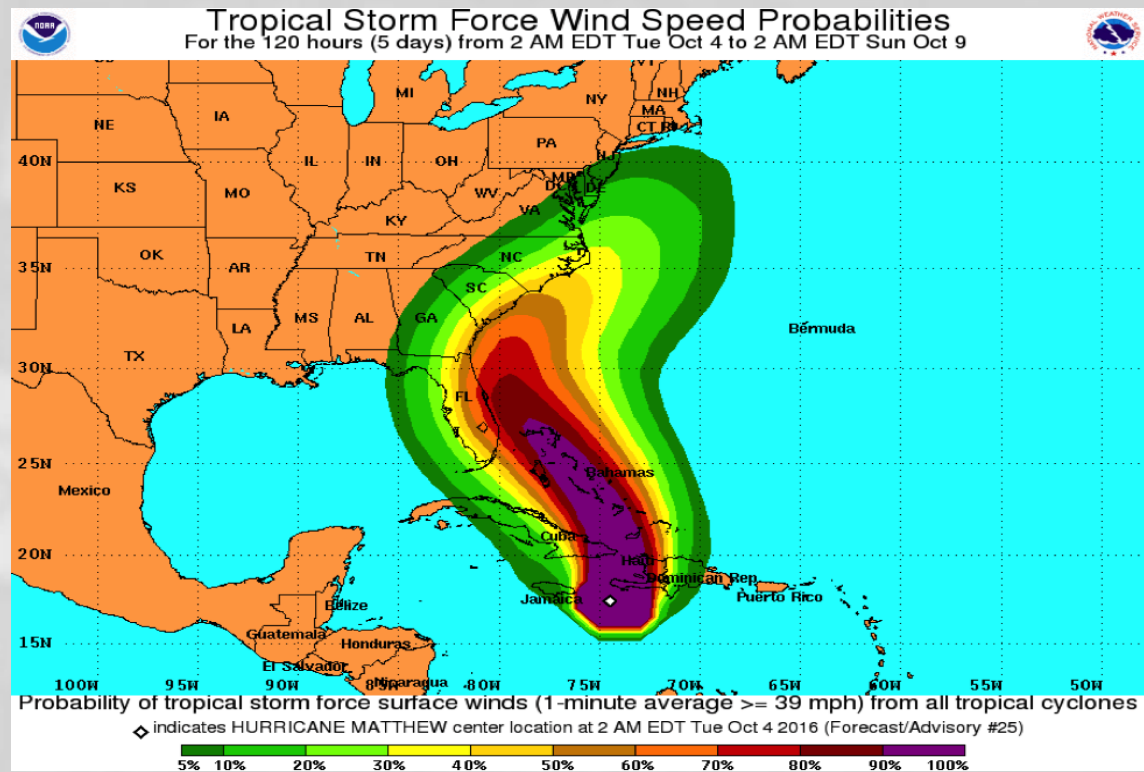


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Creative People, Practical Solutions.®

Hurricane Matthew - 2016

- Inland Waterways
- Waterfront & Marinas



St. Augustine - Florida

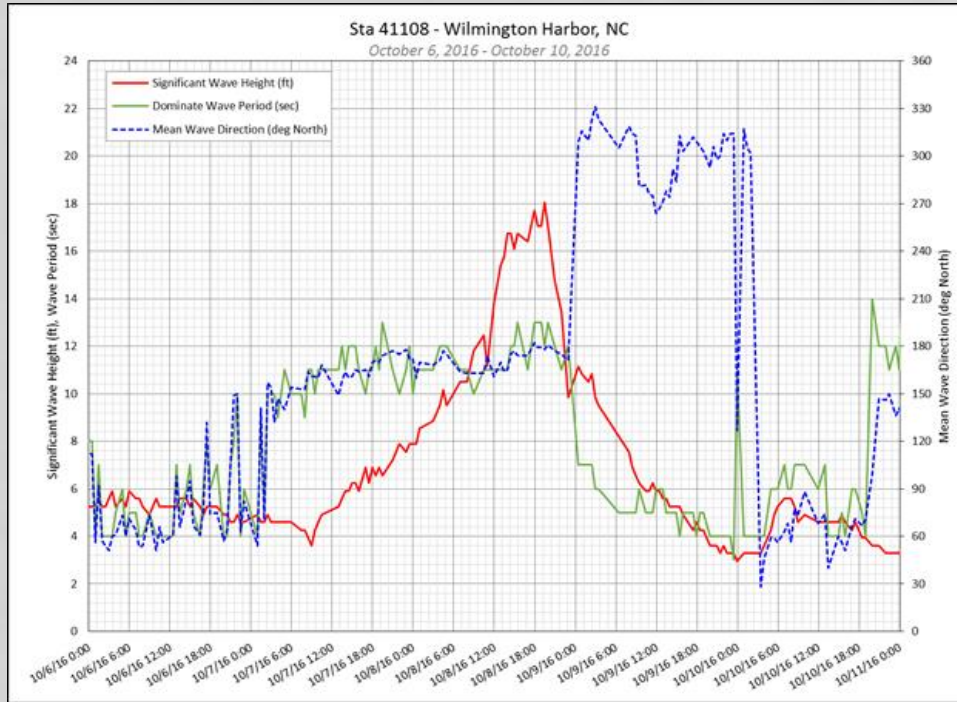
- St. Augustine
- New inlet between the Atlantic Ocean and the Matanzas River, stripping away a 3.7 meter (12-foot) dune and carrying sand into the estuary



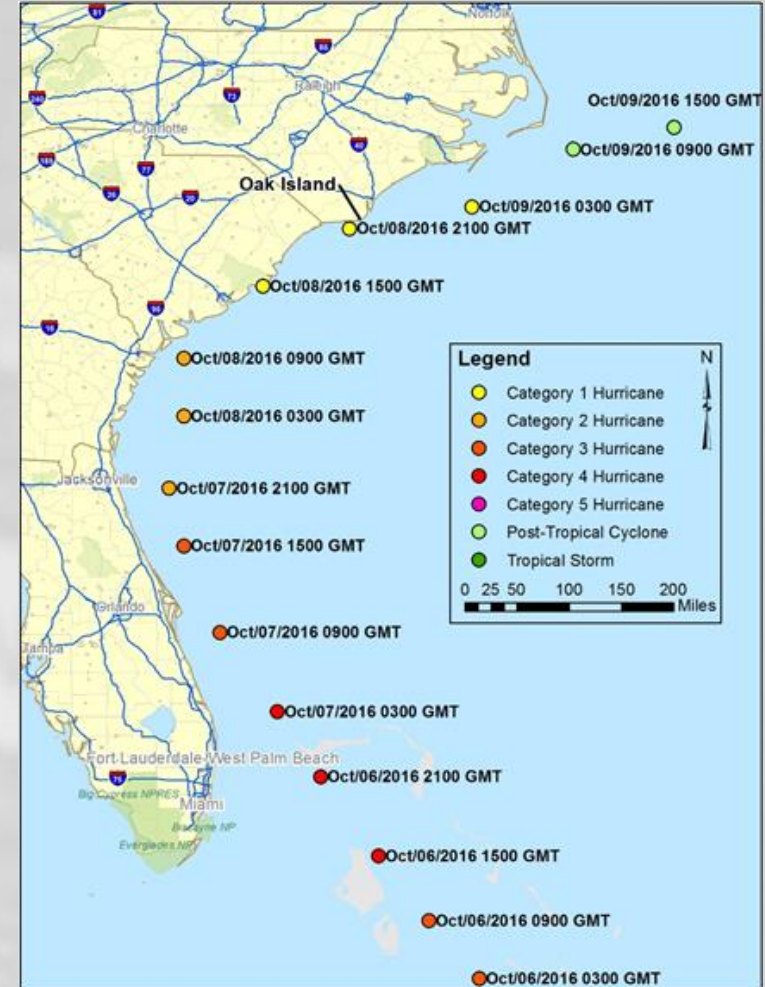
Courtesy USGS



Oak Island - North Carolina



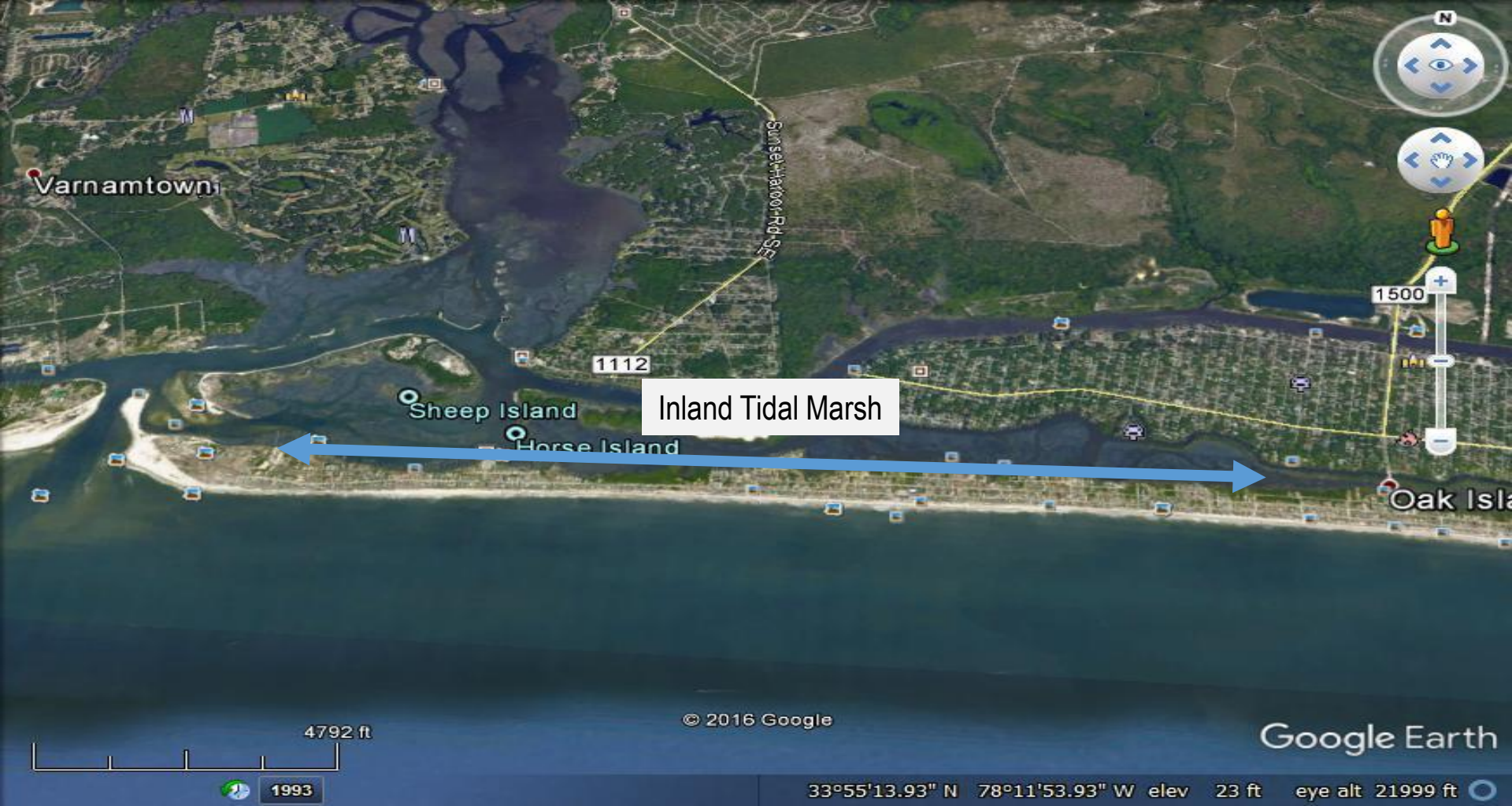
Tidal Data



Hurricane Matthew - Storm Track

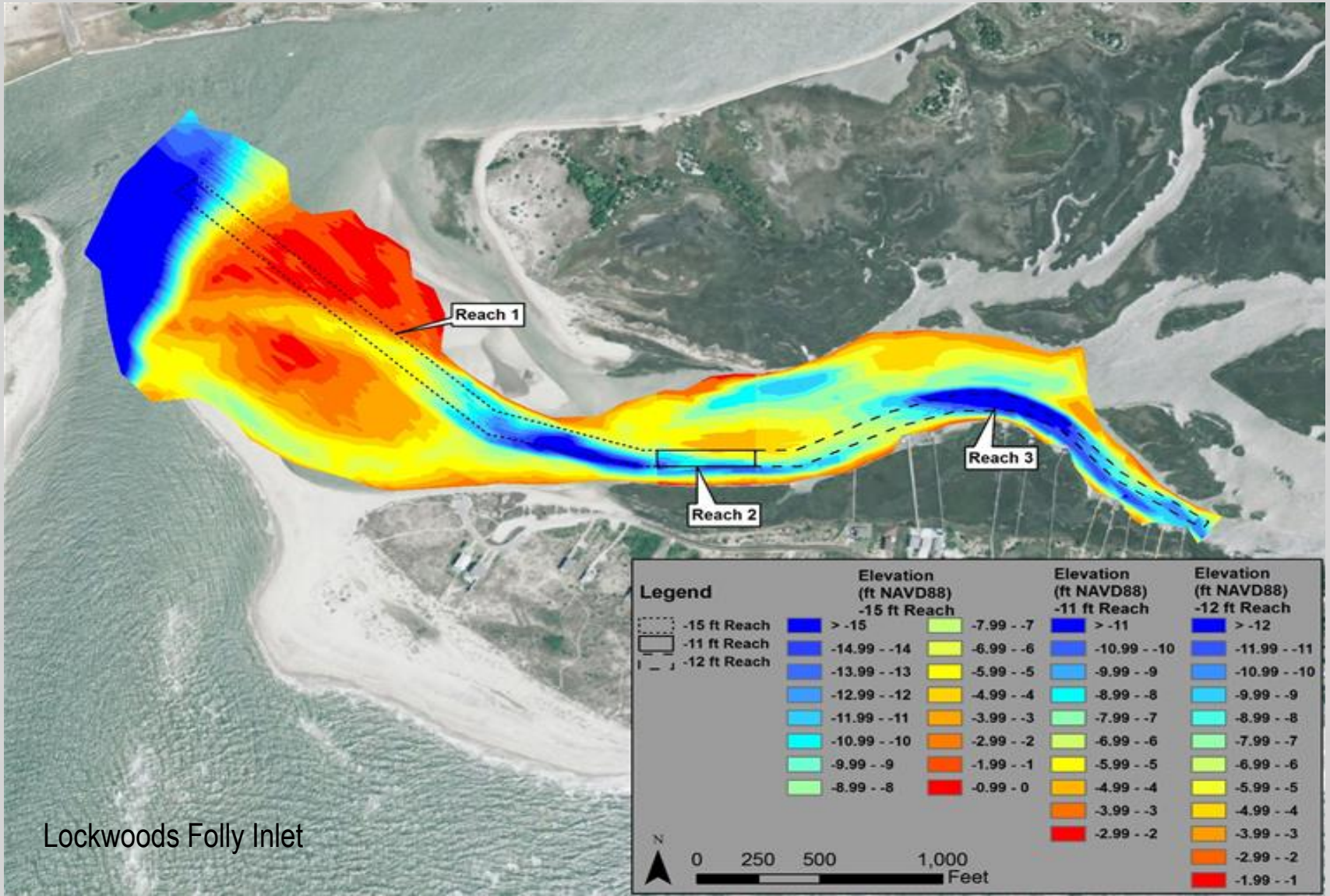


Oak Island - North Carolina



Oak Island - North Carolina

Navigation Channel Shoaling - Hurricane Matthew



Mangroves - Florida

- East Coast – to Cape Canaveral
- West Coast – to Cedar Key
- 469,000 Acres – FDEP
- Shore Protection – upland
- Minimize storm surge – friction
- Improve Water Quality
- Habitat
- Losses – human activities
- Continued restoration - essential



Indian River Lagoon, FL



Living Shorelines

Shore Protection and Beautification

- Sustainable
- Low Maintenance
- Funding Opportunities



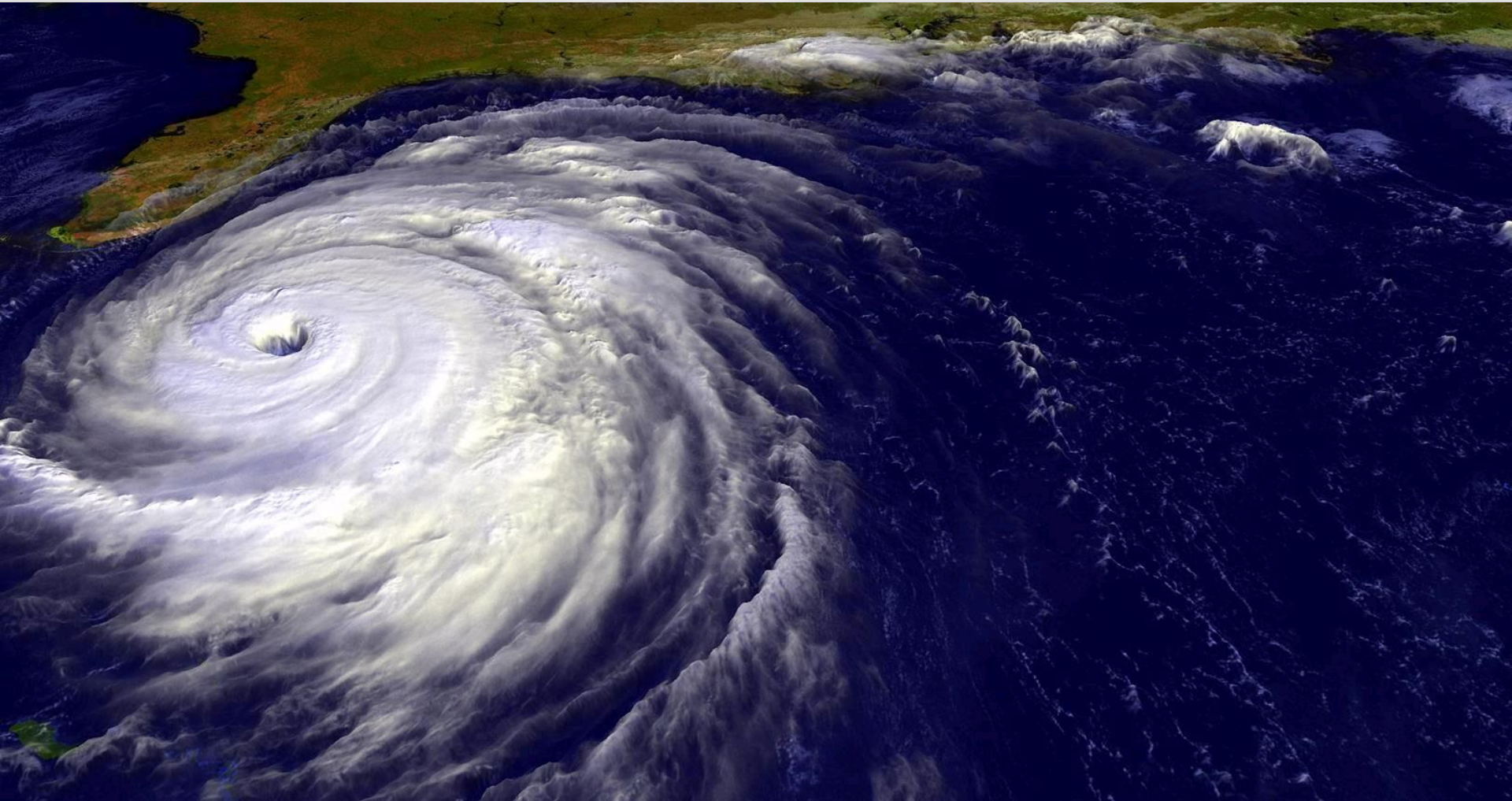
Rickenbacker Causeway, Miami-Dade Co.



Riverside Garden Park
Shoreline Stabilization, Tampa



Hurricane Frances - 2004



Hurricane Frances - 2004

Ft. Pierce Marina, Florida



Ft. Pierce Marina, Florida

- 2004 Hurricane Frances
- \$31M Redevelopment
- \$18.9M Breakwater System
- 13 Barrier Islands
- 137 New Slips
- Completed May, 2013
- 9 Year Schedule



Courtesy TetraTech



New Orleans Municipal Yacht Harbor

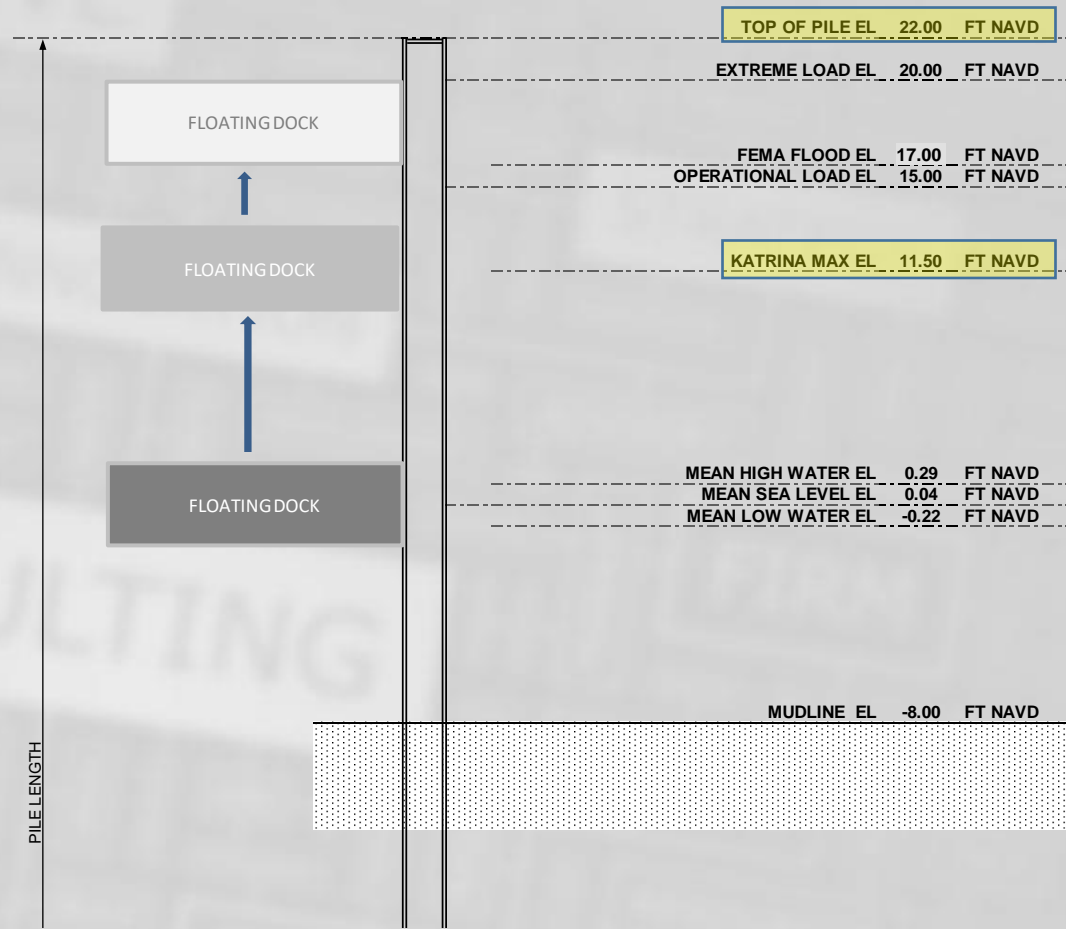
Damage from Hurricane Katrina - 2005



New Orleans Municipal Yacht Harbor

Planning for the future

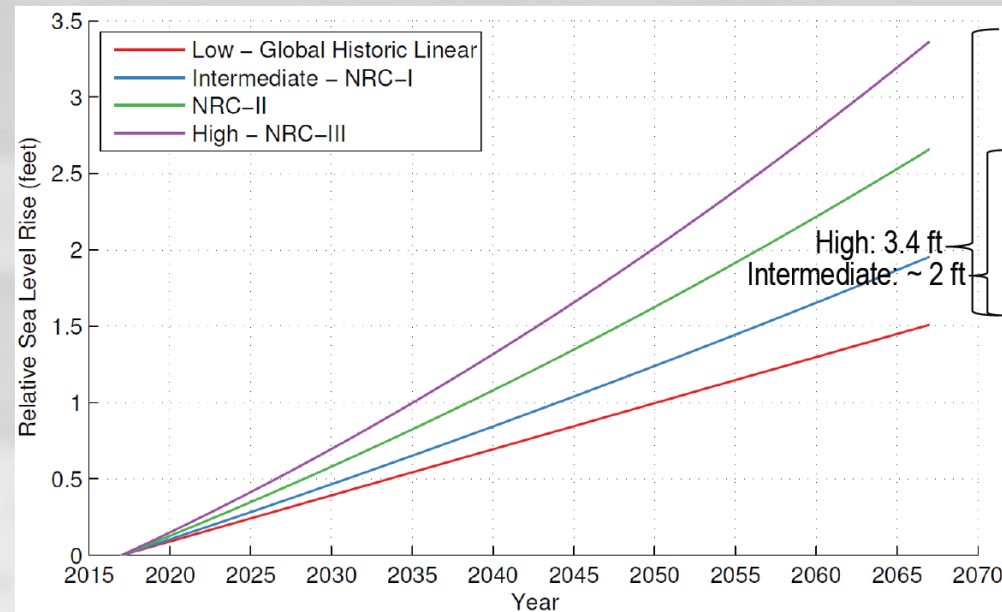
- Conservative, scientifically sound sea level rise and subsidence projections
- Future hurricane waves and surge based on HSDRRS project – most rigorous data available
- Pile caps (how high docks can rise with surge) are set at +22' NAVD88 – more than 10.5' higher than Katrina's high water



New Orleans Municipal Yacht Harbor

Resiliency

- Land subsidence rate of **7.5 mm/yr.**
 - *West Shore Lake Pontchartrain Hurricane and Storm Damage Risk Reduction Study* (US Army Corps of Engineers, 2014).
- Global mean sea level rise rate of **1.7 mm/yr.**
 - Intergovernmental Panel on Climate Change (IPCC, 2014)
- Projection equations, which account for **accelerated rates** of mean sea level rise and subsidence
 - *Engineering Technical Letter 1100-2-1: Procedures to Evaluate Sea Level Change* (US Army Corps of Engineers, 2014).



- Recommend using **Intermediate** value for design, while also assessing cost implications for accommodating **High** scenario

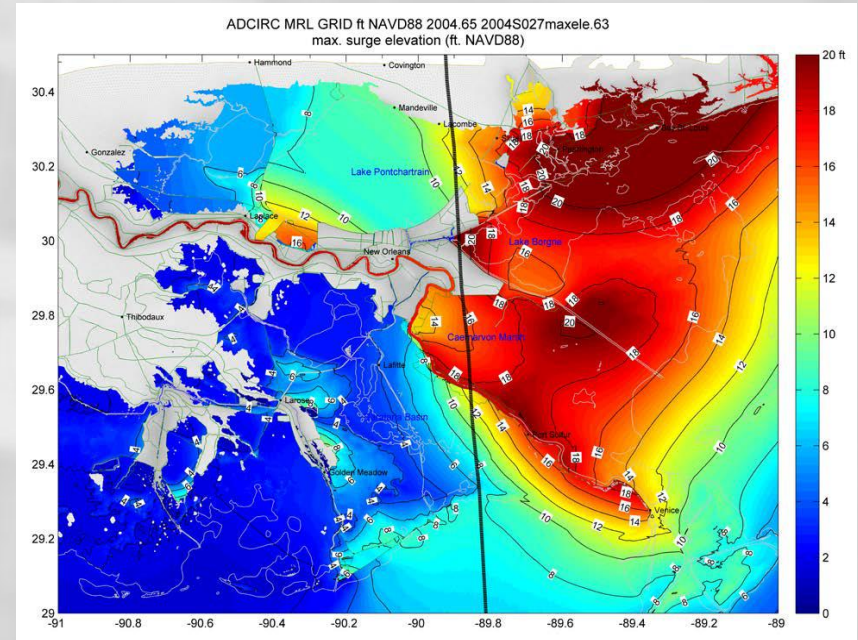
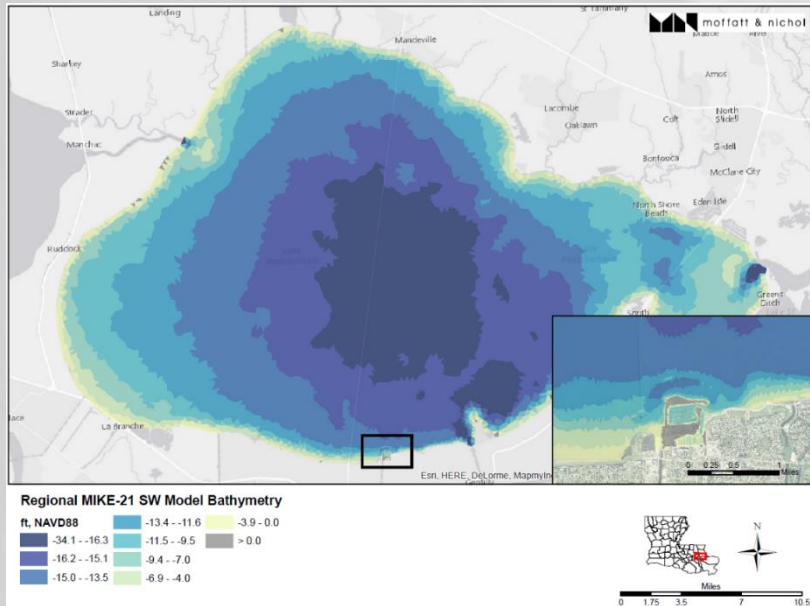


New Orleans Municipal Yacht Harbor

Operational and Extreme Wave Conditions

Operational storms simulated in-house,
based on wind records

Design 100-year (1% annual chance)
storm taken as US Army Corps'
conservative 2057 event used in
HSDRRS projects



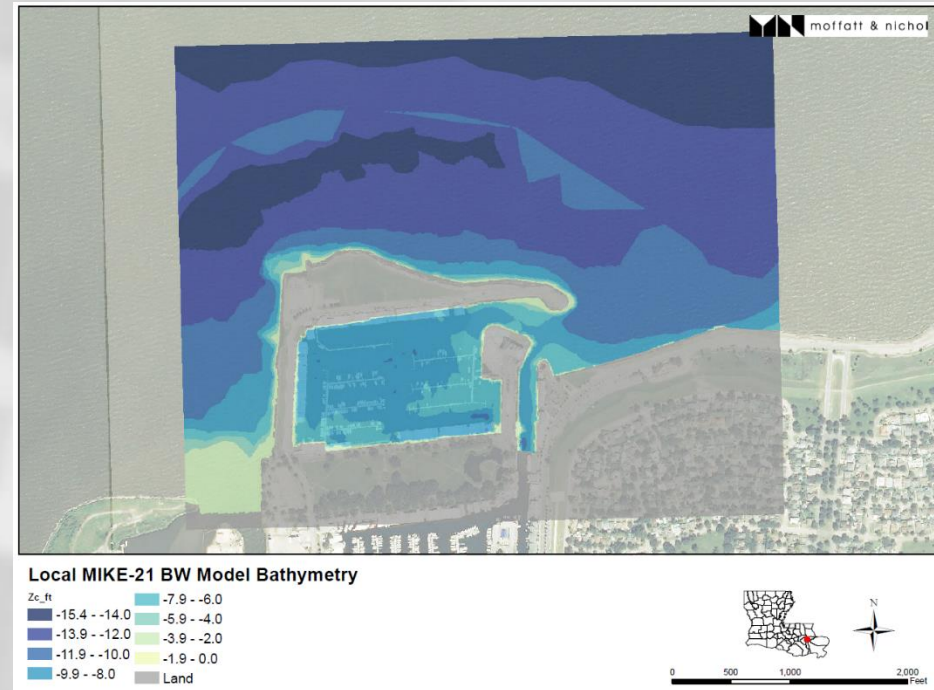
Source: US Army Corps *Elevations for Design of Hurricane Protection Levees and Structures: Lake Pontchartrain and Vicinity...* Appendix A (2014)



New Orleans Municipal Yacht Harbor

Wave Modeling

- Model propagation of offshore waves into harbor
 - Robust diffraction/reflection formulations
- Operational wave conditions
 - From statistical analysis of regional wave modeling
- Extreme wave conditions
 - 1% annual chance surge and wave conditions offshore of harbor (from USACE HSDRRS studies)



New Orleans Municipal Harbor

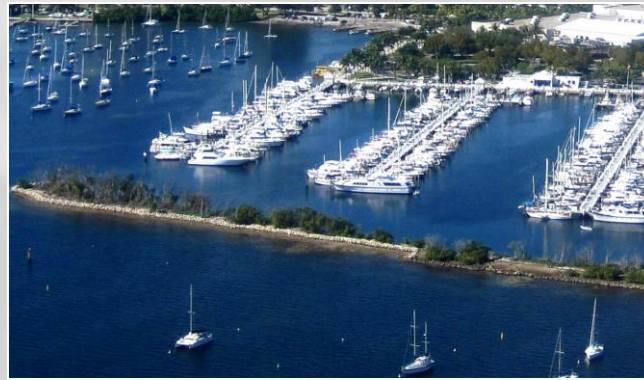
Marina Rendering

- Marina design protects dock infrastructure from inundation damage during surges
- Pile height accommodates future conditions with SLR
- Modeled with accurate data and state-of-the-art tools



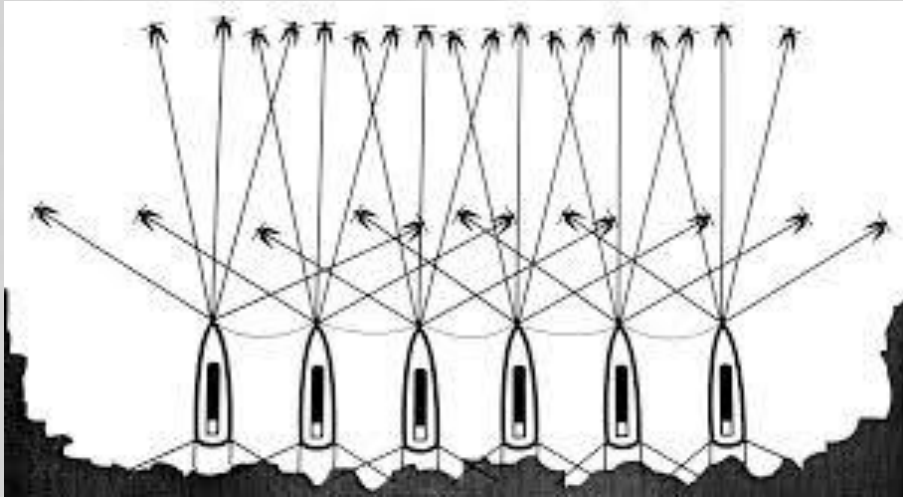
Dinner Key Marina, Miami, Florida

- Largest Wet Slip Marina in FL – 582 slips
- Spoil Islands
- Hurricane Andrew - 1992
- Hurricane Wilma - 2005



Vegetated Shorelines

- Storm Mooring of vessels

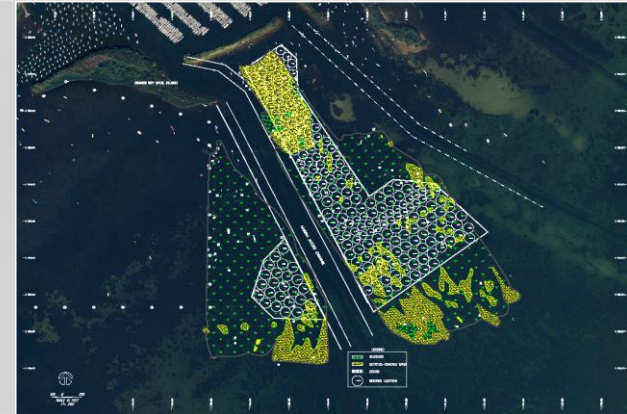


Storm mooring diagram in mangroves



Managed Mooring Fields

- Anchoring Technology
- Design – Cat 1 to Cat 2 conditions
- 12 mooring fields in Florida



Dinner Key Mooring Field, Miami, FL



Underwater Anchor Installation



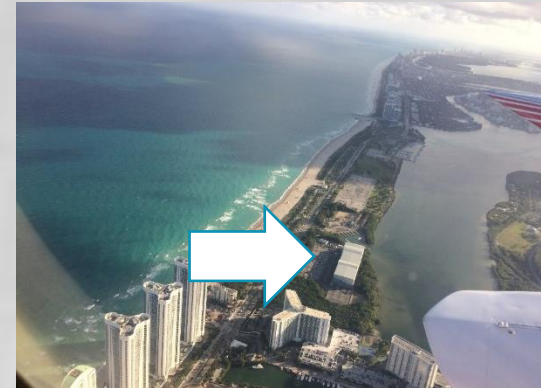
Dry Stack Marinas

- Beach Nourishment
 - Bluepoints Marina – Port Canaveral, FL
 - Hurricane Matthew – 2016
 - Max sustained winds 120mph
 - No damage – reopened in about 3 days
 - Staging Docks – removed before hurricane
 - Building – rated at 150mph – more stringent



Haulover Marine Center, Sunny Isles, FL

- 508 dry slips
- 60' long boats; up to 70,000 lbs
- 175 mph wind rating
- Florida Building Code – 2012 update



Conclusions

- Hurricanes – will continue to impact the coasts
- Inland Waterways – impacts to shorelines
- Recovery – minimize damage
- Living shorelines – restoration/enhancement
- Balanced Design Cost – Benefit
- Select Design Storms
- Dry stack marinas
- Sustainability
- Resiliency





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THANK YOU!

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