# TECHNICAL ADVICE SECTION

## Approach for Sand Searches On the Southeast Florida Atlantic Coast

## 1.1 METHODOLOGICAL APPROACH FOR SAND SEARCHES ON THE SOUTHEAST FLORIDA ATLANTIC COAST

Offshore sand resources along the southeast Florida Atlantic coast occur in four main depositional settings: (1) nearshore sand flats, (2) offshore sand flats, (3) sand ridge fields (northern Palm Beach County), (4) tidal sand flats (Southern Miami-Dade County), (5) tidal sand ridges (Southern Miami-Dade County), and (6) reef gaps and reef gap ramps (Finkl, Andrews and Benedet, 2007). Interreefal sand flats accumulate sandy sediments between nearshore rock reefs and offshore coral reefs. The long, narrow rectangular basins provide potential for large volumes of sand resources that may be suitable for beach renourishment.

Ridge fields are an alternative sediment resource to sand flats. These bathymetrically-positive features, known as sand ridges, are a prominent but under-used, offshore sand deposit. These offshore sand ridges are "mounds of sand" anchored in hardbottom that are generally composed of admixed silicates (quartz) and carbonates (shell fragments, shell hash). Generally, silt content increases with depth and rock fragments are encountered in the boundary between the ridge's sandy sediments and the underlying hardbottom, but sediment thickness and specific composition varies between ridges within the same field and between ridges located in different geographic locations along the coast.

Reef gaps, reef gap ramps, and associated deepwater submarine deltas may represent a new sand source for beach renourishment. The barrier reef along the southeast coast is disjointed with reef sections separated from one another by gaps, which often form conduits for sand transport from the sand flats offshore beyond the barrier reef (Finkl, 2004).

Searches for beach quality sand in sand flats, on sand ridges, or in reef gaps should be based on investigations that feature a logical sequence of steps (Figure 1-1). Sand search procedures developed, for example, by Finkl, Khalil and Andrews (1997), Benedet *et al*. (2004), Finkl and Khalil (2005), and Finkl *et al*. (2006) follow strategic sand search protocols that are widely accepted in the industry. The three-phased protocol suggests that, in areas where bathymetrically positive features (*e.g.* sand ridges, bars, shoals) occur, reconnaissance investigations should concentrate on bathymetric data (preferably recently obtained) and reconnaissance sand samples (Phase I), followed by jet probes (Phase II), and finally seismic reflection (sub-bottom) profiles and vibracores (Phase III).

A logical sequence of offshore sand searches targeting sand resources along the central Florida Atlantic coast should approximate the following steps. These suggested procedures can be adapted to individual survey requirements, but they nevertheless provide a basic framework for sequencing steps in a logical cost-effective progression.

### 1.1.1 Review of Historical Data

Using the ROSS database, the investigator should download historical datasets containing seabed relief information, description of geotechnical data (vibracore logs, jet probe logs, grain size data) and geophysical data (sidescan sonar and seismic reflection profiles) to identify initial target areas for more detailed investigation. The gray scale shaded relief image available from ROSS should be used to identify offshore morphosedimentary features (sand ridges, bars, shoals, sand flats) occurring near a project area. The geotechnical and geophysical layers should then be turned on to see if available sediment data overlie morphosedimentary features of interest. These data may provide initial information regarding deposit thickness and sediment textural properties. After target ridges are identified and data availability checked, the investigator can design a reconnaissance survey plan.

## 1.2 RECONNAISSANCE SURVEY PLAN

The reconnaissance survey plan should focus on obtaining better definition of seafloor geomorphology and morphosedimentary properties. Commonly, a few (more than five) offshore morphosedimentary features are selected on the basis of the Phase I analyses. These potential sand targets typically are then narrowed down to one or two features for more detailed field investigations that may define final borrow areas.

The bathymetric data that is used to define the morphosedimentary features of interest in Phase I most likely will consist of historical NOAA-NOS data that may be several decades old. Because morphosedimentary features tend to be modified by tidal currents and wave action, an updated bathymetric survey is required to determine whether seafloor features changed shape or migrated over time. A reconnaissance seismic reflection profile survey can be conducted simultaneously with the bathymetric survey to determine sediment thickness. Bathymetric data and seismic records can be used to determine sediment thickness and presentation of results in an isopachous map. Undesirable materials such as rubble layers or presence of fine-grained sediments can normally be identified in seismic records if calibration data (*i.e.* historical vibracores) are available. Line spacing in reconnaissance surveys depends on the survey area, but generally ranges from 1000 to 2000 feet.

Traditionally, sand quality and thickness are investigated during preliminary sampling surveys using surface grab samples and jet probes. Because vibracores are more expensive and time-consuming, they are reserved for detailed phases of offshore investigation after the search area has been narrowed to target areas using other methods.

Sand quality and thickness may be investigated during preliminary sampling surveys using surface samples, jet probes or widely-spaced vibracores. Surface grab samples can be deceiving because they only sample the upper few inches of seafloor sediments (generally sediment transported by modern processes) and do not show the characteristics of deeper lying sediments. Jet probes are a cost-effective method to estimate sediment thickness and broadly indicate sediment quality in deeper layers. Because sediment samples extracted from jet probes are disturbed by the water jet, silt content may be underestimated.

One important consideration of sediment variability is that sand quality on the surface, as indicated by surface samples and widely spaced jet probes, may not always be the most effective procedure to select morphosedimentary features for further investigation during reconnaissance efforts. It may be found, for example, that relict sediments underlying the surface of the feature contain cleaner sandy sediments (*e.g.* fewer shell and rubble fragments) than surface sediments. This occurs because modern sedimentation processes that are linked to the upper layers of sedimentation on a sand ridge, for example, may be significantly different from relict sedimentation processes that formed the ridge. Evidence of relict processes is normally found in deeper subsurface layers that have been unaffected by subsequent events. Thus, it is suggested that during reconnaissance investigations of offshore morphosedimentary features on the central Florida Atlantic coast, at least one undisturbed sample (vibracore) be acquired to supplement jet probe and surface sample data for each sedimentary feature that is under investigation. The purpose of this suggestion is to provide better insight into the nature of sediments comprising the core of the feature under study.

Reconnaissance sampling plans should be designed to target the crests or divides of the main morphosedimentary features. Spacing between samples will thus span a range depending on the size of the area under investigation, the total volume targeted, and the project budget.

## 1.3 DETAILED SURVEY PLAN AND PRELIMINARY BORROW AREA DESIGN

Following analysis of the data collected in Phase II, a plan to conduct detailed investigations over a smaller area should be prepared. Detailed investigation plans should strive to obtain enough information to define sand quality for specific quantities and to map the vertical and horizontal continuity of sand layers. This level of investigation also provides sufficient information to identify layers or zones of undesirable sediments that should be avoided during borrow area design. The detailed investigations usually consist of detailed bathymetry, sidescan sonar and seismic reflection profile surveys on 200 to 300 foot grids with vibracores obtained on 1,000 foot centers. Analysis of the information obtained in detailed surveys permits preliminary design of offshore borrow areas and mapping of surface features (*i.e.* environmental resources, possible obstructions to dredging) that occur in or near the borrow area. Tools that assist in the visualization of deposit morphology, sediment thickness, and general characteristics of the borrow area include geological cross-sections and fence diagrams, three-dimensional isopach maps and bathymetric charts, color-coded interpretation of seismic records, etc.

Although these detailed investigations allow for preliminary borrow area design, they are usually not adequate to meet final engineering requirements of complete borrow area design. It must be appreciated that characteristics of sand resources, even in geologically well-known sites, are still subject to interpretive errors that are linked to spatial and temporal variability of natural environments.

### 1.3.1 Cultural Resource Investigations

Detailed geophysical investigations are required to determine whether cultural resources occur within the boundary limits of a proposed borrow area. Geophysical surveys are usually conducted on a grid with tracklines spaced 30 m (98 feet) apart (Note: Cultural resource surveys are conducted on metric grids). The cultural resource surveys generally consist of magnetometer, sidescan sonar and seismic reflection profile surveys. Because these investigations must be conducted at 30 m intervals, other geophysical Phase III investigations are generally conducted along multiple trackline spacings at 60 m (196 feet) and 90 m (294 ft). These multiple-spaced grids are so spaced so that cultural resource investigations can make use of data from Phase III by nesting additional tracklines between lines of prior Phase III geophysical surveys. It is desirable that the cultural resource investigations be conducted using the same type of geophysical equipment deployed in other Phase III geophysical surveys. In this way, borrow area design can be refined using the additional (cultural resource) data obtained, making for efficient use of separate surveys. Presence of cultural resources (i.e. shipwrecks, large cultural artifacts, etc.) requires modification of the borrow area design to avoid disturbing the mapped features. The addition of 200-foot no-dredge buffers around the cultural resource feature usually satisfies this requirement. The margins of the borrow area (when the cultural resource features occur near the borders of the borrow area) may also be modified to meet cultural resource requirements.

### 1.3.2 Borrow Area Impact Analysis (Environmental Investigation and Numerical Modeling)

Data from Phases III and IV may be used to map sensitive environmental resources (e.g. hardbottoms) occurring near the proposed borrow site. If sensitive environmental resources occur near the proposed dredge site, the borrow area design is modified.

In addition to cultural resources and consideration of environmental impacts, there is a need to evaluate whether the proposed borrow sites will adversely affect the nearshore wave climate to cause additional erosion of adjacent beaches. This evaluation is preferably accomplished by using a range of numerical models that simulate wave transformation over the borrow sites. These models can also simulate wave-induced currents, sediment transport, shoreline change, and variation in beach morphology. Several wave models evaluate borrow area impacts on nearshore wave climates. In order to properly evaluate borrow area impact on nearshore waves, spectral wave models that incorporate most of the relevant physical processes of wave transformation (e.g. wave refraction, bottom friction and to a lesser extent diffraction) are recommended. Even though proposed borrow areas may induce changes in the nearshore wave climate, these changes may not necessarily cause additional erosion of adjacent beaches. To evaluate whether the impacts of borrow areas on nearshore waves is significant in terms of beach erosion and deposition patterns, shoreline change models or beach morphology change models can be used.

These models can be either empiric (i.e. sediment transport is calculated based on the output of a wave transformation model that feeds empirical sediment transport formulas) or process-based (output from a wave transformation model is used to calculate wave-induced currents and these are in turn used to calculate bed-load and suspended load sediment transport). Simulations are run for scenarios with and without the proposed dredging. By comparing the with/without dredging scenarios, the investigator can evaluate the impact of dredging on the beach deposition and erosion patterns. If numerical modeling indicates that significant undesirable impacts are expected on adjacent beaches due to borrow area dredging, borrow area design modifications may be required.

### 1.3.3 Final Borrow Area Design

Final borrow area designs, plans, and specifications are prepared when all concerns regarding sediment quality, cultural resource potential, environmental impacts, and physical considerations are addressed. Due to implementation of no-dredge buffers that reduce negative impacts from dredging, final shape and cut depths may differ significantly from the design prepared at the end of Phase III.

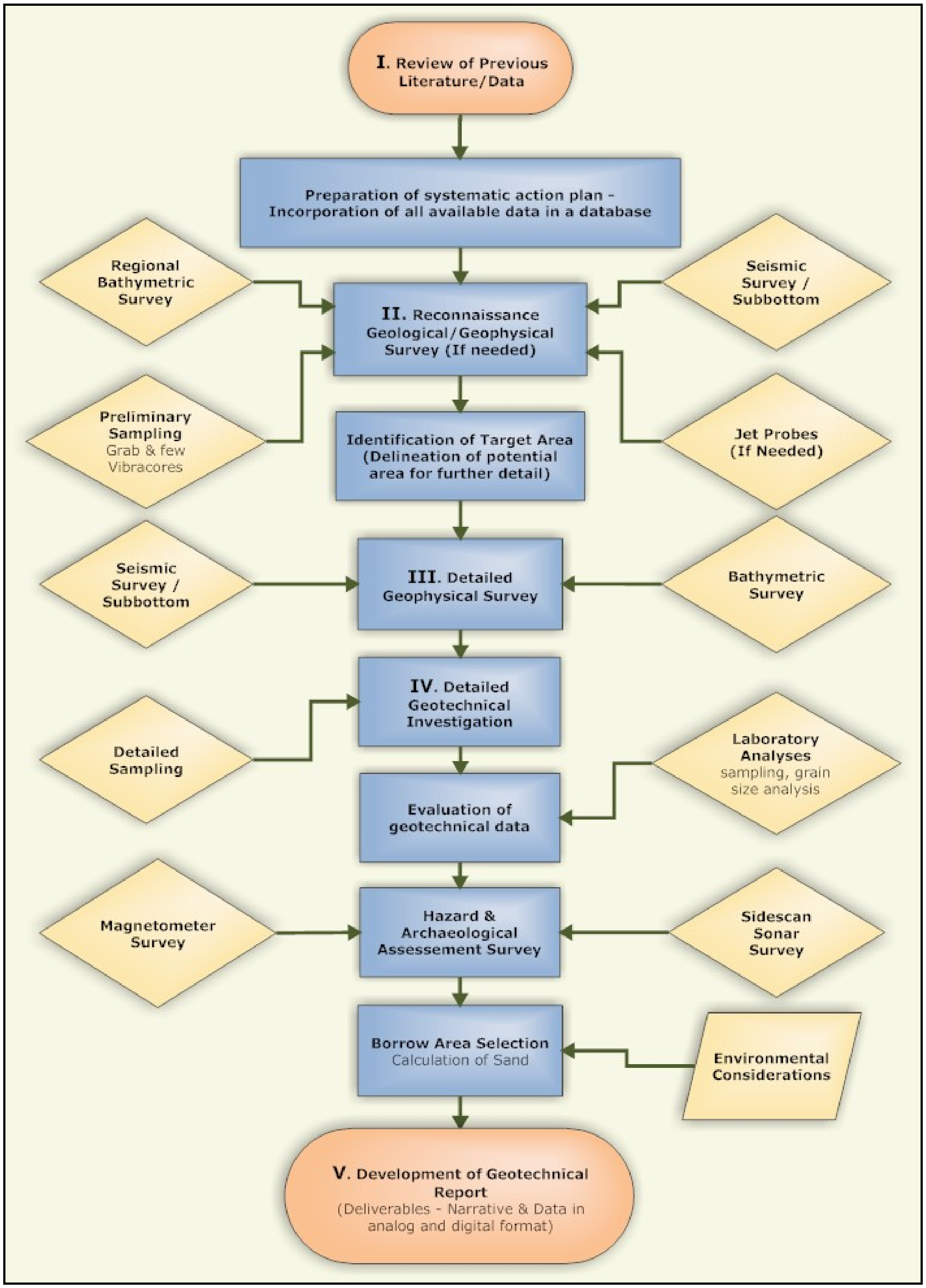


Figure 1-1. Flow diagram showing systematic approaches to offshore sand searches, based on major steps that incorporate a range of subset activities that are restrained by local circumstances. Each task is meant to direct the course of subsequent actions so that sand searches along sandy coasts proceed following a logical strategy that produces an efficient exploration methodology.