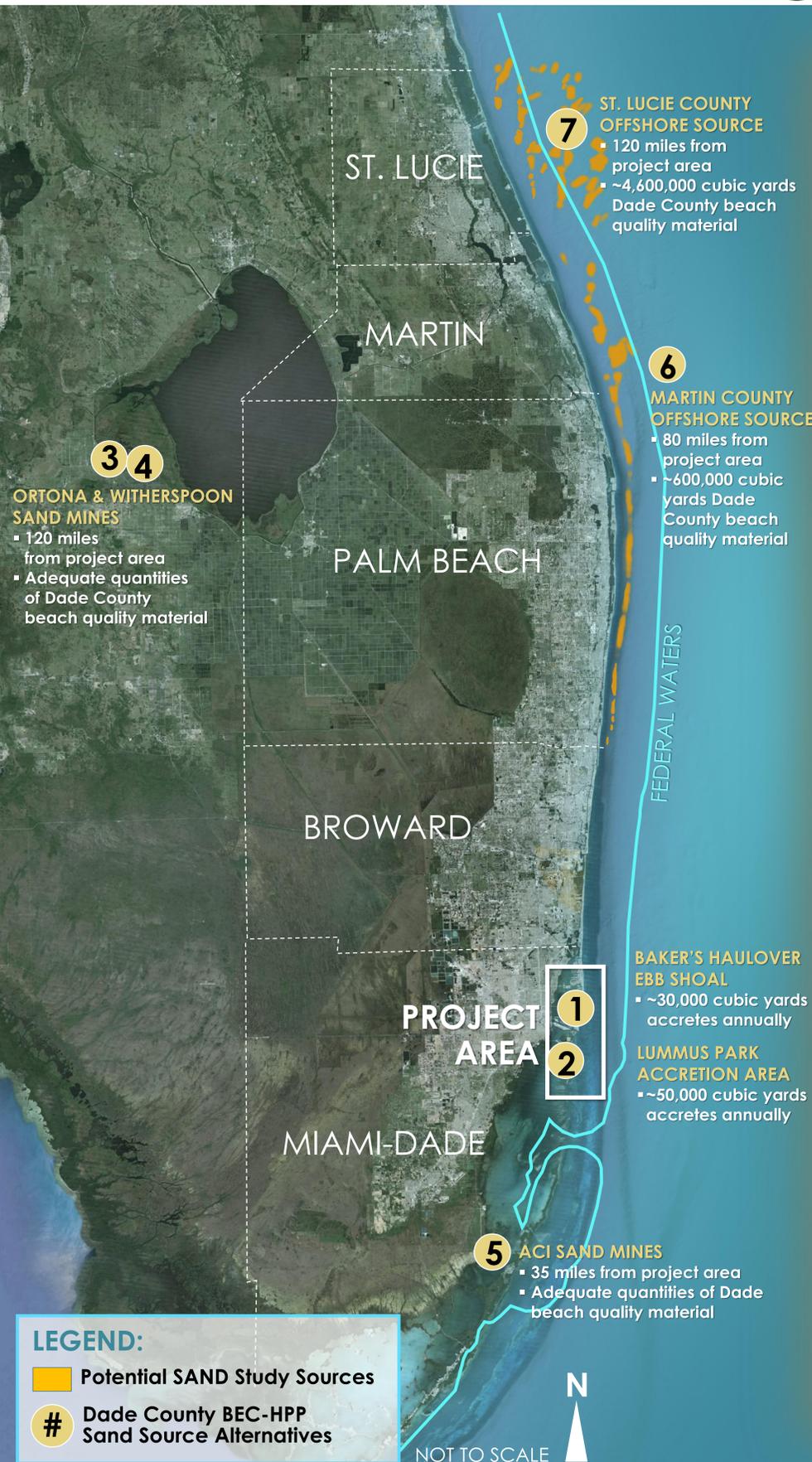


ENGINEERING CONSIDERATIONS



WAVE REFRACTION ANALYSIS FOR ST. LUCIE & MARTIN COUNTY BORROW SOURCES

As waves enter shallow waters, wave heights and directions become affected by the bathymetry they propagate across. Since dredging offshore borrow areas alters the ocean bathymetry by deepening these sites, wave refraction analyses are performed to determine if existing wave refraction patterns along the adjacent shorelines are modified as a result of borrow area dredging. Any such changes could indicate the potential for increased (or decreased) erosion along the shoreline.

THE ANALYSIS

Wave conditions throughout the region were simulated under a wide variety of scenarios, both with and without the proposed borrow area excavation. Model results were compared in each case to determine the effects of excavation under those particular wave conditions. Any changes between the with- and without-project conditions that extend landward into the littoral zone would suggest that the proposed borrow area excavation could impact sediment transport along the shoreline.

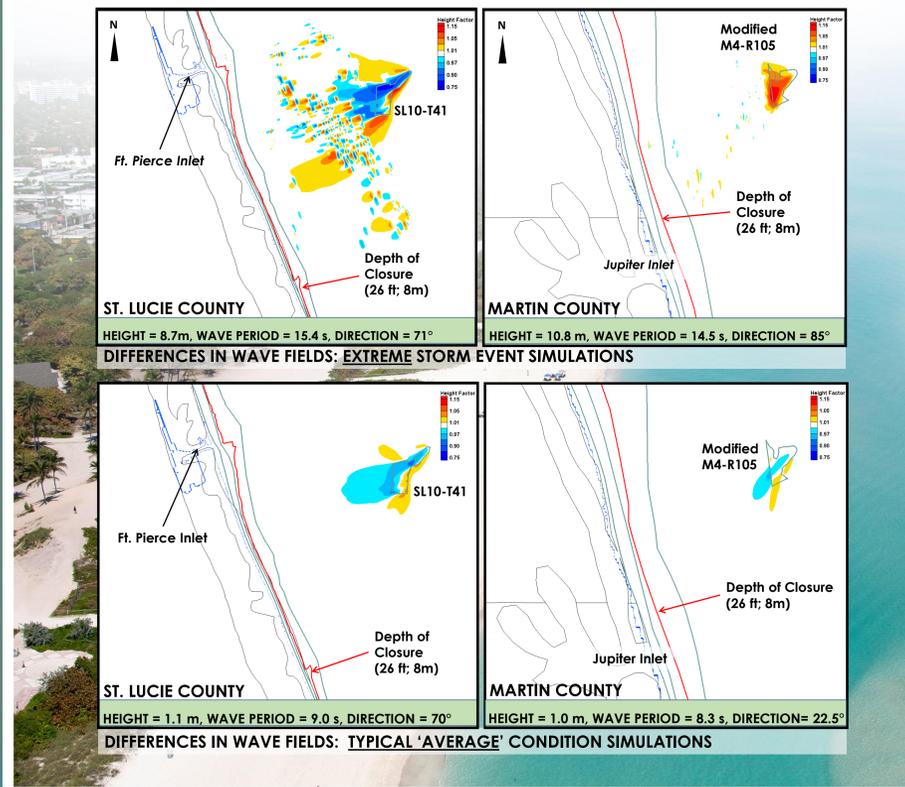
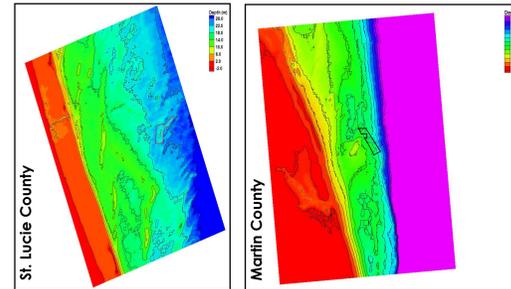
Long-term wave records were used to develop average wave conditions at each borrow site, to define the most frequently-occurring conditions. Extreme wave conditions were also derived from these databases to define the most severe scenarios for this wave refraction analysis. These extreme wave events represent very infrequent occurrences.

The threshold used in this analysis to determine if changes to existing wave refraction patterns were "significant" was whether any changes in wave height, period, or direction due to borrow area excavation were observed landward of the approximate depth of closure, meaning the seaward limit of active sediment transport along the shoreline. The depth of closure in these areas corresponds to the -26-foot depth contour.

THE RESULTS

The significant finding of this analysis was that in no case did any changes to existing wave refraction patterns due to borrow area deepening extend landward of the depth of closure.

The only events that even approached this limit were the most extreme wave cases, particularly those with exceptionally long wave periods. However, even using the longest wave periods and largest wave heights on record, in no cases were any changes to the nearshore wave environment observed within the depth of closure. No potential for increased (or decreased) beach erosion as a result of borrow area excavation is therefore indicated.



GEOTECHNICAL INVESTIGATIONS

The evaluation and search for alternative sand sources in southeast Florida has been underway for over 20 years. Recent efforts include a broad undertaking led by the Florida Department of Environmental Protection (FDEP) to quantify the sand needs of southeast Florida, as well as the 2015 Dade County Beach Erosion Control and Hurricane Protection Project Limited Reevaluation Report and Environmental Assessment conducted by the U.S. Army Corps of Engineers. These studies are discussed below.

2011-2013 SOUTHEAST FLORIDA SEDIMENT ASSESSMENT & NEEDS DETERMINATION STUDY

The regional investigation, known as the "SAND Study" involved extensive coordination and collaboration between FDEP, the five southeast Florida counties, the U.S. Army Corps of Engineers, and the Bureau of Ocean Energy Management (BOEM):

- Corps provided technical support, data collection and analysis.
- Study quantifies sand resources to support construction of planned, full-sized beach nourishment projects through the next 50 years (year 2062) for St. Lucie, Martin, Palm Beach, Broward, and Miami-Dade counties.
- Each county determined their own 50-year sand need for federal & non-federal projects.
- All needs assessments were peer reviewed.
- Geological investigations identified sand sources meeting FDEP criteria; contingencies were applied to reach a final volume available.
- FDEP funded an independent technical review of the study.

ALTERNATIVE SAND SOURCES ASSESSED

Sand sources in the SAND Study included known borrow areas in state and federal waters.

SAND STUDY RESULTS

The Southeast region of Florida has excess sand of 100,000,000 cubic yards beyond its 50-year need.

County	Sand Needs (cy)		Sand Availability (cy)		Excess (cy)
	50-Year Volume Need	50-Year Volume Need + 55% Contingency	2012 Total Volume Available Per County	Volume + Contingency/Confidence	
St. Lucie	18,017,487	27,927,105	175,847,874	106,149,618	78,222,514
Martin	22,111,000	34,272,050	107,593,227	56,160,331	21,888,281
Palm Beach	45,577,000	70,444,350	191,951,814	117,728,007	47,083,657
Broward	11,650,000	18,057,500	-	-	-18,057,500
Miami-Dade	14,968,300	23,200,865	-	-	-23,200,865
TOTAL	112,323,787	174,101,870	475,392,915	280,037,956	105,936,086

2 All Palm Beach County categories have an additional 25% contingency removed talus content applied in the "Volume Contingency/Confidence" column.
 3 Further investigation, project construction & environmental constraints reduced volumes for Broward and Miami-Dade counties to 0 cubic yards.
 Project 50-year volumes assume placement of scheduled full-sized projects until the end of 2062.

Sand sources in the table include known borrow areas in state and federal waters. Renewable sources such as sand dredged from ebb shoals are incorporated by reducing needs.



THE FLORIDA DEPARTMENT OF ENVIRONMENT (FDEP) SAND RULE

The Florida Department of Environment (FDEP) Sand Rule and Sediment Quality is directed by Florida Administrative Code (F.A.C.) 62B-41.007. The Sand Rule is designed to protect the environmental functions of Florida's beaches and includes parameters regulating:

- Grain Size
- Silt Content
- Sediment Sorting
- Beach Rocks
- Sand Color (Munsell Value)
- Debris
- Shell Content

Other state sediment source criteria not covered specifically in the Sand Rule:
 two-foot (minimum) vertical buffers above poor quality material
 horizontal buffers around sediment sources to prevent damage to hard bottom habitats and cultural resources (can vary from 200 feet or more depending on the quality of the resources the buffers are protecting)

2015 DADE COUNTY LIMITED REEVALUATION REPORT AND ENVIRONMENTAL ASSESSMENT

The sands which currently characterize Miami-Dade County beaches are not "native beach sands" but are the product of over 25 years of beach nourishment using sand dredged primarily from offshore of Miami Beach. Native Miami-Dade County sand was finer-grained and slightly darker than the material that is on the beach today.

The following criteria was used to develop a renourishment scenario for the remaining years of federal participation in the Dade County Beach Erosion Control and Hurricane Protection project:

- Erosion rate
- Color compatibility
- Federal authority to acquire sand source
- Identified for use by another county in SAND Study
- Significant investment/existing permit by other project
- Volume meeting Florida Department of Environment Sand Rule
- Existing core borings
- Completed seismic survey of area
- Volume meeting Miami-Dade grain size specifications
- Volume meeting Miami-Dade color specifications
- Volume meeting Miami-Dade sand specifications
- Production rate
- State versus federal waters
- Distance from project center
- Environmental resource conflicts
- Cultural resource conflicts
- Impact on other beaches

MIAMI-DADE COUNTY SAND-SPECIFIC CRITERIA

GRAIN SIZE	MAXIMUM SILT CONTENT	MUNSELL VALUE
0.30 to 0.55 mm	5% Passing #230 Sieve	6 to 8

- Composed of quartz and/or calcium carbonate with up to 5 % of other composition.
- The sand is naturally occurring, durable and solid.
- Silt content (passing No. 230 sieve (0.063 mm)) of less than 5 %.
- The coarse grains must meet the following gradation limits:
 - 95 % passing the #4 sieve (4.75 mm).
 - 99 % passing the 3/8 inch sieve (9.51 mm).
 - 100 % passing the 3/4 inch sieve (19.0 mm).
- Average Mean Grain Size: 0.30 mm (1.74 phi)-0.55mm (0.86 phi).
- Standard Deviation: 0.50-1.75 phi.
- Free of debris, rocks, rubble, clay and organic material.
- Sand color shall be similar to the existing beach.
 - HUE of: 2.5-10 YR; 2.5-5 Y
 - CHROMA of: 1, 2, or 3
 - VALUE of: 6, 7, or 8

RESULTS

MAP REFERENCE	EXISTING MIAMI-DADE ACCRETION SOURCES		UPLAND SOURCES			OFFSHORE SOURCES (Federal Waters)	
	1	2	3	4	5	6	7
SOURCE	BAKER'S HAULOVER EBB SHOAL	LUMMUS PARK (SOUTH BEACH)	ORTONA	WITHERSPOON	ACI	MARTIN COUNTY	ST. LUCIE COUNTY
VOLUME (cubic yards)	30,000 Annually (no less than 10 years between events)	50,000 Annually (no less than 5 years between events)	adequate	adequate	adequate	600,000	4,600,000
DISTANCE FROM PROJECT SITE	4.5 miles south of northern project limit	Southern 1.5 miles of project	120 miles	120 miles	35 miles	80 miles	120 miles
TRANSPORT	Dredge & pipeline	Dredge & pipeline	Truck haul	Truck haul	Truck haul	Dredge & pipeline	Dredge & pipeline

DADE COUNTY BEACH EROSION CONTROL & HURRICANE PROTECTION PROJECT IDENTIFICATION OF ALTERNATIVE SAND SOURCES FOR THE REMAINING PERIOD OF FEDERAL PARTICIPATION

U.S. ARMY CORPS OF ENGINEERS, JACKSONVILLE DISTRICT

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