Sand Resource Survey Offshore Sand Key
Pinellas County, Florida

by

Guy Gelfenbaum, Stanley D. Locker, and Gregg R. Brooks

Open-File Report 95-547
Sand Resource Survey Offshore Sand Key
Pinellas County, Florida

by

Guy Gelfenbaum¹, Stan D. Locker², and Gregg R. Brooks³

Open-File Report 95-547

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards or with the North American Stratigraphic Code. Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

¹U. S. Geological Survey, Center for Coastal Geology and Regional Marine Studies, St. Petersburg, FL
²University of South Florida, Department of Marine Sciences, St. Petersburg, FL
³Eckerd College, St. Petersburg, FL
TABLE OF CONTENTS

I. INTRODUCTION

II. METHODS
   GEOPHYSICAL SURVEYS
      High-Resolution Seismic Survey
         Acquisition
         Processing
         Interpretation
      Side-Scan Sonar Survey
   VIBRACORE SAMPLING
      Field
      Laboratory

III. RESULTS
   GEOPHYSICAL SURVEYS
      Side-Scan Sonar Bottom Type Map
      Sediment Thickness Map
   VIBRACORE SAMPLING
      Core Log Descriptions
      Grain Size Analysis

IV. INTERPRETATION

V. ACKNOWLEDGEMENTS

VI. REFERENCES

VII. APPENDICES
   A1. SEISMIC SEGMENTS AT CORE SITES
   A2. CORE LOGS
   A3. GRAIN SIZE GRADATION CURVES

VIII. PLATES
   Plate 1. Location Map
   Plate 2. Trackline and Vibracore Location Map
   Plate 3. Side-Scan Sonar Interpretation Map
   Plate 4. Sediment Isopach Map
1. INTRODUCTION

The purpose of this investigation is to identify potential sand sources for beach nourishment on the north end of Sand Key in Pinellas County, west-central Florida (Plate 1). Much of Sand Key is considered a "critical erosion area" by the state's Department of Environmental Protection (Clark, 1992). This designation is used for "segments of the shoreline where substantial development or recreational interests are threatened by the erosion processes." Since the late 1960's, various segments of Sand Key have been nourished, including Indian Rocks Beach, Indian Shores, and North Redington Beach (Loeb, 1994). A primary source of sand for these nourishment projects has been the ebb tidal delta on the north side of the main Egmont channel. The primary Egmont borrow area is 20 miles away from the northern end of Sand Key. Future nourishment projects on the north end of Sand Key would benefit from a closer borrow area. Location of a closer source of sand could result in significant savings in cost.

A previous investigation offshore of Sand Key identified limited sand resources in the adjacent vicinity. A survey conducted in the early 1980's extended approximately 5 miles offshore of Sand Key (D. Rosen, unpub. mapping, 1984). This survey found a thin sand cover approximately 2-4 ft thick over most of the area and several sand ridges extending nearly perpendicular to shore that had sand up to 15 ft thick. This previous study showed a potential sand resource offshore of Sand Key. The purpose of the present investigation is to further identify sand sources in this region.

Two areas, marked A and B in Plate 1, have been selected for detailed geophysical and vibracoring surveys. Area A is approximately 12 miles long and one mile wide and extends along most of the length of Sand Key from just north of John's Pass to just south of Clearwater Pass. Area B is 6 miles long and one mile wide and is located offshore of area A along the northern part of Sand Key. The geophysical surveys were used to identify potential sand deposits and to select sites for vibracoring. Twenty-two vibracore sites were selected based on these geophysical surveys, as well as previously gathered data.
II. METHODS

GEOPHYSICAL SURVEYS

A total of 135 trackline nautical miles of seismic reflection and side-scan sonar data were collected on October 12-13, 1994 using the Florida Institute of Oceanography vessel R/V Suncoaster (Plate 2). The geophysical instrumentation were deployed at the same time and included a high-resolution “boomer” type seismic system and an EG&G side-scan sonar. Tracklines were run in the defined survey areas A and B at a 1000 ft spacing. Navigation was by differential GPS, WGS84 datum, using the differential correction broadcast by the USCG from Egmont Key. Time (GMT), latitude and longitude were logged at 1 minute intervals by computer, annotated on seismic profiles and recorded with seismic shot headers at 1 minute intervals, and annotated on the side scan records every two minutes. The side scan data were recorded on 8 mm tape in EG&G format and include navigation fixes approximately every 2 seconds.

Navigation data were post-cruise processed to remove bad fixes and to correct for the offset between the GPS antenna and the survey equipment location. The final navigation used for mapping has an accuracy estimated at 20-30 feet.

High-Resolution Seismic Survey

Acquisition

Seismic data were recorded using a digital, single-channel acquisition system. This included a HUNTEC Sea Otter boomer source powered at 135 Joules, an ITI 10-channel streamer with 4 adjacent channels selected for this survey, and an Elics Delph2 digital acquisition and processing package. Digital acquisition parameters were set at a 400 ms shot rate, 150 ms record length, and 10,000 Hz sample rate. Separation between the Huntac source and streamer was approximately 5 feet.
Processing

All seismic data were processed using the Elics Delph2 system at USF with the objective of enhancing resolution of the thin sedimentary cover in the survey area. Pertinent processing parameters found to work best were 1000-3500 Hz bandpass filter, the Elics ADD AGC (gain), stacking 3 shots, and positive polarity display. Reflector resolution to 0.5 milliseconds (~1 ft.) was obtained.

Interpretation

The seismic data were used to map sediment thickness in the survey area and to choose targets for vibracoring. Sediment thickness estimates were compared to results from vibracore and jet probe penetrations. Good agreement was found between predicted and actual measurements. Seismic interpretation also incorporated information on rock or sediment at the seafloor as determined from side scan sonographs. Interpreted seismic profiles were digitized to output a file of time of day and sediment thickness measurements in milliseconds. Times were merged with the corrected navigation to calculate positions, and thickness in ms was converted to feet using a sound velocity of 5250 ft/s. The sediment isopach map was drawn by hand using 4 overlays of, in order of importance, the actual digitized values, the side scan interpretation map showing rock outcrop and sediment-covered areas, a computer generated contour map of sediment thickness based on a gridded cell size of about 350 ft, and bathymetry from NOAA Chart 11412. Actual digitized values took precedence and the smoothing of values inherent in computer contouring was eliminated. Where the side scan sonographs indicated oriented bedform topography, such as in the southern portion of area A, that trend was applied as a bias for contouring where small scale variability was noticeable.

Side-Scan Sonar Survey

An EG&G side scan sonar was deployed to help define the spatial extent of unconsolidated sediment and hardbottoms in the study area. An EG&G 272-TD towfish was
operated at 100 kHz with a total swath of 300 m (984 ft), or 150 m (492 ft) on a side. Digital side scan data were taped on an EG&G 380 Exabyte unit.

Side scan data were used to map the distribution of sediment and rock in the study area (Plate 3). The technique used was to “paint in” a 300 m (984 ft) swath display of the cruise track. Three bottom types were identified: 1) a coarse, irregular high backscatter bottom return, 2) a low backscatter return, and 3) a high backscatter return but smoother bottom. These three acoustic patterns are inferred to be sediment, rock (hardground), and other (uncertain), respectively (Figure 1). Experience has shown us that rock/hardbottom exposures exhibit a distinctive coarse, high-backscatter image, while unconsolidated sediments typically exhibit low backscatter, with or without bedforms. A third type mapped exhibited a high-backscatter bottom but smoother and may not have been rock. This "other" type occurred in the southern portion of the study area and often correlated to rock interpreted on adjacent lines.

VIBRACORE SAMPLING

A total of 20 sites were originally selected for vibracoring. Site selection was based upon seismic and side scan sonar data collected for this project as well as previously collected geophysical data. Sites were selected in what were interpreted to represent thick sediment accumulations. Most sites were on bathymetric highs that were interpreted from the seismic data to represent sediment accumulations, whereas others were located in subbottom depressions believed to represent sediment fill. Seismic expressions of core sites are shown in Appendix A1. Due to poor recovery at a few sites and additional side-scan sonar data, an additional two sites were added, making a total of 22 sites occupied (Plate 2).

Field

All vibracoring was conducted aboard the USGS vessel R/V G. K. Gilbert during October - December, 1994. Navigation was by a Trimble NavGraphic GPS used in differential mode. It is estimated that cores were collected within twenty feet of the GPS antennae and that accuracy of the differential GPS was between 10-15 feet. The vibracoring
B. SC94, line 11

“OTHER” probably hardgrounds

SEDIMENT
(low backscatter)

HARDGROUND
(high backscatter)

Figure 1. A and B) side scan data showing three major bottom types mapped. C) Bedforms (λ=60-80 m) on sand ridge at vibracore site COE 13 (see seismic in Appendix A1). Ridge trend and bedform axes are nearly parallel. Dark return = high backscatter.
system utilized consisted of a Branford series R5000 flange-mount vibrating head mounted on an aluminum frame. Two 7.5 hp compressors ran the vibrator at a pressure of 60 psi and a volume of 45 scfm. Cores were collected in 20' long x 3" diameter aluminum barrels. A series of 10' long tubes were first attempted but abandoned due to poor penetration and recovery. Brass core catchers were used in all cases to insure full recovery. Penetration was determined both visually and by marking the side of the barrel. Recovery was determined by directly measuring the thickness of the sediments in the barrel immediately following retrieval. When weather permitted, the sea floor was probed with a jetting lance in an attempt to determine sediment thickness.

Laboratory

Cores were transported to the Eckerd College Marine Geology Laboratory where they were split longitudinally and immediately logged using the Unified Soil Classification System (USCS). Logs were entered into the Geotechnical Graphics computer logging program GTLog, using a template from the Jacksonville District Corps of Engineers (Appendix A2). Sediment samples from each core were collected to represent the variation of sediments encountered, with a minimum of three samples per core. A total of 62 samples were collected and analyzed and the results are in Appendix A3. Grain-size analysis was performed on each sample using the sieve and pipette method. Mean grain size and standard deviation were determined by the method of moments. Grain-size gradation curves were constructed and are reported on ENG form 2087 as is an estimate of shell content.

III. RESULTS

GEOPHYSICAL SURVEYS

Side Scan Sonar Bottom Type Map

The bottom type map represents a direct interpretation of the side scan sonographs to show two primary bottom types - sediment or hardground (Plate 3). Examples of the side
scan data are shown in Figure 1. Side scan images suggest hardgrounds are extensive, with sand occurring as positive relief lenses or ridges above a relatively flat bedrock surface that is exposed between the sediment accumulations. Bathymetry is often a good indicator of sand or rock, the lows being hardbottom, and highs correlating to a sandy bottom. The side scan interpretation was used to aid and verify seismic interpretations and to guide sediment thickness contouring.

Several observations can be made based on the side scan data. In the northern part of the study area (survey areas B and north part of A) sediments occur in large-scale ridge deposits trending NW-SE. These deposits are on the order of 1 km wide and extend for several kilometers. The sediment cover increases in an onshore direction and is mostly continuous near the beach. Toward the southern part of area A more complex side scan backscatter patterns are observed. This appears to reflect a thinner sediment cover over the rock surface, although some thicker deposits do occur. Additionally, east-west lineation patterns are more common associated with large bedforms and perhaps a more mobile substrate.

Sediment Thickness Map

The sediment thickness map represents an integration of all available data on sand thickness and trends (Plate 4). It should be viewed as a conservative estimate of sediment thickness that would correlate with the upper clean quartz sand unit recovered in the cores. Thickest sediment accumulations occur in the northern and far southern portions of the study area in the form of WNW-ESE trending ridges. Almost all of the sediment thickness is due to positive relief accumulation above the generally flat rock surface in this area.

Although the bedrock surface underlying the shelf sediments is generally flat, a few subsurface lows contained unconsolidated sediments penetrated by coring. Examples of this are found in vibracores 9 and 10. However these type of deposits are uncommon and restricted in extent. Where cores penetrated the upper sand unit and encountered organic-rich sediments or other sediment types, a seismic reflector was sometimes evident (see Appendix A). These reflectors typically matched the elevation of the surrounding rock surface. The
interpretive approach used here tended to exclude the presence of these deeper style deposits in the isopach map. In general, sediment thickness on the seismic records was determined to be from the seafloor to the first subbottom return.

Finally, the isopach map represents a significant smoothing of the true variability in thickness due to the depositional geometries. The larger sand ridges themselves are mantled by large sand waves creating highly variable relief (and associated thickness variability) (for example, see Appendix A1 core 13).

VIBRACORES

A summary of the vibracoring cruise log is given in Table 1. Core penetration ranged from 2' to 14'. Recovery ranged from 0 to 12.5'. Jetted depth to refusal ranged from 5.3' to 16.7'. The percent of sediment recovered versus penetration ranged from 65% to 93%. The difference between the amount recovered and that penetrated was mostly due to compaction of the sediments in the core. Longest cores (>7') were collected from sites 1, 6, 8, 9, 13, 16, 17, 18, and 22; most of which are in the northern and inshore portion of the study area. Eight cores (sites 1, 3, 8, 9, 11, 13, 21, and 22) had the bottoms of the barrels chewed up as if encountering a hard refusal layer. Eight cores (sites 1, 3, 9, 10, 12, 13, 15 and 21) contained limestone fragments wedged in the bottom. Three cores (sites 8, 10 and 18) contained a compact blue-gray clay in the bottom. Cores 4, 9, 11, 13, 17, and 22 contained large shell fragments at the base. Core 14 contained a large quantity of blackened (phosphatic?) sand grains at the base.

Core Logs

Core logs are shown in Appendix A2. In general, seven basic lithologies are represented. Relatively clean, fine-grained quartz sand is the dominant lithology, generally occupying the uppermost portion of the cores. Thickest accumulations of clean sand were encountered in cores 6, 9, 13, 17, 18, and 22; most of which are located in the northern portion of the study area. A mixture of quartz sand and shell fragments is common in layers that can be found at any depth downcore and throughout the study area. Quartz sands mixed with blackened grains (phosphorite ?) were abundant in cores 4, 11 and 14. These sediments were found most often in the central to southern part of the study area. Cores were generally
quite short (<3') and, at least in the case of core 14, these blackened sands constitute refusal. Dark brown to black, organic-rich, fine-grained sediments were found in cores 6 and 16 in the northern portion of the study area. They generally occur as relatively thin layers near the core base. Thin layers of light-colored, lime mud were found near the base of cores 8 and 18, both located in the northern region. A hard, compact, blue-gray clay was found at the base of several cores (listed previously) and is thought to represent refusal. Large fragments of limestone found at the base of some cores (listed previously) is interpreted to represent refusal as the core penetrated the underlying limestone surface.

Grain Size Analysis

Grain size data for all sediment samples are presented in Appendix A3 and Table 2. These include two samples (15 and 19) that were collected directly from the sediment surface (i.e., there was no core retrieval). Mean grain size ranges from -0.7 phi (approximately 1.6 mm; very coarse sand) to 6.2 phi (approximately 0.015 mm; medium silt). Most, however, are between 2 and 3 phi (fine sand), especially in the uppermost portions of the core. Standard deviation (a measure of sediment sorting) ranges from 0.8 to 3.8 phi, but the majority are in the 1 to 2 phi range indicating sediments are generally poorly sorted. Grain size gradation curves show that most samples fall into the fine sand-size category. This is especially true for the relatively clean quartz sand samples (described above), which are consistently composed of 50% to 80% fine sand. Sediments containing an appreciable amount of shell material, limestone fragments and/or blackened grains are consistently coarser. Sediment samples containing organic-rich material and the blue-gray clay layers (both of which are located near the bottom of some cores) are consistently finer.
<table>
<thead>
<tr>
<th>Core #</th>
<th>State Plane X (feet)</th>
<th>State Plane Y (feet)</th>
<th>Water Depth</th>
<th>Core Penetration</th>
<th>Core Recovery</th>
<th>%Recovery</th>
<th>Jet Probe Depth</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>COE-94-1(2)**</td>
<td>193,223</td>
<td>1,310,701</td>
<td>28.2'</td>
<td>—</td>
<td>10.5'</td>
<td>—</td>
<td>7.3'</td>
<td></td>
</tr>
<tr>
<td>COE-94-2(2)</td>
<td>195,640</td>
<td>1,312,888</td>
<td>23.5'</td>
<td>—</td>
<td>6.2'</td>
<td>—</td>
<td>10'</td>
<td></td>
</tr>
<tr>
<td>COE-94-3(2)**</td>
<td>199,634</td>
<td>1,314,366</td>
<td>23.4'</td>
<td>—</td>
<td>5.4'</td>
<td>—</td>
<td>5.3'</td>
<td></td>
</tr>
<tr>
<td>COE-94-4(2)**</td>
<td>190,929</td>
<td>1,296,199</td>
<td>24'</td>
<td>6.4'</td>
<td>5.9'</td>
<td>92%</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>COE-94-5</td>
<td>199,756</td>
<td>1,310,663</td>
<td>25'</td>
<td>2.4'</td>
<td>9.6'</td>
<td>—</td>
<td>8.5'</td>
<td></td>
</tr>
<tr>
<td>COE-94-6(2)</td>
<td>209,354</td>
<td>1,312,403</td>
<td>22'</td>
<td>14'</td>
<td>12.5'</td>
<td>89%</td>
<td>16.7'</td>
<td>Muddy, organic material at core bottom.</td>
</tr>
<tr>
<td>COE-94-7</td>
<td>197,476</td>
<td>1,301,045</td>
<td>21'</td>
<td>&lt;1'</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Attempted 3 times, penetration &lt; 1', no recovery.</td>
</tr>
<tr>
<td>COE-94-8(2)**</td>
<td>210,621</td>
<td>1,310,539</td>
<td>18'</td>
<td>—</td>
<td>9.6'</td>
<td>—</td>
<td>8.5'</td>
<td></td>
</tr>
<tr>
<td>COE-94-9(2)**</td>
<td>208,502</td>
<td>1,294,641</td>
<td>19'</td>
<td>10.5'</td>
<td>8.1'</td>
<td>77%</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>COE-94-10(2)**</td>
<td>209,027</td>
<td>1,291,347</td>
<td>22'</td>
<td>2.5'</td>
<td>2.8'</td>
<td>93%</td>
<td>—</td>
<td>This site was cored 2 times.</td>
</tr>
<tr>
<td>COE-94-11(2)*</td>
<td>218,222</td>
<td>1,263,823</td>
<td>14'</td>
<td>4'</td>
<td>2.9'</td>
<td>73%</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>COE-94-12</td>
<td>221,870</td>
<td>1,258,525</td>
<td>14.8'</td>
<td>8'</td>
<td>6.2'</td>
<td>78%</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>COE-94-13(2)^</td>
<td>213,024</td>
<td>1,310,073</td>
<td>19'</td>
<td>—</td>
<td>9.5'</td>
<td>—</td>
<td>5.5'</td>
<td></td>
</tr>
<tr>
<td>COE-94-14</td>
<td>219,815</td>
<td>1,262,860</td>
<td>11.8'</td>
<td>4'</td>
<td>2.6'</td>
<td>65%</td>
<td>8.3'</td>
<td></td>
</tr>
<tr>
<td>COE-94-15(2)^</td>
<td>217,193</td>
<td>1,320,393</td>
<td>16'</td>
<td>3.5'</td>
<td>+++</td>
<td>—</td>
<td>5.3'</td>
<td>Limestone in core catcher.</td>
</tr>
<tr>
<td>COE-94-16</td>
<td>214,074</td>
<td>1,308,702</td>
<td>16'</td>
<td>9'</td>
<td>7.9'</td>
<td>88%</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>COE-94-17(2):</td>
<td>226,036</td>
<td>1,257,745</td>
<td>11'</td>
<td>—</td>
<td>7.7'</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>COE-94-18(2)**</td>
<td>216,612</td>
<td>1,309,132</td>
<td>15'</td>
<td>12'</td>
<td>9.5'</td>
<td>79%</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>COE-94-19(2B)</td>
<td>216,311</td>
<td>1,279,204</td>
<td>15'</td>
<td>4'</td>
<td>+++</td>
<td>—</td>
<td>—</td>
<td>Attempted 3 times.</td>
</tr>
<tr>
<td>COE-94-20</td>
<td>199,811</td>
<td>1,310,838</td>
<td>24'</td>
<td>2'</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Hardgrounds listed on the navigation chart.</td>
</tr>
<tr>
<td>COE-94-21**(2)</td>
<td>205,547</td>
<td>1,308,480</td>
<td>23'</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Limestone in core catcher.</td>
</tr>
<tr>
<td>COE-94-22**</td>
<td>210,794</td>
<td>1,288,546</td>
<td>17'</td>
<td>9.5'</td>
<td>7.9'</td>
<td>83%</td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>

* Bottom of core barrel banged up.
~ Blue-gray clay layer found at base of core.
^ Limestone fragments at base of core.
+++ No core, sample bag only.
: Gravel size shells in core bottom.
--- No data.
(2) Second time site occupied.
(2B) Second attempt at same site.
## Table 2. Grain Size Statistics

<table>
<thead>
<tr>
<th>CORE #</th>
<th>INTERVAL (FEET)</th>
<th>MEAN GRAIN SIZE (PHI)</th>
<th>STANDARD DEVIATION (PHI)</th>
<th>CORE #</th>
<th>INTERVAL (FEET)</th>
<th>MEAN GRAIN SIZE (PHI)</th>
<th>STANDARD DEVIATION (PHI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COE-94-1(2)</td>
<td>2.0-2.1</td>
<td>2.8</td>
<td>1.1</td>
<td>COE-94-12</td>
<td>0.7-0.8</td>
<td>1.6</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>7.3-7.4</td>
<td>2.3</td>
<td>1.3</td>
<td></td>
<td>3.2-3.3</td>
<td>2.1</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>8.7-8.8</td>
<td>0.5</td>
<td>2.0</td>
<td></td>
<td>5.3-5.4</td>
<td>-0.7</td>
<td>1.6</td>
</tr>
<tr>
<td>COE-94-2(2)</td>
<td>1.0-1.1</td>
<td>2.7</td>
<td>0.9</td>
<td>COE-94-13(2)</td>
<td>1.0-1.1</td>
<td>3.0</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>3.0-3.1</td>
<td>1.7</td>
<td>1.8</td>
<td></td>
<td>6.5-6.6</td>
<td>2.0</td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td>5.0-5.1</td>
<td>2.9</td>
<td>1.0</td>
<td></td>
<td>7.5-7.6</td>
<td>1.1</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>1.0-1.1</td>
<td>2.3</td>
<td>1.2</td>
<td></td>
<td>8.4-8.3</td>
<td>0.6</td>
<td>2.6</td>
</tr>
<tr>
<td>COE-94-3(2)</td>
<td>1.0-1.1</td>
<td>2.3</td>
<td>1.2</td>
<td>COE-94-14</td>
<td>0.4-0.5</td>
<td>1.9</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>3.5-3.6</td>
<td>2.9</td>
<td>1.2</td>
<td></td>
<td>1.3-1.4</td>
<td>2.0</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>4.8-4.9</td>
<td>-0.4</td>
<td>2.1</td>
<td></td>
<td>2.4-2.5</td>
<td>1.5</td>
<td>1.8</td>
</tr>
<tr>
<td>COE-94-4(2)</td>
<td>1.0-1.1</td>
<td>2.4</td>
<td>1.1</td>
<td>COE-94-15(2)</td>
<td>2.1</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.9-4.0</td>
<td>2.8</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.7-5.8</td>
<td>0.9</td>
<td>2.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COE-94-6(2)</td>
<td>1.0-1.1</td>
<td>3.0</td>
<td>1.3</td>
<td>COE-94-16</td>
<td>0.1-0.2</td>
<td>1.9</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>2.4-2.5</td>
<td>1.8</td>
<td>1.9</td>
<td></td>
<td>1.1-1.2</td>
<td>2.6</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>7.5-7.6</td>
<td>2.1</td>
<td>2.3</td>
<td></td>
<td>4.2-4.3</td>
<td>1.8</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>8.7-8.8</td>
<td>2.8</td>
<td>2.4</td>
<td></td>
<td>6.7-6.8</td>
<td>2.8</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>10.7-10.8</td>
<td>6.2</td>
<td>2.2</td>
<td></td>
<td>7.7-7.8</td>
<td>3.4</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>12.2-12.3</td>
<td>4.8</td>
<td>2.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COE-94-8(2)</td>
<td>1.5-1.6</td>
<td>2.8</td>
<td>1.3</td>
<td>COE-94-17(2)</td>
<td>0.2-0.3</td>
<td>2.0</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>3.6-3.7</td>
<td>2.5</td>
<td>1.9</td>
<td></td>
<td>1.8-1.9</td>
<td>1.0</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>7.6-7.7</td>
<td>2.0</td>
<td>3.1</td>
<td></td>
<td>4.0-4.1</td>
<td>2.4</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>8.7-8.8</td>
<td>5.6</td>
<td>2.6</td>
<td></td>
<td>6.2-6.3</td>
<td>0.5</td>
<td>2.2</td>
</tr>
<tr>
<td>COE-94-9(2)</td>
<td>1.1-1.2</td>
<td>2.8</td>
<td>1.0</td>
<td>COE-94-18(2)</td>
<td>2.0-2.1</td>
<td>2.4</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>3.8-3.9</td>
<td>2.7</td>
<td>1.0</td>
<td></td>
<td>6.4-6.5</td>
<td>3.2</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td>4.9-5.0</td>
<td>2.3</td>
<td>1.1</td>
<td></td>
<td>8.0-8.1</td>
<td>1.4</td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td>5.8-5.9</td>
<td>0.4</td>
<td>1.8</td>
<td></td>
<td>9.2-9.3</td>
<td>3.1</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>7.5-7.6</td>
<td>-0.6</td>
<td>1.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COE-94-10(2)</td>
<td>0.4-0.5</td>
<td>2.7</td>
<td>1.3</td>
<td>COE-94-19(2)</td>
<td>2.6</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.1-1.2</td>
<td>1.0</td>
<td>1.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.2-2.3</td>
<td>4.3</td>
<td>3.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>COE-94-19(2B)</td>
<td>3.0</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>COE-94-11(2)</td>
<td>0.5-0.6</td>
<td>2.4</td>
<td>1.4</td>
<td>COE-94-22</td>
<td>1.0-1.1</td>
<td>2.8</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>1.6-1.7</td>
<td>1.3</td>
<td>2.2</td>
<td></td>
<td>4.8-4.9</td>
<td>2.3</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>2.7-2.8</td>
<td>1.1</td>
<td>2.3</td>
<td></td>
<td>7.3-7.4</td>
<td>1.2</td>
<td>1.6</td>
</tr>
</tbody>
</table>
IV. INTERPRETATION

Vibracoring results suggest that the majority of unconsolidated sediment was penetrated by the corer and retrieved. The 65% - 93% recovery rate is consistent with this type of coring technique and is interpreted to be a result of sediment compaction. A comparison of the core recovery to the jetted depth (Table 1) indicates that for most sites the core bottomed out within two feet of the jetted depth. In three instances, however, the core penetrated deeper than was jetted, indicating that jetting did not always reach the refusal depth. The ten cores that contained limestone fragments and/or blue-gray clay at their bases, are interpreted to have penetrated the entire thickness of surficial unconsolidated sediments. The limestone fragments indicate penetration into a lithified or semi-lithified surface. The blue-gray clay probably represents the top of the Hawthorn Formation, a phosphatic limestone deposited during the Miocene (Stahl, 1970; Campbell, 1973; Brooks and Doyle, 1989). This blue-gray clay is quite distinctive and has been encountered throughout the Tampa Bay region. The cores bottoming out in the coarse shell layer may have penetrated the entire thickness of the surficial sediment layer as core logs show that it is quite common to encounter a coarse shell layer immediately above (or even in addition to) the limestone or blue-gray clay (Appendix A2). Evidence is purely circumstantial at this point, however, as shell layers are encountered at all depths. Sediments rich in blackened grains were found to be unrecoverable or yielded short cores. The reason for this is unknown but previous workers have suggested that blackened grains consist of phosphorite that has been winnowed from the underlying Hawthorn Formation (Doyle and Sparks, 1980). A reasonable interpretation is that sediment cover may be very thin in these areas.

Of the longest cores retrieved, most (cores 1, 6, 8, 13, and 18) were consistently located in a relatively confined zone in the northernmost portion of the study area (Plate 2). These cores also exhibited the thickest layers of relatively clean quartz sand, which was consistently found on, or near, the surface. The interpretation is that this area exhibits the thickest accumulation of unconsolidated surface sediments, including the thickest deposit of relatively clean, quartz sand. Seismic and vibracore data show that the bottom is represented by a series of roughly parallel, northwest-southeast trending sand ridges. The largest of these sand ridges in the study area is roughly 1 mile wide by 5 miles long. Whether they are presently mobile is unknown.
Our recommendation at this stage is that future work be focused on these sand ridges, or similar features identified within the study area. Future studies should address the geologic history of these sand ridges, as well as, whether modern processes play a role in modifying these features.

V. ACKNOWLEDGEMENTS

This work was primarily funded by the U.S. Army Corps of Engineers, Jacksonville District, and supplemented by funds from the U.S. Geological Survey's Marine and Coastal Program. We wish to thank the captain and crew of the R/V Suncoaster for their help in collecting the geophysical data, and the captain of the R/V Gilbert for his help in collecting the vibracores. We also want to thank Nancy DeWitt, Jim Edwards, Sean Leatham, and Kevin Geraghty for their help in collecting and processing the vibracores. Finally, we thank Mark Hansen and Jennifer Bexley for producing the maps.
VI. REFERENCES


APPENDIX A1

Seismic Segments at Core Sites
APPENDIX A2

Core Logs
Hole No. COE-94-1 (2)

1. PROJECT
Sand Resource Survey off Sand Key

2. LOCATION (Coordinates of Station)
X=183,223 Y=1,310,701

3. DRILLING AGENCY
U.S. Geological Survey

4. HOLE NO. (As shown on drawing title and the number)
COE-94-1 (2)

5. NAME OF DRILLER
Guy Gelfenbaum/Richard W. Young

6. DIRECTION OF HOLE
□ VERTICAL □ INCLINED

7. THICKNESS OF BURDEN
0 Ft.

8. DEPTH DRILLED INTO ROCK
0 Ft.

9. TOTAL DEPTH OF HOLE
10.5 Ft.

10. SIZE AND TYPE OF BIT
3" light vibracore

11. ELEVATION FOR ELEVATION SHOWN
TGM or MSL

12. MANUFACTURER'S DESIGNATION OF DRILL
United States Geological Survey

13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN
disturbed: 0 undisturbed: 0

14. TOTAL NUMBER OF CORE BOXES
1

15. ELEVATION GROUND WATER
+1.61

16. DATE HOLE STARTED/COMPLETED
12/28/94

17. ELEVATION TOP OF HOLE
-26.59 Ft.

18. TOTAL CORE RECOVERY FOR BORING
NA %

19. SIGNATURE OF GEOLOGIST

LEGEND

CLASSIFICATION OF MATERIALS (Description)

<table>
<thead>
<tr>
<th>ELEV.</th>
<th>DEPTH</th>
<th>STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>-26.6</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

SAND, fine grained quartz, tan, (SP)
Gradual transition into medium to coarse quartz, clean, trace shell content, (SP).

<table>
<thead>
<tr>
<th>ELEV.</th>
<th>DEPTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>-34.7</td>
<td>8.1</td>
</tr>
</tbody>
</table>

SAND, gravelly, mostly angular shell fragments, small amount of black sands (phosphates?), (SW).

<table>
<thead>
<tr>
<th>ELEV.</th>
<th>DEPTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>-36.1</td>
<td>9.5</td>
</tr>
</tbody>
</table>

GRAVEL, fine to coarse gravel size limestone fragments, small amount of sand, (GW).
Cobble size limestone at base.

<table>
<thead>
<tr>
<th>ELEV.</th>
<th>DEPTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>-37.1</td>
<td>10.5</td>
</tr>
</tbody>
</table>

NOTE:
The lines in the SAMPLE NUMBER column indicate the intervals at which samples were taken for laboratory grain size analysis.

NOTE:
LABORATORY CLASSIFICATION
Sample Depth / Classification

| 2.0-2.1 | SP     |
| 7.3-7.4 | SP     |
| 8.7-8.8 | SW     |

Classification is based upon a gradation curve.
<table>
<thead>
<tr>
<th>ELEV.</th>
<th>DEPTH</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
<th>CORSE REC %</th>
<th>REMARKS</th>
<th>SAMPLE NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>-22.5</td>
<td>0</td>
<td>SAND, clean, fine to medium quartz, gray color, trace shell fragments, (SP)</td>
<td></td>
<td></td>
<td>-22.5</td>
</tr>
<tr>
<td>-25.4</td>
<td>2.9</td>
<td>SAND, some angular shell fragments, small amount black sands (phosphates?), (SW)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-26.7</td>
<td>3.2</td>
<td>SAND, quartz, clean, fine to medium, gray color, trace shell content, (SP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-28.7</td>
<td>6.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**
The lines in the SAMPLE NUMBER column indicate the intervals at which samples were taken for laboratory grain size analysis.

**NOTE:**
LABORATORY CLASSIFICATION

<table>
<thead>
<tr>
<th>Sample Depth / Classification</th>
<th>SP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0-1.1</td>
<td></td>
</tr>
<tr>
<td>3.0-3.1</td>
<td></td>
</tr>
<tr>
<td>5.0-5.1</td>
<td></td>
</tr>
</tbody>
</table>

Classification is based upon a gradation curve.
**DRILLING LOG**

**Hole No. COE-94-3 (2)**

1. **PROJECT**: Sand Resource Survey Off Sand Key
2. **LOCATION**: (Coordinates or Station) X=99,634 Y=1,314,366
3. **DRILLING AGENCY**: U.S. Geological Survey
4. **HOLE NO.**: COE-94-3 (2)
5. **NAME OF DRILLER**: Guy Gelfenbaum/Richard W. Young
6. **DIRECTION OF HOLE**: VERTICAL
7. **THICKNESS OF BURDEN**: 0 ft.
8. **DEPT Drilled INTO ROCK**: 0 ft.
9. **TOTAL DEPTH OF HOLE**: 5.4 ft.

### Classification of Materials

<table>
<thead>
<tr>
<th>ELEV.</th>
<th>DEPTH</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-22.6</td>
<td>0</td>
<td>SAND, fine to medium quartz, gray color, trace black sands (phosphates?), trace fine shell fragments, (SP)</td>
</tr>
<tr>
<td>-25.9</td>
<td>3.3</td>
<td>Thin lens of black sands (phosphates?), 0.1' thick.</td>
</tr>
<tr>
<td>-27.2</td>
<td>4.6</td>
<td>SILTY SAND, dark gray, (SM)</td>
</tr>
<tr>
<td>-28.0</td>
<td>5.4</td>
<td>GRAVEL, limestone fragments, small amount of silty sand. Cobble size limestone at base. (GP)</td>
</tr>
</tbody>
</table>

**NOTE:**

The lines in the SAMPLE NUMBER column indicate the intervals at which samples were taken for laboratory grain size analysis.

**NOTE:**

LABORATORY CLASSIFICATION

<table>
<thead>
<tr>
<th>Sample Depth</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0–1.1</td>
<td>SP</td>
</tr>
<tr>
<td>3.5–3.6</td>
<td>SP</td>
</tr>
<tr>
<td>4.8–4.9</td>
<td>SW</td>
</tr>
</tbody>
</table>

Classification is based upon a gradation curve.

**DATE HOLE STARTED COMPLETED**: 12/28/94 12/28/94

**ELEVATION GROUND WATER**: +0.84 ft.

**TOTAL CORE RECOVERY FOR BORING**: 0 %

**SIGNATURE OF GEOLOGIST**: [Signature]
### DRILLING LOG

<table>
<thead>
<tr>
<th>DIVISION</th>
<th>INSTALLATION</th>
<th>SHEET</th>
<th>PROJECT</th>
<th>HOLE NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Atlantic</td>
<td>Jacksonville</td>
<td></td>
<td>Sand Resource Survey Off Sand Key</td>
<td>COE-94-4 (2)</td>
</tr>
</tbody>
</table>

#### 1. LOCATION (if shown on drawing title and file number)

- **X=190,929 Y=1,286,189**

#### 2. DRILLING AGENCY

- U.S. Geological Survey

#### 3. HOE NO. (As shown and file number)

- COE-94-4 (2)

#### 4. NAME OF DRILLER

- Nancy T. DeWitt/Richard W. Young

#### 5. DIRECTION OF HOLE

- 153 VERTICAL CD

#### 6. THICKNESS OF BURDEN

- 0 Ft.

#### 7. DEPTH DRILLED INTO ROCK

- 0 Ft.

#### 8. TOTAL DEPTH OF HOLE

- 5.9 Ft.

#### 9. ELEVATION GROUND WATER

- +1.68

#### 10. SIZE AND TYPE OF BIT

- 3" light vibracore

#### 11. DATE HOLE STARTED COMPLETED

- 12/20/94 12/20/94

#### 12. MANUFACTURER'S DESIGNATION OF DRILL

- United States Geological Survey

#### 13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN

- disturbed: 0 undisturbed: 0

#### 14. TOTAL NUMBER OF CORE BOXES

- 1

#### 15. SIGNATURE OF GEOLOGIST

- Nancy T. DeWitt

#### 16. TYPICAL SAMPLE NUMBER

- Core Recovery for Boring See Note

#### 17. LABORATORY CLASSIFICATION

- Sample Depth / Classification

<table>
<thead>
<tr>
<th>Sample Depth</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0-1.1</td>
<td>SP</td>
</tr>
<tr>
<td>3.9-4.0</td>
<td>SP</td>
</tr>
<tr>
<td>5.7-6.8</td>
<td>SW/SM</td>
</tr>
</tbody>
</table>

Classification is based upon a gradation curve.

#### NOTES

- The lines in the SAMPLE NUMBER column indicate the intervals at which samples were taken for laboratory grain size analysis.

- Penetration 6.4'

- 92% Recovery due to compaction

- Laboratory classification is based upon a gradation curve.
<table>
<thead>
<tr>
<th>ELEV.</th>
<th>DEPTH</th>
<th>LEGEND</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
<th>CORE REC</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>-21.4</td>
<td>0</td>
<td></td>
<td>SAND, clean fine to medium quartz, (SP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-23.7</td>
<td>2.3</td>
<td></td>
<td>Thin layer with small amount black sands (phosphates?), and fine gravel size shells (whole and fragments), 0.2' thick, (SW)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-25.2</td>
<td>3.8</td>
<td></td>
<td>SANDS fine to medium with some coarse gravel size shells (whole and fragments), (SM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-28.3</td>
<td>6.9</td>
<td></td>
<td>SAND, clean fine to medium quartz, (SP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-29.4</td>
<td>8.0</td>
<td></td>
<td>Thin layer with mostly black sands (phosphates?) and gravel size limestone fragments, 0.2' thick, (SW)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-31.5</td>
<td>10.1</td>
<td></td>
<td>SAND, quartz, trace of fine gravel size shell fragments, (SP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-33.4</td>
<td>12.0</td>
<td></td>
<td>SILT, dark brown and black, trace of fine gravel size shells, (whole and fragments), wet, low to medium plasticity, (OL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-33.9</td>
<td>12.5</td>
<td></td>
<td>ORGANIC SILT, trace clays, homogeneous, black color, medium plasticity, wet, organic odor, (OL)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE: clean, fine to medium quartz sand down to 7.1 feet with the exception of the layers listed.

NOTE: Transitional zone from sands to sandy silts

NOTE: The lines in the SAMPLE NUMBER column indicate the intervals at which samples were taken for laboratory grain size analysis.

NOTE: Penetration 14' 89% Recovery due to compaction.

NOTE: Laboratory Classification

classification

Sample Depth / Classification

1.0-1.1 SP/SC
2.4-2.5 SW
4.7-4.8 SP/SM
8.7-8.8 SM
10.7-10.8 ML
12.2-12.3 ML

Classification is based upon a gradation curve.
**Hole No. COE-94-8 (2)**

<table>
<thead>
<tr>
<th>ELEV.</th>
<th>DEPTH</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
<th>Core Rec</th>
<th>Sample Number</th>
<th>Remarks (Bit or Barrel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-16.9</td>
<td>0</td>
<td>SAND, quartz, fine to medium grained, (SP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-19.5</td>
<td>2.6</td>
<td>SAND, fine to medium quartz mixed with fine, gravel size whole shells, (SW)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-21.0</td>
<td>4.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-21.5</td>
<td>4.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-21.9</td>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-22.0</td>
<td>5.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-22.8</td>
<td>6.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-23.9</td>
<td>7.0</td>
<td>CARBONATE Silt, light tan color, (CL)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-24.9</td>
<td>8.0</td>
<td>CLAY, blueish green-gray color, wet, (CH)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-26.5</td>
<td>9.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**LEGEND**
- Ø VERTICAL
- □ INCLINED

**NOTE:** The (SW) layers from depth 0.0' - 7.0' all have the same description as the first (SW) layer described.

**NOTE:** The (SP) layer from depth 0.0' - 7.0' all have the same description as the first (SP) layer described.

**NOTE:** The lines in the SAMPLE NUMBER column indicate the intervals at which samples were taken for laboratory grain size analysis.

**NOTE:** LABORATORY CLASSIFICATION
Sample Depth / Classification
- 1.5-1.6 SP
- 3.6-3.7 SP/SC
- 7.6-7.7 SM
- 8.7-8.8 CL

Classification is based upon a gradation curve.
**DRILLING LOG**

<table>
<thead>
<tr>
<th>DIVISION</th>
<th>South Atlantic</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSTALLATION</td>
<td>Jacksonville</td>
</tr>
<tr>
<td>HOLE NO.</td>
<td>COE-94-9 (2)</td>
</tr>
<tr>
<td>PROJECT</td>
<td>Sand Resource Survey Off Sand Key</td>
</tr>
<tr>
<td>LOCATION</td>
<td>Coordinates or Station: X=208,502 Y=1,284,644</td>
</tr>
<tr>
<td>DRILLING AGENCY</td>
<td>U.S. Geological Survey</td>
</tr>
<tr>
<td>HOLE NO. (as shown on drawing title and file number)</td>
<td>COE-94-9 (2)</td>
</tr>
<tr>
<td>NAME OF DRILLER</td>
<td>Gregg Brooks/Richard M. Young</td>
</tr>
<tr>
<td>DIRECTION OF HOLE</td>
<td>Vertical</td>
</tr>
<tr>
<td>THICKNESS OF BURDEN</td>
<td>0 ft.</td>
</tr>
<tr>
<td>TOTAL DEPTH OF HOLE</td>
<td>8.1 ft.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ELEV.</th>
<th>DEPTH</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
<th>CORE REC %</th>
<th>SAMPLE NUMBER</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>-18.3</td>
<td>0</td>
<td>SAND, fine to medium quartz, light tan color, (SP)</td>
<td>-</td>
<td>-18.3</td>
<td>Bit or Barrel</td>
</tr>
<tr>
<td>-23.7</td>
<td>5.4</td>
<td>GRAVEL, fine to coarse angular shell fragments, some sand, (GP)</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>-26.4</td>
<td>8.1</td>
<td>GRAVEL, coarse size shells (whole and fragments), and limestone fragments, some sand, (GP)</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**
The lines in the Sample Number column indicate the intervals at which samples were taken for laboratory grain size analysis.

**NOTE:**
Penetration 10.5'
77% Recovery due to compaction.

**NOTE:**
LABORATORY CLASSIFICATION
Sample Depth / Classification
1.0-1.2 SP
3.8-3.9 SP
4.0-5.0 SP
5.8-5.9 SW
7.5-7.6 SW
Classification is based upon a gradation curve.
<table>
<thead>
<tr>
<th>ELEV.</th>
<th>DEPTH</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
<th>CORE REC %</th>
<th>SAMPLE NUMBER</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>-21.0</td>
<td>0</td>
<td>SAND, fine to medium quartz, dark gray, trace shell fragments, trace black sands (phosphates?), (SP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-22.0</td>
<td>0.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-22.5</td>
<td>1.4</td>
<td>SAND, with mostly fine grained angular shell fragments, trace black sands (phosphates?), (SW)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-23.0</td>
<td>1.9</td>
<td>Cobble size, limestone (GP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-23.8</td>
<td>2.8</td>
<td>CLAY, blue/green to gray color, with distinct white, coarse, gravel size limestone fragments, (CH)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**
The lines in the SAMPLE NUMBER column indicate the interval at which samples were taken for laboratory grain size analysis.

**NOTE:**
Penetration 3', 93% Recovery due to compaction.

**NOTE:**
LABORATORY CLASSIFICATION
Sample Depth / Classification

- 0.4–0.5 SP
- 1.1–1.2 SP
- 2.2–2.3 ML

Classification is based upon a gradation curve.
<table>
<thead>
<tr>
<th>ELEV. (FT)</th>
<th>DEPTH (FT)</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
<th>CORE REC. %</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>-12.9</td>
<td>0</td>
<td>SAND, medium grained quartz, dark gray, small amount black sands (phosphates?), trace angular shell fragments, (SP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-14.4</td>
<td>1.5</td>
<td>SAND, some medium to coarse sand size, angular shell fragments (SW)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-14.7</td>
<td>1.8</td>
<td>Some medium to coarse size, angular shell fragments at base.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-15.8</td>
<td>2.9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**
- The lines in the SAMPLE NUMBERS column indicate the intervals at which samples were taken for grain size analysis.
- NOTE: Penetration 4', 73% Recovery due to compaction.
- NOTE: LABORATORY CLASSIFICATION
  Sample Depth / Classification
  0.5-0.6 SP/SC
  1.6-1.7 SW/SC
  2.7-2.8 SW/SC
  Classification is based upon a gradation curve.
<table>
<thead>
<tr>
<th>ELEV.</th>
<th>DEPTH</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
<th>CORE SAMPLE NUMBER</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>-13.9</td>
<td>0</td>
<td>SAND, quartz, fine to medium, tan color, some sand size shell fragments (SP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-15.9</td>
<td>2.0</td>
<td>SAND with mostly coarse angular shell fragments, 0.2' thick, (SW)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-17.5</td>
<td>3.6</td>
<td>SAND with mostly coarse, angular shell fragments, 0.1' thick, (SW)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-18.4</td>
<td>4.5</td>
<td>SAND with mostly coarse shell fragments, 0.1' thick, (SW)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-19.0</td>
<td>5.1</td>
<td>GRAVEL, with cobble size limestone, some sand, (GP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-19.4</td>
<td>5.5</td>
<td>Same sand as in (SP) above.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE: The lines in the SAMPLE NUMBER column indicate the intervals at which samples were taken for laboratory grain size analysis.

NOTE: Penetration 8'. 78% Recovery due to compaction.

NOTE: LABORATORY CLASSIFICATION
Sample Depth / Classification
0.7-0.8 SP
3.2-3.3 SP
5.3-5.4 SW

Classification is based upon a gradation curve.
# DRILLING LOG

<table>
<thead>
<tr>
<th>ELEV.</th>
<th>DEPTH</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
<th>CORE REC. %</th>
<th>SAMPLE NUMBER</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>-17.2</td>
<td>0</td>
<td>SAND, fine to medium quartz, tan color, homogenous, (SP)</td>
<td>-17.2</td>
<td></td>
<td>Bit or Barrel</td>
</tr>
<tr>
<td>-23.3</td>
<td>6.1</td>
<td>SAND, fine to medium quartz, some coarse gravel size shell fragments, (SP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-24.4</td>
<td>7.3</td>
<td>SILT lens, inorganic, (MH)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-25.1</td>
<td>7.9</td>
<td>SAND, coarse grained with black sands (phosphates?), (SP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-26.7</td>
<td>9.5</td>
<td>GRAVEL, limestone fragments, and angular shell fragments, (GW)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**
The lines in the SAMPLE NUMBER column indicate the intervals at which samples were taken for laboratory grain size analysis.

**NOTE:**
LABORATORY CLASSIFICATION Sample Depth / Classification

- 1.0-1.1 SP/SC
- 6.5-6.6 SP
- 7.5-7.6 SW/SC
- 8.4-8.5 SW/SC

Classification is based upon a gradation curve.
**Hole No.: COE-94-14**

<table>
<thead>
<tr>
<th>ELEV. DEPTH</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
<th>CORE REC %</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>-12.1</td>
<td>SAND, quartz, fine to coarse, dark gray color, some black sands (phosphates?), and mostly angular shell fragments throughout (SN)</td>
<td>-12.1</td>
<td>Bit or Barrel</td>
</tr>
<tr>
<td>-14.7</td>
<td>2.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**
- The lines in the SAMPLE NUMBER column indicate the intervals at which samples were taken for laboratory grain size analysis.

**NOTE:**
- Penetration 4'
- 65% Recovery due to compaction.

**NOTE:**
- LABORATORY CLASSIFICATION
  - Sample Depth / Classification
    - 0.4-0.5 SP
    - 1.3-1.4 SP
    - 2.4-2.5 SP/SC
  - Classification is based upon a gradation curve.
<table>
<thead>
<tr>
<th>ELEV.</th>
<th>DEPTH</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
<th>CORE REC %</th>
<th>SAMPLE NUMBER</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>-14.5</td>
<td>0</td>
<td>SILTY SAND, dark gray color,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>some black sands (phosphates?), (SM)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-15.1</td>
<td>0.6</td>
<td>SAND, clean, quartz, grey color,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>trace black sands (phosphates?) (SP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-16.5</td>
<td>2.0</td>
<td>SAND, quartz, grey color, sand</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>size angular shell fragments,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>trace black sands (phosphates?), (SP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-17.8</td>
<td>3.2</td>
<td>Cobble size limestone fragment,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>gravel size shells, some sand</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-20.4</td>
<td>6.8</td>
<td>SAND, same as SP above</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-21.3</td>
<td>6.8</td>
<td>SANDY SILT with some organics, (OL)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-21.7</td>
<td>7.2</td>
<td>Organic rich layer (OL)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-22.4</td>
<td>7.9</td>
<td>SILTY CLAY with medium stiffness (OL)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** The lines in the SAMPLE NUMBER column indicate the intervals at which samples were taken for laboratory grain size analysis.

**NOTE:** Penetration 8', 88% Recovery due to compaction.

**NOTE:** LABORATORY CLASSIFICATION

Sample Depth / Classification

- 0.1-0.2 SP
- 1.1-1.2 SP
- 4.2-4.3 SP
- 6.7-6.8 SP/SM
- 7.7-7.8 SC

Classification is based upon a gradation curve.
<table>
<thead>
<tr>
<th>ELEV.</th>
<th>DEPTH</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
<th>CORE REC %</th>
<th>REMARKS</th>
<th>Bit or Barrel</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10.7</td>
<td>0</td>
<td>Thin sandy shell layer 0.1&quot; thick</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-11.7</td>
<td>1.0</td>
<td>Thin sandy shell layer 0.1&quot; thick</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-12.5</td>
<td>1.8</td>
<td>Thin layer of coarse gravel size shells, 0.1&quot; thick</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-15.2</td>
<td>6.2</td>
<td>Thin layer of gravel size shell fragments, 0.1&quot; thick</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-17.7</td>
<td>7.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-18.4</td>
<td>7.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### legends:
- **SP**: Sand, clean fine quartz, gray color, trace black sands (phosphates?) throughout the entire core.
- **SW**: Sand, coarse fragment.

**NOTE:**
The lines in the Sample Number column indicate the intervals at which samples were taken for laboratory grain size analysis.

**NOTE:**
LABORATORY CLASSIFICATION

<table>
<thead>
<tr>
<th>Sample Depth / Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2-0.3</td>
</tr>
<tr>
<td>1.8-1.9</td>
</tr>
<tr>
<td>4.0-4.1</td>
</tr>
<tr>
<td>6.2-6.3</td>
</tr>
</tbody>
</table>

Classification is based upon a gradation curve.
<table>
<thead>
<tr>
<th>ELEV.</th>
<th>DEPTH</th>
<th>LEGEND</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
<th>CORE REC.</th>
<th>SAMPLE NUM.</th>
<th>REMARKS</th>
<th>Bit or Barrel</th>
</tr>
</thead>
<tbody>
<tr>
<td>-13.5</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-18.8</td>
<td>5.3</td>
<td></td>
<td>SAND, quartz, fine to medium, clean, gray color, trace black sands (phosphates?), (SP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-18.6</td>
<td>6.1</td>
<td></td>
<td>SAND with gravel size angular shell fragments, (SW)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-20.5</td>
<td>7.0</td>
<td></td>
<td>SANDY SILTS to sandy clays, dark brown to gray color variations, trace shell fragments, (ML)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-22.5</td>
<td>9.0</td>
<td></td>
<td>CARBONATE MUD; sandy mud and silty gravel mixture, coarse gravel size shell fragments, (GM)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-23.0</td>
<td>9.5</td>
<td></td>
<td>CLAY, blue mixed with small amount of carbonate mud, (CH)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**
The lines in the SAMPLE NUMBER column indicate the intervals at which samples were taken for laboratory grain size analysis.

**NOTE:**
Penetration 12', 79% Recovery due to compaction.

**NOTE:**
LABORATORY CLASSIFICATION
Sample Depth / Classification

<table>
<thead>
<tr>
<th>Sample Depth</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0-2.1</td>
<td>SP</td>
</tr>
<tr>
<td>6.4-6.5</td>
<td>SM</td>
</tr>
<tr>
<td>6.0-8.1</td>
<td>SM/SM</td>
</tr>
<tr>
<td>9.2-9.3</td>
<td>SP/SM</td>
</tr>
</tbody>
</table>

Classification is based upon a gradation curve.
<table>
<thead>
<tr>
<th>ELEV.</th>
<th>DEPTH</th>
<th>LEGEND</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
<th>COREL REC %</th>
<th>SAMPLE NUMBER</th>
<th>REMARKS Bit or Barrel</th>
</tr>
</thead>
<tbody>
<tr>
<td>-15.8</td>
<td>0</td>
<td></td>
<td>SAND, fine to medium quartz, clean, gray color, with finer grains at the top, (SP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-21.4</td>
<td>5.6</td>
<td></td>
<td>SAND, fine, gravel size angular shell fragments with whole shells intermixed, some black sands (phosphates?), (SW)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-23.7</td>
<td>7.9</td>
<td></td>
<td>Coarse gravel size angular shell fragments and gravel size whole shells at base, (SW)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**
- The lines in the SAMPLE NUMBER column indicate the intervals at which samples were taken for grain size analysis.
- Penetration 9.5'
- 83% Recovery due to compaction.
- Laboratory Classification
  - Sample Depth / Classification
  - 1.0-1.1 SP
  - 4.8-4.9 SP
  - 7.3-7.4 SW
- Classification is based upon a gradation curve.
APPENDIX A3

Grain-Size Gradation Curves
Sample No. 2.0-2.1
Elev or Depth

Visual Classification
SAND, FINE GRAINED QUARTZ,
TAN COLOR, (SP)

Net wt % LL PI PI

Project SAND RESOURCE SURVEY OFF SAND KEY

Area

Stage No. COE-94-1(2)

Date 12-28-94

GRADATION CURVES
### Visual Classification

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Clay or Depth</th>
<th>Visual</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.3-7.4</td>
<td></td>
<td>SAND, MEDIUM TO COARSE</td>
<td>QUARTZ, CLEAN, TRACE SHELL CONTENT, (SP)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VISUAL %SHELL APPROX. 5%</td>
<td></td>
</tr>
</tbody>
</table>

**Gradation Curves**

**Project** SAND RESOURCE SURVEY OFF SAND KEY

**Area**

**Rearing No.** COE-94-1(2)

**Date** 12-28-94

**ENG FMM MAY 28 2007**
Sample No. 8.7-8.8

<table>
<thead>
<tr>
<th>Grains of Depth</th>
<th>Visual Classification</th>
<th>Net w%</th>
<th>LL</th>
<th>PL</th>
<th>PP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GRAVELY SANDS, MOSTLY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ANGULAR SHELL FRAGMENTS,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SMALL AMOUNT BLACK SANDS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(PHOSPHATES?), (SW)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>VISUAL %SHELL APPROX. 80%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Project SAND RESOURCE SURVEY OFF SAND KEY

Area

Battery No. COE-94-1(2)

Date 12-28-94

ENG FORM 1 MAY 95, 2007
Sample No.  Elev or Depth  Project  Date  
1.0-1.1   SAND RESOURCE SURVEY OFF SAND KEY  12-28-94  
SAND, FINE TO MEDIUM QUARTZ  
GRAY COLOR, TRACE SHELL  
FRAGMENTS, (SP)  
VISUAL %SHELL APPROX. 1%  

data

ENG MAN, MAY 9, 2007
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Grain Size in MM</th>
<th>Visual Classification</th>
<th>Visual Shell Approx.</th>
<th>Project Area</th>
<th>Area</th>
<th>Report No.</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0-5.1</td>
<td></td>
<td>SAND, FINE TO MEDIUM QUARTZ</td>
<td>CLEAN, GRAY COLOR, TRACE</td>
<td>SAND RESOURCE SURVEY OFF SAND KEY</td>
<td>COE-94-2(2)</td>
<td>12-28-94</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SHELL CONTENT, (SP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Gradation Curves**

---

**Visual % Shell Approx. 1%**

---

**U.S. Standard Sieve Opening in Inches**

---

**U.S. Standard Sieve Numbers**

---

**Hydrometer**

---

**Percent Coarse by Weight**

---

**Percent Fine by Weight**

---

**Grain Size in Millimeters**
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Elev or Depth</th>
<th>Visual Classification</th>
<th>Net w%</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
<th>Project</th>
<th>SAND RESOURCE SURVEY Off SAND KEY</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.8-4.9</td>
<td></td>
<td>GRAVELS AND LIMESTONE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>FRAGMENTS, SMALL AMOUNT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>OF SILTY SAND, (GP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>VISUAL % SHELL APPROX. 0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**GRADATION CURVES**

**Date**: 12-28-94
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Elev of Depth</th>
<th>VISUAL Classification</th>
<th>Mat % X</th>
<th>LL</th>
<th>PL</th>
<th>MT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0-1.1</td>
<td></td>
<td>SAND, FINE TO MEDIUM QUARTZ, GRAY COLOR, TRACE BLACK SANDS (PHOSPHATES?), (SP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>VISUAL &amp; SHELL APPX. 0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**GRADATION CURVES**

**Project** SAND RESOURCE SURVEY OFF SAND KEY

**Date** 12-20-94

**Revised No.** COE-94-4(2)

**Area**

**ENG May 8, 2007**
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Elev. or Depth</th>
<th>Visual Classification</th>
<th>% Shell</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.9-4.0</td>
<td>VISUAL</td>
<td>SAND, FINE TO MEDIUM QUARTZ, GRAY COLOR, TRACE BLACK, SANDS (PHOSPHATES?), (SP)</td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td>12-20-94</td>
</tr>
</tbody>
</table>

**SAND RESOURCES SURVEY OFF SAND KEY**

** Area  
Sediment No. COE-94-4(2)**

**Date 12-20-94**
Sample No. | Elev or Depth | Classification |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5.7-5.8</td>
<td>VISUAL</td>
<td>SAND WITH COARSE GRAVEL SIZE, ANGULAR SHELL FRAGMENTS, SMALL AMOUNT BLACK SANDS (PHOSPHATES?), (SW) VISUAL SHELL APPROX. 10-15%</td>
</tr>
</tbody>
</table>

GRADATION CURVES

Date 12-20-94
### Sample No. 1.0-1.1

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Elevation or Depth</th>
<th>Visual Classification</th>
<th>Net %</th>
<th>LL</th>
<th>PL</th>
<th>MT</th>
<th>Project</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SAND, FINE TO MEDIUM QUARTZ CLEAN, (SP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SAND RESOURCE SURVEY OFF SAND KEY</td>
<td></td>
</tr>
</tbody>
</table>

**Visual**

- **Sand, Fine to Medium Quartz**
- **Clean, (SP)**
- **Visual Shell Approx. 0%**

**Gradation Curves**

**Date**: 12-08-94
SAND, FINE TO MEDIUM QUARTZ.
FINE GRAVEL SIZE SHELLS (whole and fragments), BLACK SANDS (PHOSPHATES?), (SW)

VISUAL % SHELL APPROX. 10%

GRADATION CURVES

Sample No. Elev or Depth Visual Classification Net w X LL PL PI
2.4-2.5

SAND RESOURCE SURVEY OFF SAND KEY

SAND RESOURCE SURVEY OFF SAND KEY

Area

Date 12-08-94

ENG FORM 2007
### Sample No. 8.7-8.8

#### Elevation or Depth

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Elevation or Depth</th>
<th>Visual Classification</th>
<th>Particle Size</th>
<th>LL</th>
<th>PL</th>
<th>ML</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.7-8.8</td>
<td></td>
<td>Silty Sand, Small Amount of Gravel Size Shell Fragments, (SM)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Visual &amp; Shell Approx. 10-15%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Comments

- Project: SAND RESOURCE SURVEY OFF SAND KEY
- Area: 
- Series No.: COE-94-6(2)
- Date: 12-08-94

---

**U.S. Standard Sieve Numbers**

- Sieve Opening in Inches
- Sieve Opening in Millimeters

**Hydrometer**

- 0.1
- 0.05
- 0.01
- 0.005
- 0.001

**Gradation Curves**

- Graph showing grain size distribution.
### Gradation Curves

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Elev or Depth</th>
<th>Visual Classification</th>
<th>Material</th>
<th>LL</th>
<th>PL</th>
<th>MT</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.7-10.8</td>
<td></td>
<td>Organics, Dark Brown and Black, Wet, Low to Medium Plasticity, Trace of Fine Gravel Size Shells, (OL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Visual Percentage Shell Approx. 58**

---

**Project**: SAND RESOURCE SURVEY OFF SAND KEY

**Date**: 12-08-94

---

**Letter**: CEE-94-6(2)
**Visual Classification**

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Elev. of Depth</th>
<th>Visual Classification</th>
<th>Net w t</th>
<th>LL</th>
<th>PL</th>
<th>FT</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.2-12.3</td>
<td></td>
<td>ORGANIC RICH FINE SILT AND SILTY CLAYS, HOMOGENOUS, DARK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SAND RESOURCE SURVEY OFF SAND KEY</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BLACK COLOR, ODOR, WET</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MEDIUM PLASTICITY, (OL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bank No. COE-94-6(2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VISUAL % SHELL APPROX. 0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Date</td>
</tr>
</tbody>
</table>

**Gradation Curves**

Date 12-08-94
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Elev. or Depth</th>
<th>VISUAL Classification</th>
<th>Nat. w%</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
<th>Project</th>
<th>SAND KEY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5-1.6</td>
<td></td>
<td>SAND, FINE TO MEDIUM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>QUARTZ, (SP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Visual & Shell Approx. 0%**

**Gradation Curves**

**SAND RESOURCE SURVEY OFF**

**Area**

**Survey No.** COE-94-8(2)

**Date** 12-08-94
<table>
<thead>
<tr>
<th>Sample No</th>
<th>Elev or Depth</th>
<th>Visual Classification</th>
<th>Visual &amp; Shell Approx. %</th>
<th>Project</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.6-7.7</td>
<td></td>
<td>CARBONATE MUD, LIGHT TAN</td>
<td></td>
<td>SAND RESOURCE SURVEY OFF SAND KEY</td>
<td>12-08-94</td>
</tr>
<tr>
<td></td>
<td></td>
<td>COLOR, (CL)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Visual & Shell Approx. 0%**

**Gradation Curves**

**Project:** SAND RESOURCE SURVEY OFF SAND KEY

**Date:** 12-08-94
U.S. STANDARD SIEVE OPENING IN INCHES  U.S. STANDARD SIEVE NUMBERS  HYDROMETER

PERCENT PASS BY WEIGHT

GRAIN SIZE IN MILLIMETERS

COBBLES  GRAVEL  SAND  SILT OR CLAY

COARSE  FINE  COARSE  MEDIUM  FINE

Sample No.  Elev. of Depth  Visual  Classification  Net w %  LL  PL  PI
8.7-8.8  VISUAL  BLUE CLAY, BLUEISH GREEN TO  GRAY COLOR, WET, (CH)

VISUAL & SHELL APPROX. 0%

GRADATION CURVES

Project: SAND RESOURCE SURVEY OFF SAND KEY

Area

Bed No. COE-94-8 (2)

Date  12-08-94

ENG MAY 30 2007
### Gradation Curves

<table>
<thead>
<tr>
<th>Sample No</th>
<th>Elevation or Depth</th>
<th>Classification</th>
<th>Visual %</th>
<th>LL</th>
<th>PL</th>
<th>MF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1-1.2</td>
<td></td>
<td>SAND, FINE TO MEDIUM QUARTZ</td>
<td>LIGHT TAN COLOR, (SP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>VISUAL SHELL, APPROX. 0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Project** SAND RESOURCE SURVEY OFF SAND KEY

**Area**

**Sampling No.** COE-94-9 (2)

**Date** 11-10-94
<table>
<thead>
<tr>
<th>Sample No</th>
<th>Elev or Depth</th>
<th>VISUAL Classification</th>
<th>Nat w %</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.9-5.0</td>
<td></td>
<td>SAND, QUARTZ, MEDIUM TO COARSE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TAN COLOR, (SP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**GRADATION CURVES**

Project: SAND RESOURCE SURVEY OFF SAND KEY

Area

Ref. No. COE-94-9 (2)

Date 11-10-94
### Gradation Curves

#### Visual Classification
- **8.4-8.5**
- **Gravels:** Limestone Fragments and Angular Shell Fragments (GN)
- **Visual % Shell Approx. 40%**

#### Project Information
- **SAND RESOURCE:** SURVEY OFF.: SAND KEY
- **Ride No.: COE-94-13(2)**
- **Date:** 12-08-94

#### Graph Details
- **U.S. Standard Sieve Opening in Inches**
- **U.S. Standard Sieve Numbers**
- **Hydrometer**
- **Percent Pass by Weight**

#### Tables

<table>
<thead>
<tr>
<th>Sample No</th>
<th>Grain Size (mm)</th>
<th>Visual Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.4-8.5</td>
<td></td>
<td>Gravels: Limestone Fragments and Angular Shell Fragments (GN)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Visual % Shell Approx. 40%</td>
</tr>
</tbody>
</table>

#### ENGMAY 07 2007
**U.S. STANDARD SIEVE OPENING IN INCHES**

**U.S. STANDARD SIEVE NUMBERS**

**HYDROMETER**

**PERCENT FINE BY WEIGHT**

**GRAIN SIZE IN MILLIMETERS**

**PERCENT COURSE BY WEIGHT**

<table>
<thead>
<tr>
<th>Cobble</th>
<th>Gravel</th>
<th>Fine</th>
<th>Coarse</th>
<th>Medium</th>
<th>Fine</th>
<th>Silt or Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Sample No.**

<table>
<thead>
<tr>
<th>Elev or Depth</th>
<th>Visual Classification</th>
<th>Mo w X</th>
<th>LL</th>
<th>F1</th>
<th>F2</th>
<th>Project Sand Resource Survey Off Sand Key</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3-1.4</td>
<td>SAND, FINE TO COARSE QUARTZ, DARK GRAY COLOR, BLACK SANDS (PHOSPHATES?), ANGULAR SHELL FRAGMENTS, (SW)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Ground**

<table>
<thead>
<tr>
<th>Area</th>
<th>Bnk No.</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>COE-94-14</td>
<td>12-05-94</td>
</tr>
</tbody>
</table>
### Gradation Curves

<table>
<thead>
<tr>
<th>Sample No</th>
<th>Elev of Depth</th>
<th>Visual Classification</th>
<th>%</th>
<th>LL</th>
<th>PL</th>
<th>MT</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.4-2.5</td>
<td></td>
<td>SAND, FINE TO COARSE QUARTZ, DARK GRAY COLOR, BLACK SANDS (PHOSPHATES?), ANGULAR SHELL FRAGMENTS, (SW)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SAND RESOURCE SURVEY OFF SAND KEY</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VISUAL % SHELL APPROX. 50%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**GRADATION CURVES**

**SAND RESOURCE SURVEY OFF SAND KEY**

**Area**

**Report No. COE-94-14**

**Date** 12-05-94
Cobble, Gravel, Sand, Silt or Clay Gradation Curves

Sample No.  | Elev or Depth  | Visual Classification | Net wt x | LL  | FL  |
-------------|---------------|-----------------------|----------|-----|-----|
             |               | Sand, Fine to Medium Quartz, Dark Gray Color, Small Amount, Black Sands (Phosphates?), Cobble Size Limestone Associated with This Sample. |          |     |     |

Project: SAND RESOURCE SURVEY OFF SAND KEY

Area: COE-94-15(2)

Date: 12-08-94

NO CORE, SURFACE SEDIMENT SAMPLE ONLY
Sample No. | Elev. or Depth | Classification | Nat w % | LL | PL | M | Project
--- | --- | --- | --- | --- | --- | --- | ---
0.1-0.2 | | MUDDY SAND, DARK GRAY COLOR, SMALL AMOUNT BLACK SANDS (PHOSPHATES?), TRACE ANGULAR SHELL FRAGMENTS, (SM) VISUAL % SHELL APPX. 5% | | | | | SAND RESOURCE SURVEY OFF SAND KEY
Area
Project No. | COE-94-16
Date | 10-21-94

ENG FORM, MAY 94, 2007
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Elev or Depth</th>
<th>VISUAL Classification</th>
<th>Gradation Curves</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5-7.6</td>
<td>VISUAL: 50% SHELLS (WHOLE &amp; FRAGMENTS), SOME SAND, (GP)</td>
<td>60% VISUAL SHELL</td>
<td>SAND RESOURCE SURVEY OF SAND KEY</td>
</tr>
</tbody>
</table>

**Notes:**
- **Area:**
- **Date:** 11-10-94

**Form:**
- Form, Eng, May 30, 2007
Sample No. | Elev or Depth | VISUAL Classification | Nat w % | LL | PL | PT
--- | --- | --- | --- | --- | --- | ---
1.1-1.2 | | SAND, FINE TO MEDIUM QUARTZ, DARK GRAY COLOR, FINE GRAINED ANGULAR SHELL FRAGMENTS, (SM) | | | | |

VEIUAL SHELL APPROX. 45°

GRADATION CURVES

Project: SAND RESOURCE SURVEY OFF SAND KEY

Area

Batch No. COE-94-10(2)

Date 12-13-94
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Elev. or Depth</th>
<th>VISUAL Classification</th>
<th>Mat w%</th>
<th>LL</th>
<th>PL</th>
<th>P&lt;</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2-2.3</td>
<td></td>
<td>BLUE/GREEN TO GRAY COLOR CLAY WITH DISTINCT WHITE GRAVEL SIZE LIMESTONE FRAGMENTS, (CH)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>VISUAL &amp; SHELL APPROX. 0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GRADATION CURVES

PROJECT: SAND RESOURCE SURVEY OFF SAND KEY

Date: 12-13-94

ENG FORM 2007
Sample No: 1.0-1.1
Elev or Depth: V

Visual Classification:
- SAND, FINE TO MEDIUM QUARTZ, TRACE SHELL FRAGMENTS, GRAY
- COLOR, TRACE BLACK SANDS (PHOSPHATES?), (SP)
- VISUAL %SHELL APPROX. 5%

Gradation Curves

Project: SAND RESOURCE SURVEY OFF SAND KEY

Area:

Receipt No: COE-94-3(2)

Date: 12-28-94
Sample No. | Elev. or Depth | Visual Classification | Nkt w X | LL | PI | PI |
--- | --- | --- | --- | --- | --- | --- |
3.5-3.6 | SILTY SAND, (SM) | | | | | |

Visual Shell Approx. 0%

Gradation Curves

Date: 12-28-94
Sample No. | Elev or Depth | Visual Classification | % Gravel | LL | PL | Pt
--- | --- | --- | --- | --- | --- | ---
0.7-0.8 | SAND, FINE TO MEDIUM QUARTZ, TAN COLOR, MEDIUM SIZE SHELL FRAGMENTS, (SP) | | | | | 

**Project** SAND RESOURCE SURVEY OFF SAND KEY

Area: 

Sample No.: COE-94-12

Date: 11/18/94
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Eleo &amp; Depth</th>
<th>Visual</th>
<th>Classification</th>
<th>Nat w%</th>
<th>LL</th>
<th>PL</th>
<th>MT</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2-3.3</td>
<td></td>
<td>Sand, Quartz, Tan Color</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fine to Medium Size Shell Fragments, (SP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Visual Shells Approx. 10-15%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Gradation Curves**

**Project:** SAND RESOURCE SURVEY OFF SAND KEY

**Date:** 11-18-94

**Drawn:** Eng., 5/8/87

**U.S. Standard Sieve Opening in Inches**

**U.S. Standard Sieve Numbers**

**Imponder**

**Grain Size in Millimeters**

**Percent Passing by Weight**

**Percent Coarse by Weight**

**Percent Fine by Weight**
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Elev. at Depth</th>
<th>Visual Classification</th>
<th>Mesh %</th>
<th>LL</th>
<th>PL</th>
<th>MT</th>
<th>Field</th>
<th>Result</th>
<th>Sand Key</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.3-5.4</td>
<td>VISUAL</td>
<td>SAND, MEDIUM GRAINED WITH COBBLE SIZE LIMESTONE, (CP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SAND RESOURCE SURVEY OFF SAND KEY</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VISUAL &amp; SHELL APPROX. 0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**GRADATION CURVES**

**ENG FORM 1 MAY 99 2007**
### SAND RESOURCE SURVEY OFF SAND KEY

**Project:** SAND RESOURCE SURVEY OFF SAND KEY

**Date:** 12-08-94

**Area:**

**Sample No.** | Elev. or Depth | VISUAL Classification | Nat w. % | LL | PL | PT |
--- | --- | --- | --- | --- | --- | --- |
1.0-1.1 | 100 feet | SAND, FINE TO MEDIUM QUARTZ. TAN COLOR, (SP) | | | | |

**Visual Shell Approx.:** 0%

**Gradation Curves**

<table>
<thead>
<tr>
<th>COBBLES</th>
<th>GRAVEL</th>
<th>SAND</th>
<th>Silt or Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>COARSE</td>
<td>FINE</td>
<td>COURSE</td>
<td>MEDIUM</td>
</tr>
</tbody>
</table>

---

**Notes:**

- [Image of graph and data table related to sand analysis and gradation curves.]
- **U.S. Standard Sieve Numbers** and **Hydrometer** scales are used to measure particle size distribution.
- The graph depicts the percentage of sand, gravel, and silt or clay across different particle sizes.

---

**Form:** MAY 28, 2007
SAND RESOURCE SURVEY OFF SAND KEY

SAMPLE NO. 6.5-6.6

<table>
<thead>
<tr>
<th>GRAIN SIZE (mm)</th>
<th>COBBLES</th>
<th>GRAVEL</th>
<th>SAND</th>
<th>SILT OR CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>Course</td>
<td>Fine</td>
<td>Course</td>
<td>Fine</td>
</tr>
<tr>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.005</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.001</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Visual Classification**
- Sand, Fine to Medium Quartz.
- Some Coarse Gravel Size Shell Fragments, (SP)

**Gradation Curves**

**Project Data**
- Date: 12-08-94
- Area

**Form:** ENG, MAY 00, 2007
SAND, COARSE GRANED WITH
BLACK SANDS (PHOSPHATES?),
(SP)

VISUAL SHELL APPRX. 0%

GRADATION CURVES
### Gradation Curves

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Elev or Depth</th>
<th>Visual Classification</th>
<th>NL w A</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.4-6.5</td>
<td></td>
<td>SANDY SILTS TO SANDY CLAYS, TRACE SHELL FRAGMENTS, DARK BROWN TO GRAY COLOR VARIATIONS (ML)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>VISUAL &amp; SHELL APPROX. 5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Area:**

<table>
<thead>
<tr>
<th>Project SAND RESOURCE SURVEY OFF SAND KEY</th>
</tr>
</thead>
</table>

**Date:** 12-20-94
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Elev or Depth</th>
<th>Visual Classification</th>
<th>Net w%</th>
<th>LL</th>
<th>PL</th>
<th>MI</th>
<th>Project &amp; Resource Survey</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.0-8.1</td>
<td></td>
<td>Carbonate Mud: Sandy Mud and Silty Gravel Mixture, Coarse Gravel Size Shell Fragments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(GM)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Visual Shell Approx. 30-40%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gradation Curves</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample No.</td>
<td>Description</td>
<td>Percent Coarse by Weight</td>
<td>Percent Fine by Weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------------------------------------</td>
<td>--------------------------</td>
<td>------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.2-9.3</td>
<td>BLUE CLAY MIXED WITH SMALL AMOUNT OF CARBONATE MUD, (CH)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>VISUAL SHELL APPROX. 0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Gradation Curves**

**Sample Description:**
- Blue clay mixed with small amount of carbonate mud, (CH)
- Visual shell approx. 0%

**Survey Information:**
- Project: SAND RESOURCE SURVEY OFF SAND KEY
- Area:
- Date: 12-20-94

**Date of Survey:**
- 12-20-94
Sample No.: 2.7-2.8
Elev. or Depth: 0
Visual Classification: MEDIUM QUARTZ SAND, DARK GRAY COLOR, MEDIUM TO COARSE SAND SIZE SHELL FRAGMENTS, (SW)
Visual % Shell Approx.: 20%
Gradation Curves

Project: SAND RESOURCE SURVEY OFF SAND KEY

Date: 12-13-94

ENG FORM MAY 04 2087
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Elev or Depth</th>
<th>VISUAL Classification</th>
<th>Nat w %</th>
<th>LL</th>
<th>PL</th>
<th>PT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7-0.8</td>
<td></td>
<td>SAND, FINE TO MEDIUM QUARTZ.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TAN COLOR, MEDIUM SIZE SHELL FRAGMENTS, (SP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>VISUAL %SHELL APPROX. 10-15%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GRADATION CURVES

Project SAND RESOURCE SURVEY OFF SAND KEY

Area

Survey No. COE-94-12

Date 11/18/94
### Sample No. 3.2-3.3

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Elev or Depth</th>
<th>Visual Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2-3.3</td>
<td></td>
<td>SAND, QUARTZ, TAN COLOR, FINE TO MEDIUM SIZE SHELL FRAGMENTS, (SP)</td>
</tr>
</tbody>
</table>

**GRADATION CURVES**

**Grading:**
- **Visual:** SAND, QUARTZ, TAN COLOR, FINE TO MEDIUM SIZE SHELL FRAGMENTS, (SP)  
- **Visual:** SHELL APPROX. 10-15%

**Project:** SAND RESOURCE SURVEY OFF SAND KEY

**Area:**

**Rocky No.:** COE-94-12

**Date:** 11-18-94

---

**ENG FORM MAY 28 2007**
### Visual Classification

**Sample No.** 5.3-5.4  
**Elev or Depth**  
**Classification**  
**Note**  
**LL**  
**Pl**  
**Pr**  

**Project SAND RESOURCE SURVEY OFF SAND KEY**

**Area**

**Date** 11-18-94

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Elev or Depth</th>
<th>Classification</th>
<th>Note</th>
<th>LL</th>
<th>Pl</th>
<th>Pr</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.3-5.4</td>
<td></td>
<td>SAND, MEDIUM GRAINED WITH COBBLE SIZE LIMESTONE, (GP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>VISUAL SHELL APPROX. 0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**GRADATION CURVES**
Sample No. | Elevation of Depth | Visual Classification | % Shell Approx. | Gradation Curves
---|---|---|---|---
1.0-1.1 | | Sand, Fine to Medium Quartz, Tan Color, (SP) | | Project SAND RESOURCE SURVEY OFF SAND KEY

Date: 12-08-94
**SAND RESOURCE SURVEY OFF SAND KEY**

Project: SAND RESOURCE SURVEY OFF SAND KEY

Sample No.: 7.5-7.6

Elev or Depth: 12-08-94

Net w%: 0

LL: 0

PL: 0

PI: 0

Visual Classification: SAND, COARSE GRAINED WITH BLACK SANDS (PHOSPHATES?), (SP)

Visual % Shell Approx.: 0%

Gradation Curves

Date: 12-08-94

BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BBB BB
<table>
<thead>
<tr>
<th>Sample No</th>
<th>Elev or Depth</th>
<th>Classification</th>
<th>Soil w%</th>
<th>LL</th>
<th>PL</th>
<th>ML</th>
<th>Date</th>
<th>Area</th>
<th>Batch No</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.4-6.5</td>
<td></td>
<td>VISUAL, SANDY SILTS TO SANDY CLAYS, TRACE SHELL FRAGMENTS, DARK BROWN TO GRAY COLOR VARIATIONS (ML)</td>
<td>VISUAL</td>
<td>5%</td>
<td></td>
<td></td>
<td>SAND RESOURCE SURVEY OFF SAND KEY</td>
<td></td>
<td></td>
<td>12-20-94</td>
</tr>
<tr>
<td>Sample No.</td>
<td>Ele of Depth</td>
<td>Visual Classification</td>
<td>Nat w%</td>
<td>LL</td>
<td>PL</td>
<td>ML</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>--------------</td>
<td>-----------------------</td>
<td>--------</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.2-9.3</td>
<td></td>
<td>BLUE CLAY MIXED WITH SMALL AMOUNT OF CARBONATE MUD, (CH)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>VISUAL SHELL APPROX. 0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GRADATION CURVES

Project SAND RESOURCE SURVEY OFF SAND KEY
Area
Bank No. COE-94-18 (2)
Date 12-20-94

ENG FORM MAY 2007
SAND RESOURCE SURVEY OFF SAND KEY

Sample No. | Elevation or Depth | Classification | Visual | % Shell Approx. | Project
--- | --- | --- | --- | --- | ---
SAND, FINE TO MEDIUM QUARTZ | | | | 0% | SAND RESOURCE SURVEY OFF SAND KEY
GRAY COLOR, SMALL AMOUNT | | | | | Area
BLACK SANDS (PHOSPHATES?) | | | | | Bearing No. COE-94-19(2)
VISUAL | | | | | Date 12-13-94

ENG FORM MAY 2007
NO CORE. SURFACE SEDIMENT SAMPLE ONLY.
### Gradation Curves

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Clay or Depth</th>
<th>Visual Classification</th>
<th>%M</th>
<th>L</th>
<th>P</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0-1.1</td>
<td></td>
<td>SAND, FINE TO MEDIUM QUARTZ, CLEAN, GRAY COLOR, (SP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>VISUAL %SHELL APPROX. 0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Project SAND RESOURCE SURVEY OFF SAND KEY**

Area: 

Boat No. COB-94-22

Date: 12-20-94

---

**ENG FORM MAY 29 2007**
### Gradation Curves

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Elev or Depth</th>
<th>Visual Classification</th>
<th>% Shell</th>
<th>LL</th>
<th>PL</th>
<th>ML</th>
<th>Project</th>
<th>Area</th>
<th>Borough No.</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.3-7.4</td>
<td></td>
<td>Sand, Coarse Gravel Size Angular Shell Fragments, and Small Cobble Size Whole Shells (SW)</td>
<td>Visual % Shell Approx. 45%</td>
<td></td>
<td></td>
<td></td>
<td>Sand Resource Survey Off Sand Key</td>
<td></td>
<td>COE-94-22</td>
<td>12-20-94</td>
</tr>
</tbody>
</table>

**ENG Form MAY 2007**
Location Map

Contours in feet
Vertical Datum: Mean lower low water
Horizontal Datum: NAD27
Transverse mercator projection, Clarke 1866 spheroid
20,000 foot grid based on Florida Coordinate System, West Zone

Scale = 1:300,000

Plate 1
Sand Resource Survey off Sand Key
Pinellas County, Florida

Trackline and Vibrocoring Location Map

Prepared for Jacksonville District Corps of Engineers
February 1995 U.S. Geological Survey

Base from USGS and NOAA digital and analog data.
Sand Resource Survey off Sand Key
Pinellas County, Florida

Side-Scan Sonar
Interpretation Map

Prepared for Jacksonville District Corps of Engineers
February 1995   U.S. Geological Survey

LEGEND:
- sand
- rock hardground
- dark return (rock?)

Scale = 1:85,000

Contour in feet
Vertical Datum: Mean Lower Low Water
Horizontal Datum: NAD27

Transverse mercator projection, Clarke 1866 spheroid
20,000 foot grid, Florida Coordinate System, West Zone
Sand Resource Survey off Sand Key
Pinellas County, Florida

Sediment Isopach Map

Prepared for Jacksonville District Corps of Engineers
February 1995 U.S. Geological Survey

LEGEND:

- 0 foot isopach
- 0-2 foot isopach
- 2-4 foot isopach
- 4-6 foot isopach
- 6-8 foot isopach
- >8 foot isopach

Scale = 1:85,000

Base from USGS and NOAA digital and aerial data.

Plate 4