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A GEOLOGICAL INVESTIGATION OF THE OFFSHORE AREA ALONG FLORIDA'S NORTHEAST COAST

YEAR 2

ANNUAL REPORT TO

THE

UNITED STATES DEPARTMENT OF THE INTERIOR

MINERALS MANAGEMENT SERVICE

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Executive Summary (back to TOC)

The Florida Geological Survey (FGS) and the U.S. Minerals Management Service (MMS) have entered into a multi-year cooperative agreement (cooperative agreement # 1435-0001-30757) with the specific goal of locating and characterizing both the areal extent and volume of available sands suitable for beach nourishment lying in federal waters adjacent to state submerged lands off the northeast coast of Florida. In Year 2 of this study, 190 miles of seismic data were collected offshore of Nassau, Duval and Flagler Counties. This data was subsequently processed, interpreted, and integrated with the data collected in Year 1. Additionally a total of 127 beach samples were collected from the beaches of St. Johns and Flagler Counties. Samples collected from the beaches of St. Johns County are included in this Year 2 Report. Samples collected from the beaches of Flagler County will be included in the Year 3 Report. A total of 52 vibracores were collected offshore of Nassau and Duval Counties for this report. Of that total, 11 vibracores were directly collected by the FGS and 41 were collected by the FGS's subcontractor Athena Technologies Inc. offshore of Southern Duval County. An additional 3 vibracores were collected by the Athena Technologies Inc. in the mouth of the St. Johns River.

All of the above referenced data are accessible within this report. The seismic data from both Year 1 and Year 2 is provided as processed images. Photographs and granulometric analyses of the beach samples collected from St. Johns County are included. Photographs and granulometric analyses of the beach samples collected from Flagler County will be provided in the Year 3 Report. The vibracoring data as provided in this report is divided into two sets based on how the vibracores were acquired. Those vibracores directly acquired by the FGS are provided as photographs and granulometric analyses. Those vibracores acquired by a Athena Technologies Inc. were processed according to U.S. Army Corps of Engineers protocols by their contracted laboratory Wolf Technologies Inc. and are provided as penetration curves, drilling diagrams and, with a few exceptions, as granulometric curves.

Included in this report is the age date analysis of woody material present in one of the vibracores. The calculated sedimentation rate for the first 16.8 feet of sediments in this core, albeit based on a single radiocarbon date, would be 0.3621 mm per year +\- .0015 mm. Considering the effect of natural compaction and that inherent in the vibracoring method, the effect of any recent erosion of the seabed and the supposition that this figure would probably be more representative of the rate of deposition of the clay sequence immediately above the sand in which the organic material was found it is believed that this figure would set an approximate lower limit on the average Holocene sedimentation rate locally.

Initial analysis of all vibracore data available for inclusion in this report infers potential reserves of up to 198.5 million cubic yards of restoration-quality sand offshore of southern Duval County. Review of additional data collected and but not available for inclusion in this report should better confirm the quality, and quantity of those reserves. It is anticipated that the analysis of planned vibracores to be obtained for the Year 3 Report will facilitate the quality and quantity of potential reserves offshore of northern Duval and Nassau Counties as well.

Seismic stratigraphic analysis of the sub-bottom profiler data indicate the presence of areas of anomalous dip offshore of Nassau and Duval Counties a well as three clearly identifiable buried depressions in the seafloor sediments which are interpreted to be dissolution collapse features. All of these features are believed to be related to karst processes. The conjectured collapse features are vertically persistent to the base of the seismic data recorded, appear to be of limited areal extent, and are not expressed bathymetrically. One of these features appears to have been expressed as a bathymetric feature until quite recently however. All three of these conjectured collapse features lie approximately six to seven miles offshore.

Introduction (back to TOC)

Beach erosion is a chronic problem in Florida. Beach restoration has a long history in the state and ongoing planning for future restoration projects requires that abundant sources of suitable fill material be available for use. As coastal development of the state proceeds at an ever increasing pace and as readily available onshore sources are either preempted or depleted, offshore sediment bodies are becoming increasingly sought after sources of sand for beach restoration. To address this burgeoning need, the Minerals Management Service (MMS) of the United States Department of the Interior and the Florida Geological Survey (FGS) have entered into a multi-year cooperative agreement (cooperative agreement # 1435-0001-30757) with the specific goal of locating and characterizing both the areal extent and volume of available sands suitable for beach nourishment lying in Federal waters adjacent to state submerged lands off the northeast coast of Florida. Years 1 and 2 tasks focused on:

- Seismic profiling data acquisition in the area offshore of Duval County and Nassau Counties and the northern half of St. Johns County,
- Vibracoring offshore of Nassau and Duval Counties,
- Sediment sampling along the beaches of Nassau, Duval, St. Johns and Flagler Counties,
- Bottom sediment grab sampling and surficial sediment coring offshore of Nassau and Duval, Counties, and;
- The refinement of a cost effective plan for offshore data acquisition in succeeding years based on Years 1 and 2 reconnaissance data.

The primary goal of this report is to identify sand resources which are suitable for beach restoration projects anticipated along the study area shoreline. Within the study area, over 30 percent of the coastline, totaling about 44 miles, are classified as Critically Eroding Beaches, Clark, 1993. (http://www.dep.state.fl.us/beaches/publications/tech-rpt.htm#Critical_Erosion_Reports)

Year 1 (2002-2003) Summary of Work (back to TOC)

The following is a summary of work accomplished in Year 1:

- A bibliography referencing both previously completed work in the study area in general and in Nassau and Duval Counties in particular, as well as more general publications germane to this study were compiled,
- Over 230 miles of sub-bottom profile data was collected off Nassau and Duval Counties and interpreted to determine locations thought to have been favorable for the deposition of beach-quality sand,
- A total of 34 beach sampling locations were identified and 106 surface samples collected,
- A total of 18 offshore seabed grab samples were collected,
- 3 push cores were collected on the ebb tidal delta of the Nassau River,
- Descriptions were made and grain size distributions were determined for all beach and offshore seabed grab samples and push cores,

- A preliminary seismic stratigraphic analysis of the sub-bottom profiler data collected was completed.

Year 1 (2002-2003) Conclusions (back to TOC)

As a result of the seismic stratigraphic analysis conducted, several features indicative of high potential for the occurrence of beach-restoration quality sand in federal waters off Duval County were identified. This analysis was discussed with representatives of the U.S. Army Corps of Engineers Jacksonville District Office and a copy of the preliminary work map delineating those features provided to them. From that data, they selected a number of locations in the study area of particular interest for vibracoring in Year 2. The results of the tasks completed in Year 1 of this investigation are detailed in “A Geological Investigation of the Offshore Area along Florida’s Northeast Coast, Year 1 Annual Report to the United States Department of Interior Minerals Management Service” (Phelps et al., 2003).

This report documents the findings of Year 2 of the cooperative agreement. The Year 2 study area includes Federal waters extending from three to approximately ten miles offshore of Nassau and Duval Counties and the northern half of St. Johns County (Figure 1). Succeeding years will further investigate submerged lands beneath federal waters offshore of St. Johns, Flagler and Volusia Counties.

Information derived from this study will assist the MMS in making decisions concerning the future use of the deposits of sand delineated. Additionally, identifying and inventorying now, what suitable offshore sand resources are presently available, will serve to expedite the replenishment of sands on beaches adversely impacted by hurricanes and/or winter storms in future years.

Year 2 (2003-2004) Scope of Work (back to TOC)

Data collection in Year 2 of this study concentrated primarily on the areas offshore of Nassau and Duval Counties as well as the northern half of St. Johns County. Year 2 tasks included:

- The collection of subsurface acoustic profile data consisting of a reconnaissance survey offshore of the northern half of St. Johns County as well as infill and tie line data collected off Nassau and Duval Counties,
- The computer processing of all subsurface acoustic profile data collected in Years 1 and 2,
- The collection of vibracores offshore of Nassau and Duval Counties,
- A continuation of the beach sampling program, designed to establish a baseline characterization of “native” beach sands in the study area, into St. Johns and Flagler Counties, and;
- A continuation of the offshore sediment reconnaissance sampling program.

Both beach and offshore sediment samples were collected, processed, and analyzed. Beach sample locations visited in Year 2 were spaced at an approximate one mile interval, at every fifth beach monument survey point where practicable, along the beaches of St. Johns and Flagler Counties. Photos of the beach samples collected in Year 2 can be found in Appendix A. Results of the offshore sample analysis will be used to aid in the selection of sampling locations for the continuance of the vibracore collection program in Year 3.

Year 2 (2003-2004) Data Acquired (back to TOC)

During Year 2 the following data were obtained:

- Over 190 miles of seismic data were collected and interpreted to determine locations thought to be favorable to have beach-quality sand,
- A total of 63 beach sampling locations were identified and 127 points sampled,
- A total of 52 vibracores were collected offshore of Nassau and Duval Counties with 11 vibracores collected by the FGS and 41 collected by the FGS's subcontractor Athena Technologies Inc., and;
- An additional 3 vibracores were collected by Athena Technologies Inc. in the mouth of the St. Johns River.

Additional offshore seabed grab and gravity/slide hammer sample locations, based on the subsurface acoustic profile data, are currently being chosen. These samples will be collected during the Year 3 field season and evaluated to help identify locations for the Year 3 vibracoring program.

Beach sediment grab samples were collected at the outset of the field season. These sediment samples were brought to the FGS laboratory for sample description and granulometric analysis. Photos of the vibracores collected in Year 2 by the FGS can be found in Appendix B. Similar to the Year 1 samples, granulometric analyses were conducted using the general guidelines of the American Society for Testing and Materials (2000a, 2000b) and specific procedures followed by the FGS sedimentology laboratory (Balsillie, 1995, 2002a, 2002b,; Balsillie and Tanner, 1999; Balsillie, et.al. 1997, 1999; Balsillie, Dabous, and Fischler, 2002; Balsillie et.al. 2002; Balsillie and Dabous, 2003). All sample descriptions and granulometric data were entered into the FGS database. Appendices A through H, link via their respective sample indices to the beach, grab sample and vibracore photographs, descriptions and the results of the granulometric analyses. Please note that Appendix C is provided primarily for penetration logs of the vibracores, the vibracore drilling log sheets provided blank in Appendix C are completed in Appendix G.

Previous Work in the Study Area (back to TOC)

Meisburger and Field (1975, 1976) conducted studies of the Florida inner continental shelf from Cape Canaveral to the Georgia border which are valued antecedents to this study. In their studies, they collected and analyzed more than 1,153 nautical miles of high resolution seismic reflection profiles and 197 vibracores as part of the Inner Continental Shelf Sediment and Structure (ICONS) Study. Nocita et.al. (1991) further analyzed vibracores collected for the ICONS study and, based on low mud to high sand percentages, suggested that the region had several concentrated sites with low mud percentages that may be good potential borrow sites. LaPlace (1993) analyzed in detail 20 vibracores and 400 km of seismic records collected off of St. Augustine for the ICONS study. This study suggests that the remnants of an earlier barrier island complex may be locally preserved off central and northern St. Johns County. These studies discuss the geomorphology and shallow sub-bottom structure of the continental shelf as well as the surficial and sub-bottom sediments in the study area.

Field and Laboratory Procedures: an Overview (back to TOC)

The exploratory phase of the second year of this multi-year program involved the use of continuous seismic reflection profiling, also known as subsurface acoustic profiling, the collection of beach samples from St. Johns and Flagler Counties, the collection of bottom samples offshore of Nassau and Duval Counties, and the collection of vibracores off Nassau and Duval Counties. Survey track lines for the subsurface acoustic profiling off the northern half of St. Johns County were laid out as a reconnaissance grid, with a north/south line spacing of one statute mile, (Figure 1). Additionally, some infill lines were collected off Nassau County as well as two north-south trending "tie" lines off Nassau County and northern half of St. Johns County (Figure 1). The reconnaissance grid spacing was a continuation of the Year 1 grid previously acquired off shore of Nassau and Duval Counties and provides sufficient density to determine where additional subsurface acoustic profiling and later reconnaissance bottom sampling and vibracoring should be conducted in Year 3. Selection of vibracore sites for Year 3 will be based on a seismic stratigraphic analysis of the seismic data as well as the analysis of bottom samples and surficial sediment cores yet to be obtained.

A simple alphanumeric scheme was utilized to identify loose sediment samples. All beach samples proceed with a two letter designation, SJ for St. Johns County and FG for Flagler County. This is followed by consecutive beach location numbers, 1, 2, 3, 4 etc. and completed by a two letter designation indicating the sample's location on the beach profile. Thus, samples collected from the swash zone, berm, mid beach, and back beach are designated SS, B, MB, and BB, respectively. For example, a sample collected in St. Johns County at sample location 1 in the swash zone would be delineated as SJ-1-SS. All grab samples collected offshore with a "clam-shell" dredge sampler, are labeled with the beginning two letter geographic code referenced above, followed by a multi digit location number and the two letter designator "CG" for clamshell grab. Thus, a grab sample collected off Duval County might be designated DU-101-CG.

The numbering scheme utilized for the vibracores collected varies depending on whether they were:

- Collected by the Florida Geological Survey using the survey's research vessel R/V GeoQuest, or;
- If they were collected using an independent contractor, Athena Technologies, with onboard oversight by Florida Geological Survey personnel.

In the latter case, the collection and processing of those vibracores was done in close coordination with the U.S. Army Corps of Engineers Jacksonville District Office.

The vibracores collected by the Florida Geological Survey are designated in the following manner:

- V for vibracores,
- Followed by the either DU for Duval or NA for Nassau to identify the adjacent county, and;
- A unique core number.

For example, the first vibracore collected offshore of Duval County would be VDU-01. Individual sediment samples obtained from the vibracore are identified as follows. The representative sediment sample collected from the top of core VDU-01 to 2 foot below the top of core would be labeled VDU-01-01. A representative sample collected from 2 foot below the top of the core to 4 foot below the top of the core would be labeled VDU-01-02. This procedure is repeated until the bottom of the core is reached. A sample collected from within the vibracore for the purposes of radioactive carbon dating would be designated by its depth in the core and RC. Thus a sample collected from vibracore VDU-01 at a depth of 14 feet for the purpose of radioactive carbon dating would be labeled VDU-01-14-RC.

Those cores collected by Athena Technologies Inc., are designated in the following manner:

- They are identified as CB-DUC03- with a subsequent numerical designator referring to the location number which is followed in some cores by a letter designation of A, AJ, BJ, CJ and R.

- The designator A when it appears alone indicates that that core is the second attempt at that location.

- The designators AJ, BJ and CJ refer to cores from locations that required jetting, in the case of BJ and CJ multiple jetting and vibracoring repetitions, to achieve sufficient penetration at a specific location.

- The designator R appearing on the “Drilling Logs” and “Gradation Curves” supplied by Wolf Technologies, the U.S. Army Corps of Engineer’s contracted laboratory, represents a composite vibracore synthesized by them from the results of multiple jetting and vibracoring repetitions.

For example, the vibracore collected by Athena Technologies designated CB-DUC03-33 is a vibracore obtained in the first attempt at location 33. Core CB-DUC03-34A on the other hand represents a second attempt at vibracoring at location 34. The vibracores designated CB-DUC03-42, CB-DUC03-42 AJ, CB-DUC03-42 BJ represent vibracores that sequentially comprise, through a process of alternating jetting and vibracoring, full penetration and recovery at location 42. The vibracore designated CB-DUC03-42R represents a synthesized composite vibracore from location 42. Individual samples obtained from cores are described at the end of each core’s drilling log and on the individual gradation curve sheets.

Sample/Core Collection Methodologies (back to TOC)

Loose sediment samples were collected on the beaches of St. Johns and Flagler Counties and grab samples and vibracores were collected offshore of Nassau and Duval Counties. The following is a description of these sampling methodologies used in each of these cases.

Beach Sample Collection

Beach samples, with the exception of those collected at the northern most St. Johns County location, were collected from December 1 to 4, 2003, from a total of 63 sampling locations at a sample location spacing of approximately one mile (Figure 1) which included every fifth beach monument survey point where practicable, along the beaches of St. Johns and Flagler Counties. Table 1 ties monument points to beach sampling locations. The only exceptions were the four samples collected from St. Johns County location SJ 1. Those samples were collected on December 4, 2002, during the Year 1 round of beach sampling. From the 63 sample locations selected, a total of 127 sample points were sampled in the Year 2 round of beach sampling. Photographs of the samples collected are provided in this report and can be reached using either the “on-disk” map, the Arcview project or the sample index. Please note that to access the “on-disk” map requires down loading, from the disk, of the free ArcReader 9.0 software and that ArcReader 9.0 requires Windows NT 4.0 with Service Pack 6a (or) Windows 2000 (or) Windows XP (Home Edition and Professional) to operate.

While it was intended that at each sampling location surface samples were to be collected from the swash zone, the beach berm, mid-beach and back beach; only at the northern most sampling location in St. Johns County, SJ-1, was that practicable. Due to the narrowness of the beach, at approximately a third of the locations visited in Year 2 only swash zone, mid beach and back beach samples were collected and only swash zone and back

beach samples were collected and only swash zone and back beach samples were collected at the remaining locations, (Figure 2/photo). GPS fixes were obtained for each of the sampling points at each sampling location. While the elevation of the sediment surface respective to mean sea level was not recorded, at no time did such elevations exceed 3 feet. At each sampling point within an individual sampling location, three individual duplicate samples, each totaling approximately 50 grams of sediment, were obtained for sieving analysis. Samples were collected by scooping up sediments from to an approximate depth of 30 millimeters below the beach surface at each sample point using a 50 gram scoop, (Figure 3/photo). Photos of the beach samples collected in Year 2 on the beaches of St. Johns County by the FGS can be found in Appendix A.

Seabed Grab Sample Collection (back to TOC)

A “clam shell” dredge sampler was used for seabed grab sample retrieval in Year 1. Water depths of the sample locations were obtained by reference to bathymetric charts. Sample collection for the FGS/MMS survey offshore of Duval and Nassau Counties, Florida, was initiated on August 5, 2002. Samples were recovered in Year 1 using the FGS research vessel R/V GeoProbe (Figure 4/photo) and the smaller of the two “clam shell” dredge samplers illustrated in Figure 5/photo. Photographs and analysis of these samples were provided in the Year 1 Report. A total of 18 grab samples were obtained comprising 6 and 12 samples collected offshore of Nassau and Duval Counties respectively. GPS fixes were obtained for each sampling location.

Previous bottom sampling work off the central Florida east coast to the south of the survey area and in Year 1 offshore of Nassau and Duval Counties experienced the following problems when sampling with the clamshell dredge sampler was attempted:

- At numerous sample locations, multiple attempts were necessary to obtain sufficient sediment sample for bottom characterization.
- During recovery at several sites the jaws of the dredge were found to be repeatedly propped open by shell material and no sediments were recovered.
- Fines appeared to have been selectively removed by “washing” of the sample during recovery of the dredge.

The circumstances cited above resulted in the necessity of combining the results of successive successful dredging attempts at individual locations. It was felt that the combining of samples so collected might lead to an exaggerated reporting of the coarser grain sized fractions. For these reasons, the FGS acquired a second more robust “clamshell” dredge sampler with a larger sample capacity for use in Year 3. it is intended that future offshore sampling will be conducted using either the R/V GeoProbe (Figure 4/photo) or the FGS’s Carolina Skiff (Figure 6/photo) and the sampler shown in (Figure 7/photo). See (Figure 5/photo) for a photographic comparison of the two samplers.

Proposed Gravity/Slide Hammer Core Collection (back to TOC)

It was determined that a method which offers an opportunity to sample deeper into the surficial sediment cover of the seabed might prove useful. For this reason the FGS, in addition to grab sampling with the new more robust “clamshell dredge sampler”, will attempt in Year 3 the recovery of shallow cores, 0.5 meter or less in length, using a gravity/slide hammer coring device. The coring device was purchased from Aquatic Research Instruments and is identified in their inventory as a “slide hammer corer”. A diagram of this instrument is shown as Figure 8 and a photograph is provided as Figure 9/photo. The use of this device is not intended to supplant the use of the new dredge sampler but rather as a supplement to it. Sampling is intended to be accomplished by lowering the corer to approximately three feet off the seabed and allowing it to then free spool the remaining distance. It is intended that the slide hammer will then be cycled

through at least 5 repetitions and the corer retrieved. Water depths of these coring locations will be determined with an onboard echo sounder. GPS fixes will be obtained for each sampling location.

Vibracore Collection (back to TOC)

Vibracore collection in Year 2 was accomplished both directly by the FGS through the use of its own personnel and vibracoring equipment deployed from the R/V GeoQuest (Figure 10/photo) and by utilizing the services of an independent consultant, Athena Technologies Inc., (Figure 11/photo).

Florida Geological Survey Vibracore Collection

FGS vibracoring was accomplished using a Rossfelder Model P-3 and deployed from the stern of the FGS research vessel GeoQuest, see Figure 12/photo. Prospective vibracoring locations were initially selected based on the seismic stratigraphic interpretation made in Year 1 and additional data acquired in Year 2. Information obtained from cores initially collected was considered when selecting subsequent vibracoring locations. The limitations placed by equipment, personnel safety, and personnel availability upon vibracoring operations constrained the time available for FGS vibracore acquisition in Year 2 such that vibracores could only be acquired during day light hours and only during periods of calm sea conditions, typically seas of 2 foot or less. The daily time required for transit to and from the vibracoring area coupled with the variabilities of localized sea conditions further constrained the time available in the study area for vibracore acquisition. As the Rossfelder vibracoring system, once deployed, is somewhat decoupled from the vessel deploying it, a two point anchoring system was utilized. The first anchor was directly deployed from the vibracoring vessel while the second was deployed by a separate smaller vessel. Water depths for the vibracoring sites selected offshore of Nassau and northern Duval Counties ranged from approximately 40 to 60 feet. The sites selected lie approximately 3 to 10 nautical miles off the coast. Photos of the vibracores collected in Year 2 by the FGS can be found in Appendix B. A core summary table which includes location, water depth, penetration, and recovery is included as Table 2.

Athena Technologies Vibracore Collection (back to TOC)

Based on seismic data acquired in Year 1 and the FGS preliminary interpretation of that data delivered to the US Army Corps of Engineers' district office in Jacksonville, the USACE identified three vibracore locations on the north side of the channel mouth at Jacksonville, Florida as well as forty two vibracore locations in the area offshore of central and southern Duval County. These sites were sampled as potential sand sources for the 2005 Jacksonville Beach Nourishment Project. Water depths for the vibracoring sites offshore of Duval County were between approximately 40 and 60 feet. These sites lie approximately 3 to 10 nautical miles off the coast. Vibracoring operations to collect these cores were accomplished using Athena Technologies' purpose built vessel R/V Artemis and their custom-designed vibracoring system. That system utilizes a mechanical vibrator to drive a continuous length sample barrel into the bottom through the vessel's center point "moon hole" (Figure 11/photo). As this vibracoring system requires that the vessel maintain a fixed position during vibracoring operations a three point anchoring system was used. The intent of the coring operation was to achieve penetration of at least 16 and up to 20 feet into the seabed or until refusal was met. Sampling was continuous unless refusal was reached before the contractual minimum 16-foot penetration depth was achieved. In the few instances when refusal was encountered and the FGS representative on board determined that refusal was caused by the core barrel encountering rock or substantially indurated sediments, no further penetration was required. At those locations where refusal was not due to rock or substantially indurated sediments, a second attempt was made. If penetration did not then result in a minimum of 16 feet of recovered core, the site was placed on a list of sites to be revisited later when the vessel was reconfigured for jetting. During the jetting phase of the project, these listed sites were reoccupied and a new attempt made after jetting to

approximately a foot above the base of the previous penetration. If sufficient penetration at a particular site was not then achieved, the partially filled core barrel was removed and a new one fitted. Jetting was utilized to return the core barrel to approximately a foot above the depth of previous refusal and additional vibration sampling commenced. A few locations required multiple repetitions of this process to achieve sufficient penetration. Athena's vibracoring operations extended from August 1, 2003 to August 24, 2003 and were overseen on the vessel by FGS personnel comprising either Daniel C. Phelps, P.G., or James Balsillie, P.G. Forty five locations were vibracored by Athena Technologies during the period. During the process of transferring the cores to the USACE's designated laboratory for processing, it was discovered that core #: CB-DUC03-35 could not be found. After an exhaustive search was made by Athena Technologies, it was surmised that the missing core was most probably stolen for the value of the pipe containing it from the temporary storage point in Mayport, Florida. Athena's report is included as Appendix C and consists primarily of penetration curves for each individual core. A core summary table which includes location, water depth, penetration, and recovery is included as Table 3.

Sediment Sample Processing (back to TOC)

The sieve nest used in sample processing by the Florida Geological Survey is delineated in Table 4 which includes a photograph (Figure 13/photo). All grain size distribution analyses , granulometric analyses were conducted using the general guidelines of the American Society for Testing and Materials (2000a, 2000b) and specific procedures advanced by the FGS sedimentology laboratory (Balsillie, 1995, 2002a, 2002b,; Balsillie and Tanner, 1999; Balsillie, et.al. 1997, 1999; Balsillie, Dabous, and Fischler, 2002; Balsillie et.al. 2002; Balsillie and Dabous, 2003). Each sample was initially weighed after oven drying. The sample was then wet sieved through a #230 (0.63 mm or 4 phi) sieve, oven dried and reweighed with the weight loss being assigned to the fine fraction. The sample was then dry sieved with the portion of the pan fraction obtained during dry sieving also assigned to the fine fraction. The sample was then digested with a 4 Molar hydrochloric acid solution, rinsed, oven dried, resieved and reweighted.

Sodium hexametaphosphate, following the procedures of Folk (1974) and Galehouse (1971) was used to disperse clay particles when deemed necessary. The density of this solution was measured for the samples obtained from vibracores exhibiting a significant percentage of clays and those samples were pipetted after being wet sieved. The significance of fines in the selection sediments for beach nourishment is further discussed below.

The cumulative grain size distribution curves reflect the total grain size distribution (GSD) of the sample. The weight of the fine fraction (weight loss from wet sieving and weight of the pan fraction combined) was assigned to the finer than 4 phi fraction. Separate GSD's were determined for the carbonate and non-carbonate fractions of each sample along with the combined GSD of the entire sample. The grain size distribution curves are provided within the analysis (Excel spreadsheet). A link is provided in the grain size analysis column on the index for beach, offshore grab samples, gravity/slide hammer cores and vibracores respectively.

For beach samples, sample #1 of the set was processed as described above. Sample #2, subsequent to being dried, was described and photographed. This data can be accessed via the index under the photo page column. Sample #3 of the set was dried and 10% of these samples were processed like sample #1, for the purpose of quality control, for granulometric analysis. The results of their granulometric analysis are provided in Appendix D. Those samples not selected for processing were archived.

Florida Geological Survey Vibracores (back to TOC)

The vibracores collected by the Florida Geological Survey were subsequently split, photographed, and described. These photographs can be accessed via the index under the photo page column.

Samples were taken from the top of the core and sequentially at two foot intervals down the length of the core until the bottom of the core was reached. This was done by removing a plug of approximately 50 grams of sediments from each of those points. These samples were processed individually as referenced above. The results of their granulometric analysis are provided in Appendix E. The grain size distribution curves are provided with the analysis (excel spreadsheet). A link is provided in the grain size analysis column on the index for vibracores. The other halves of the cores were archived.

Radiocarbon Age Dating (back to TOC)

When organic material of a "woody" nature was observed in the vibracores collected by the FGS, selected samples were obtained for radiocarbon age dating so that an estimate of average sediment accumulation rates could be calculated. One of these samples was processed by Beta Analytic, Inc. and identified as follows:

Beta	FGS Sample	Measured Radiocarbon Age	Conventional Radiocarbon Age
188958	VDU-01-16.8-RC	14,160 +/- 60 BP	14,140 +/- 60 BP

Beta Analytic's report is included as Appendix F. The date established for this sample would indicate deposition at the end of the Pleistocene. This would suggest that the base of the Holocene in this core would be either at the bottom of the clay seen at approximately 10 foot below the seabed, where the sediments abruptly change to a sandy clay, or at approximately 14 foot below the seabed, where the sediments transition into a clean sand. Calculated sedimentation rates from VDU-01-16.8-RC to the seabed would be 0.3621 mm per year +/- .0015 mm. Considering the effect of natural compaction and that inherent in the vibracoring method, the effect of any recent erosion of the seabed and the supposition that this figure would probably be more representative of the rate of deposition of the clay sequence above the sand in which the organic material was found, i.e. that of the Holocene, rather than that of the sand itself, it is believed that this figure would set an approximate lower limit on the average Holocene sedimentation rate locally.

Athena Technologies Inc. Vibracores (back to TOC)

The vibracores collected by Athena Technologies Inc. were processed by Wolf Technologies Inc. of Jacksonville, Florida. While all vibracores collected were described, vibracores 1, 2, 3, 4, 19 and 27 were not sampled. After the vibracores were described, samples then were selected from portions of vibracores containing material considered possible for use in beach replenishment were processed for grain size analysis. Sampling was based on sedimentological change in individual cores and an approximate 2 to 4 foot interval in the first 10 to 12 feet of the cores. No separate analysis of the carbonate fraction was made. No photographs of the vibracores are available. Core descriptions, provided on "Drilling Logs", and the results of the grain size analysis, provided on "Gradation Curves", are included as Appendix G.

Restoration-Quality Sand Parameters (back to TOC)

It is important to note that the thickness of available restoration-quality sand is determined in part by the percent fines content. Thus, sand resources available for beach restoration can be limited vertically by the depth at which the fines content exceeded 5% as specified in Florida Administrative Code 62-41.07(5J). Fines in this instances are defined as that material that will pass though a 4.00 phi, 63 micrometer/0.0025 inch mesh opening, sieve. Discussions with the Bureau of Beaches and Wetlands Resources of the Florida Department of Environmental Protection have revealed that the 5% limit should be regarded as rough guidance for what is desired. The 5% fines content is not limiting as sediments containing up to a 10% fines fraction are routinely accepted for use in beach restoration. In previous investigations, the FGS has concentrated on vibracored locations associated with grab samples containing less than 5% fines. Grain size distributions for all samples collected as a part of this cooperative agreement will be examined with the aim of adjusting prospective sand reserves to include vibracores containing a fines content less than 10%.

Grain Size Distribution Curves (back to TOC)

The grain size distribution (GSD) curves presented in the respective indexes for beach, grab and vibracore samples are in standard geological format. Separate GSDs were determined for the carbonate and non-carbonate fractions of each sample obtained by the FGS along with the combined GSD of the entire sample. Only combined GSD's are available from the samples obtained from the Corps of Engineers' vibracores. Digital photographs were taken of all beach and grab samples, gravity cores and vibracores collected by the FGS with the images being saved in a jpeg format. These files can be accessed via the index for beach, grab samples, gravity/slide hammer cores, and vibracores under the photo page column.

Sediment Processing Quality Control (back to TOC)

As a quality control check, approximately ten percent of the beach samples were processed a second time and the results compared, on an individual basis, with the initial sample processed. A strong correlation between individual samples taken from the same sampling point was noted. The results of these comparisons can be seen in Appendix H.

Seismic Acoustic Profiling (back to TOC)

Continuous seismic reflection profiling is a technique used to delineate and define sub-bottom structures and bedding surfaces in sediments underlying the seabed. Continuous reflections are generated by generating repetitive pulses of high energy sound underwater and recording the pulses returned as reflections from the seabed and sub seabed sedimentary and structural features. The resulting acoustical profile is roughly comparable to a geologic cross section.

Seismic reflection surveys, such as the ones accomplished in Years 1 and 2 off Nassau, Duval and northern St. Johns Counties, are made by towing sound pulse generating and receiving instruments behind a survey vessel traversing predetermined survey track lines at a set vessel speed. The sound pulse generator is initiated at a fixed rapid rate and the returning signals are received on a geophone array. The reflections are recorded digitally and the data are amplified, fed to a chart recorder, and graphically plotted out in two way signal travel time as an analog paper record. Assuming a constant speed for sound in both water and the shallow shelf sediments penetrated, a vertical depth scale for the analog record can be created. Horizontal control is achieved by the use of frequent navigational fixes. The resultant digital data set recorded typically comprises three files for each line:

- a navigational file (nav.),
- a geophysical response file (tra.) and
- a data acquisition parameters file (par.).

The geophysical response file for each line was subsequently processed in-house at the FGS to produce a graphics (jpg.) file.

Seismic Reflection Data Collection (back to TOC)

More than 190 line miles of subsurface acoustic profile data were acquired during the Year 2 study. All data were acquired in Federal waters off of southern Nassau, Duval and northern St. Johns Counties with the bulk of the data being acquired off St. Johns County. The seismic program consisted of 16 approximately seven statute mile long, east-west (dip) lines (approximately 148 statute miles total), two approximately 11 and 12 statute mile long, north-south (strike) lines, lying off Nassau and St. Johns Counties respectively and two interconnected infill lines, approximately 20 statute miles total, lying off Nassau County. This infill data was collected in Nassau County to compliment data previous collected in Year 1.The strike lines connect consecutively acquired east-west lines and as such are commonly referred to as “tie lines”. Locations for the east-west lines were chosen to provide an approximate one statute mile north-south separation between east-west lines. Figure 1 displays the location of all subsurface acoustic profile data collected to date. It was noted by Freedenberg et.al., (2002), in their studies to the south that the highest quality sand accumulations were associated with bathymetric highs, which they refer to as “subsurface topographic highs”. The length of dip lines and the placement of the tie line offshore of St. Johns County were therefore determined by distance from the shore, the eastward extent of bathymetric highs, and, in the case of the tie line, the lineation of the north/south strike of the crest of those highs as determined from the available bathymetric charts.

The seismic reflection profiles recorded for this study were collected aboard the FGS vessel R/V GeoQuest, (Figure 10/photo). Signal energy for the survey conducted in Year 1 was provided by a Huntec boomer sled towed approximately 30 feet behind the survey vessel. An ITI streamer cable was deployed for signal detection. Figure 14/photo shows how such a streamer is physically deployed while Figure 15 provides a diagram of how the equipment was deployed in Year 1. The sled-mounted Huntec boomer signal source was towed at an approximate speed over the seabed of 4 knots, fired at a shooting interval of 500 milliseconds with a record length of 120 milliseconds. A boomer generates its signal via the use of a rapidly moving electromagnetically controlled plate that imparts a pulse into the water column. For the Year 1 survey, the boomer was configured so that most of the source energy had a frequency of 400 Hz.

Signal energy for the Year 2 survey was provided by a C-Products C-LVB (low voltage boomer) boomer sled. Figure 16/photo shows the unit on the vessel’s back deck and Figure 17/photo shows the unit as deployed. A Benthos multi-element mesh array (15/10s with 12 inch spacing between 10 phones) streamer cable was used for signal detection (Figure 14/photo). For Year 2, the equipment towing diagram shown as Figure 14 was essentially the same except that the C-LVB and the Benthos streamer cable were substituted for the Huntec boomer sled and ITI streamer cable respectively. The sled-mounted C-LVB 100 joule boomer signal source was towed at an approximate speed over the seabed of 4 knots, fired at a shooting interval of 500 milliseconds with a record length of 100 milliseconds. For this survey the boomer was configured so that the peak of the source energy imparted had adominant frequency of 1760 Hz. The depth of such a geophysical instrument’s ability to image sedimentary features is directly related to the frequency utilized. The ability of such instruments to resolve increasingly finer details of sedimentary stratigraphy is a function of frequency in that the higher the frequency used the greater the resolution theoretically achievable. The conundrum is that signal attenuation, and thus an instrument’s depth of effective penetration, is essentially inversely related to resolution. This is due to the fact that the physical characteristics of the medium, in our case sea water and seafloor sediments, through which a signal is transmitted attenuate the signal through reflection, scattering and absorption. This phenomenon is commonly referred to as the “earth filter”. All other things being equal, the higher the frequency utilized in a given circumstance the more a signal is attenuated. Thus resolution is traded for depth of effective penetration in determining which frequency, or band of frequencies, to utilize in any seismic survey. The instrument utilized in Year 1 operated at 400 Hz and achieved deeper effective penetration than the data recorded in Year 2. This deeper penetration was achieved at the expense of resolution, as evidenced in near seabed reflectors. It was felt that using an instrument in Year 2 operating at 1760 Hz, and achieving greater resolution albeit at the expense of depth of penetration, would be of benefit to the study. Field data was sampled and converted to a digital format. All field records were retained on CD disks in Year 1 and DVD disks in Year 2 for long term storage and are available for general distribution.

The realities of the limitations placed by equipment, safety, and personnel availability initially constrained the time window for seismic data acquisition in Year 2 such that data could only be acquired during day light hours and over 2 approximately one week periods during a time of the year not particularly notable for good sea conditions in the study area. The time required for both mobilizing and demobilizing the equipment on and off of the vessel at the beginning and end of the survey period and the daily time required for transit to and from the shooting area coupled with highly changeable and unfavorable sea conditions during the period further constrained the time actually available for data acquisition.

The data quality of the seismic reflection profiles obtained during the marine geophysical survey in Year 2 was impacted by:

- frequently marginal/adverse sea conditions,
- the second boomer sled's higher sensitivity to "choppy" sea conditions,
- the amount of energy transmitted into the water column by the signal source and
- a pernicious, if somewhat intermittent, noise problem experienced in the first week of data acquisition.

Data quality improved in the second week of shooting as the noise problems experienced earlier seem to have been abated. It is anticipated that, during the marine geophysical survey conducted during Year 3, certain selected lines may be reacquired using a different signal source set at a lower frequency and/or it may be deemed efficacious to selectively acquire some infill lines thereby tightening the grid to a 0.5 mile interval locally offshore of the northern half of St. Johns County.

An additional 12.3 line miles of subsurface acoustic profile data, previously acquired by the United States Geological Survey over a feature know as "Crescent Beach Spring" lying 2 to 3 miles offshore of the southern half of St. Johns County, was also obtained. This data was processed and are of fair quality. It will be tied into the grid of seismic data to be acquired in Year 3.

Computer Processing of Seismic Data (back to TOC)

Processing of the seismic data collected in Years 1 and 2 was accomplished using the SonarWeb Pro software package developed by Chesapeake Technologies Inc. Individual seismic lines were processed such that the graphics (jpg.) files created produce images with west to the left on all east/west trending lines and north is to the left on all north/south trending lines. This facilitates ease of comparison of individual lines and is in keeping with standard practices and conventions generally used in seismic data processing. The sonic velocity utilized in data processing was 1500.00 meters per second (m/s) or 4921.2 feet per second (ft/sec), i.e. the average velocity of sound in sea water. While this is in keeping with standard practice in the interpretation of sub-bottom profiler records, the actual sonic velocity in the near seafloor sediments, due to their higher density relative to sea water, probably averages near or below 1800.00 meters per second (m/s) or 5905.44 feet per second (ft/sec). The depth markers provided on the seismic sections are therefore approximations. A band pass filter was utilized in processing with low and high cut frequencies set at 100 and 2000 hertz respectively. A time variant gain filter of 0.550 dB per millisecond was generally utilized as well. Seismic data acquired during Year 2 were converted to standard seismic data format (segy) prior to processing with SonarWeb Pro.

Offshore Seabed Grab Sample Analysis (back to TOC)

Seabed grab samples selected for sampling in Year 1 were chosen to emphasize those areas showing potential for sand accumulation based on the interpretation of geophysical data. Grain size distribution and percent carbonate content were determined for all grab samples and reported in the Year 1 Annual Report.

Seabed grab sample and gravity/slide hammer coring locations indicative of restoration quality sand accumulations based on analysis of bathymetric and sub-bottom profiler data will be investigated further during Year 3.

Geophysical Interpretation (back to TOC)

Previous Work in the Area (back to TOC)

Meisburger and Field (1975) noted several features of interest in the study area off Nassau County. Two of these features, described by them respectively as a “low linear shoal”, A1 on their Figure 40 our Figure 18 and as a “low linear ridge a top a bank shoal” A2 on Figure 18 lie approximately 11 and 13 miles offshore respectively. Seismic data and vibracores were collected in Year 2 to further investigate these features. Three additional features, described by them as “…low, roughly linear shoals lying parallel to the shore…” and designated B3, B4 and B5 on Figure 18 , lie approximately 5 miles offshore. Seismic data collected in Years 1 and 2 as well as vibracores collected in Year 2 further investigate these features.

Meisburger and Field (1975) noted two features of primary interest in the study area off Duval County. These features are comprised of a “channel” trending northwest to southeast which they associated with the ancestral mouth of the St Johns River, A5 on Figure 18, and a low linear shoal trending parallel with the coast line eastward of the “channel” feature, A4 on Figure 18 as well. Information provided by the Army Corps of Engineers has revealed that successful dredging of material for beach replenishment from portions of the shoal has already been accomplished. This area is show on Figure 1 as the pink block off Duval County.

Meisburger and Field (1975) noted two features of primary interest in the study area off St. Johns County north of St. Augustine. The first, “…a large irregular shoal centered 5 to 6 miles offshore between Jacksonville Beach and St. Augustine is judged to be the best prospect in the northern part of the study area.” This feature is shown as A6 on Figure 19. They describe it as “…of very low relief and nearly flat topped…” and based on the geophysical data available to them opinioned that it “… may have formed by accretion, possibly during the latter part of the last transgression.” They report that “…the few cores from the highest part of the shoal recovered up to 10 feet of clean uniform quartz sand of medium and coarse size.” They further state that:

> *Two small ridge-like features surmounting the shoal and its highest central feature are considered the best prospects. If this shoal was formed entirely by accretion, the total volume of sand within the shoal would be approximately 178 million cubic yards.*

The second area of interest identified by them was smaller and further south. This feature is shown as A7 on Figure 19. They state that it is “…the only prospective site within the St. Augustine grid.” Two of their cores in the area penetrated “…a clean medium quartz sand layer 4 to 6 feet thick.” They were of the opinion that the ridge line feature they observed is “…the most likely locale for a suitable borrow area.” They estimated the volume of sand in the ridge to be 7.4 million cubic yards.

Regarding the shoals off St. Johns County and those noted to the north, it is important to note that in previous studies on the central east Florida Coast (Freedenburg et. al., 2002) the FGS determined that the highest quality sand accumulations were associated with bathymetric highs and that subsurface acoustic profile data analysis was the predominant tool used to delineate such highs.

Seismic Stratigraphic Analysis (back to TOC)

A seismic stratigraphic analysis was made of the near seabed features noted in the seismic reflection profiles based on the data acquired in Year 1. Post processed presentations of the seismic reflection profiles acquired in Years 1 and 2 are provided as jpg files. As shown on Figure 1, our analysis of the seismic reflection profiles obtained in Years 1 and 2 has identified several near seabed features of interest. As previously discussed in our Year 1 Report this was interpreted to be a complex of channels and disturbed sediments believed to comprise the remains of channels and ebb tidal delta/estuarine complexes associated with the ancestral St. Johns, Nassau and St. Marys Rivers. These features were mapped and detailed in our Year 1 Report. As discussed in our Year 1 Report, this interpretation was considered to be consistent with Meisburger and Field's (1975) findings that showed that while portions of the "channel" they identified proved sand-rich, other portions contained a significant admixture of finer grained material unsuitable for beach restoration use. As the data suggests that a mantle of reworked sediments of variable thickness is superimposed on these features, a program of vibracoring conducted in coordination with the U.S. Army Corps of Engineers was initiated to define locations where this mantel was sufficiently absent. This mantel manifests itself off Duval County as a shoal, originally noted in Meisburger and Field (1975) to be lying seaward of the Duval/Nassau County boundary region. Because this shoal was determined to contain sufficient suitable sand-rich sediments to function as a source for beach replenishment projects in the past, it was one of our a vibracoring targets.

As reported in the Year 1 Report, lying in the northeastern extent of the survey area, in a relatively limited area, are sediments which are interpreted to be a lens of material which appears to have been laid down in a low energy environment and thus are inferred to consist of relatively fine grained sediments. Consequently this area was considered to be of very low potential to function as a sand source for beach restoration and was not vibracored.

Interpreted deeper in the geological section offshore of Nassau and Duval Counties are areas of anomalous dip as well as three clearly identifiable buried depressions in the seafloor sediments. All of these features are interpreted to be karst process related. Interpretation of the data associated with the three buried depressions strongly suggests that they are dissolution collapse features. These features are vertically persistent to the base of the seismic data recorded, apparently of limited areal extent, and not seen bathymetrically. Individually they are present on single east/west (dip) sub-bottom profiler lines ND 2, ND 15 and ND 41 but not their immediately adjacent dip lines to the north and south respectively. Two of these features are also crossed by subbottom profiler line T1, a north south strike line. The feature which is manifested both on subbottom profiler line ND 15 and as the southern most of the two such features shown on subbottom profiler line T1 appears to have displayed bathymetric expression into the Holocene. All three of these conjectured collapse features lie approximately six to seven miles off shore.

Sedimentological Interpretation of Vibracores as an Indicator of Sand Resource Potential (back to TOC)

The earliest known vibracoring investigation in the area was conducted, between August 1966 and February 1967, for the ICONS study. As was noted above, Meisburger and Field (1975) identified a number of areas off Nassau and Duval Counties that, based on the above referenced vibracoring and their analysis of sub-bottom profiler data, were of particular interest. They postulated the existence of over 5.0 million cubic yards of restoration-quality sand in a channel deposit 3 to 4 miles off the mouth of the St. Johns River, see area A5 located on Figure 18. The U.S. Army Corps of Engineers has, subsequent to that study, extensively vibracored the area and, to a lesser extent, its immediate vicinity. While granulometric analysis of the sediments recovered by these cores is not available, core descriptions were made available to us. These core descriptions are included in this report as Appendix I. Portions of area A4, located on our Figure 18, have been extensively vibracored and dredged, see Figure 1 for an outline of the previously dredged area.

Analysis of Florida Geological Survey Collected Vibracores (back to TOC)

The Florida Geological Survey in the Year 2 vibracoring program, attempted a two fold investigation of the sediments off Nassau and Duval Counties. The first of those two objectives was to investigate the potential for restoration quality sand in channel deposits contemporaneous with those identified as area A5 on Figure 18. The second objective was to investigate the shoals noted as worthy of further investigation in Meisburger and Field (1975). Of those shoals the shoal identified as area A2 was vibracored and the data acquired processed in time for inclusion in this report. Meisburger and Field (1975) report that their vibracore 76 found "…clean quartz sand with a median diameter range of 0.330 to 0.268 millimeters (1.6 to 1.9 phi)." Their vibracore 76 was only 3 feet long. Our vibracore VNA-4, south of but on the shoal's axial trend with their vibracore, is 6 feet long and evidenced restoration quality sand throughout its entire length. Diver reconnaissance in the immediate vicinity of vibracore VNA-4, accomplished at the time that vibracore was collected, suggests that this accumulation of restoration quality sand is laterally extensive. Further vibracoring to investigate this feature, and bathymetrically similar features immediately to the south, are planned for Year 3.

Analysis of Athena Technologies Collected Vibracores (back to TOC)

These vibracores were collected by Athena Technologies Inc. (Athena) but processed by Wolf Technologies Inc. (Wolf). This vibracoring program was intended to more fully investigate area A4 as noted on Figure 18. Analysis of this vibracore data set, see Figure 20 and Appendix G, suggests that significant reserves of restoration quality sand remain offshore of the southern half of Duval County both east and southwest of the area previously dredged. Although a substantial number of cores collected by Athena evidenced sand to the limit of penetration, in a number of cores sands are underlain either by clay or limestone. In calculating reserves of available sand, an effort was made to include in those calculations only those sequences which were described, sampled and granulometrically analyzed by Wolf rather than basing our sand reserve calculations on core descriptions alone. This is an important distinction to make as those cores described by Wolf typically exhibit sands to greater depths than were analyzed, albeit often with an admixture of clay and/or silt as a minor component. Thus, our sand reserve calculations involving cores collected by Athena are based primarily on Wolf's granulometric analysis of specific sedimentary units and only secondarily on Wolf's lithologic descriptions. Core descriptions were used only to establish the base of such sedimentary units that were analyzed. To delineate available sands, a sediment thickness contour interval of 5 foot was chosen, with 5 feet of sand thickness being selected as the minimum acceptable sand thickness for the purposes of sand reserve calculations. Based on the limits established by the above referenced provisos, we infer that there are potential reserves of approximately 198.5 million cubic yards (MCY) of restoration quality sand offshore of southern Duval County. These reserves are delineated on Figure 20.

Subsequent U.S. Army Corps of Engineers Vibracoring (back to TOC)

Communication with Gary Holm of the U.S. Army Corps of Engineers' Jacksonville, Florida office indicates that an additional 50 vibracores have been recently acquired off of Duval County and that a resistivity survey has been conducted in that area as well. Conversations with Mr. Holm regarding this data set suggests that localized occurrences of cobble sized shell beds, not evidenced in the vibracores previously collected, may adversely impact sediment usability in some areas. Be that as it may this additional work is

reported to have better delineated and quantified the potential reserves of restoration quality sand we have inferred both south and east of the previously dredged area. Their report, detailing the findings of this additional work, was not available in time to be utilized in this report. A discussion of their report will be included in the Year 3 Report. As might be expected, it is anticipated that our review of this recently acquired data will further confirm, qualify and quantify the available reserves discussed above. Given the volume of sand inferred to be potentially available in the area it is anticipated that this report, by concentrating both in a specific area and on sediment quality, will most probably reduce the volume of restoration quality sand ultimately established as final proven reserves.

Summary, Conclusions, and Recommendations (back to TOC)

Summary of Work (back to TOC)

The following is a summary of work accomplished to date:

- Over 420 miles of seismic data was collected in Years 1 and 2, over 190 miles of that was collected in Year 2,
- All seismic data collected in Years 1 and 2 has been computer processed, integrated with the vibracoring data obtained and interpreted to aid in determining locations thought to have been favorable for the deposition of beach-quality sand,
- 34 beach sampling locations were identified and 106 surface samples collected in Year 1 in Nassau, Duval and St. Johns Counties, a further 63 beach sampling locations were identified and 127 surface samples were collected Year 2 in St. Johns and Flagler Counties,
- A total of 18 offshore seabed grab samples were collected in Year 1,
- 3 push cores were collected on the ebb tidal delta of the Nassau River in Year 1,
- Descriptions were made and grain size distributions were determined for all beach and offshore seabed grab samples collected in and offshore of Nassau, Duval and St. Johns Counties,
- A total of 52 vibracores were collected offshore of Nassau and Duval Counties with 11 vibracores collected by the FGS and 41 collected by the FGS's subcontractor, and;
- An additional 3 vibracores were collected by the FGS's subcontractor in the mouth of the St. Johns River, and;
- All the vibracores collected have been described, and except for some noted exceptions, they have also been photographed, sampled and granulometrically analyzed.

Conclusions (back to TOC)

As a result of the seismic stratigraphic analysis, several features indicative of high potential for the occurrence of beach restoration-quality sand in federal waters off Duval County were identified. This analysis was discussed with representatives of the U.S. Army Corps of Engineers (USACE) Jacksonville District Office and a copy of the preliminary work map delineating those features provided to them. From that data, they identified 45 locations in the study area of particular interest to them preparatory to the initiation of the USACE's Jacksonville Beach Nourishment Project projected to occur in 2005. A coring contractor was selected and 44 vibracores were recovered and then processed by the USACE's designated laboratory. Analysis of 41 of the

vibracores in that data set, see Figure 20 and Appendix G, infers potential offshore reserves offshore of approximately 198.5 MCY of restoration-quality sand associated with 41 of those cores.

In addition to the 44 vibracores obtained in conjunction with the U.S. Army Corps of Engineers, 11 vibracores were obtained offshore of northern Duval and Nassau Counties. Photographs, descriptions and granulometric analysis of that vibracore data set is provided in Appendix E.

Ignoring the effect of natural compaction and that inherent in the vibracoring method, calculated sedimentation rates for the first 16.8 feet of sediments, based on radiocarbon dating, would be 0.3621 mm per year +\- .0015 mm. It is suggested that this figure would set an approximate lower limit on the average Holocene sedimentation rate locally.

Seismic stratigraphic analysis of the sub-bottom profiler data indicate the presence of areas of anomalous dip offshore of Nassau and Duval Counties as well as three clearly identifiable buried depressions in the seafloor sediments. All of these features are interpreted to be karst process related. The three clearly identifiable depressions, interpreted to be dissolution collapse features, are vertically persistent to the base of the seismic data recorded, appear to be of limited areal extent, and are not seen bathymetrically. One of these features, based on seismic stratigraphic analysis, appears to have continued its bathymetric expression into the Holocene. All three of these conjectured dissolution collapse features lie approximately six to seven miles off shore.

Recommendations for Work to be Accomplished in Year 3 (back to TOC)

It is recommended that Year 3 tasks include a comprehensive program of reconnaissance seismic profiling offshore of the southern half of St. Johns and the northern half Flagler County. It is recommended as well that additional seismic profiling offshore of Duval County and the northern half of St. Johns County to supplement data collected in Years 1 and 2 be accomplished if time allows. Year 3 tasks should also include the collection and analysis of bottom samples and gravity cores preparatory to the selection of individual vibracore sites to be investigated in Years 3 and 4. Based on data collected during Year 2 and supplemented by bottom sampling and gravity cores to be collected in Year 3 preparatory to the selection of individual vibracore sites, it is recommended that a series of vibracores be taken offshore of the northern half St. Johns County. It is further recommended that the beach samples collected off Flagler County be processed and that a program of beach sampling to characterize the existing beach sediments for the purposes of sediment matching be conducted on the beaches in Volusia County and the northern half of Brevard County, either in Year 3 or later in Year 4. It is suggested that the data collected by the United States Army Corps of Engineers (USACE) offshore of southern Duval County, acquired subsequent to our initial joint vibracoring program, be reviewed and included in the Year 3 Report. It is the FGS's current intent to further investigate the Holocene sediments offshore of Nassau, Duval and St. Johns Counties through a more detailed analysis of the most recently acquired vibracores. Additionally, it is recommended that the FGS continue communicating with the USACE during their dredging area selection process to complement the USACE's preparations for the Jacksonville Beach Renourishment Project projected to occur in 2005 and coordinate with them regarding proposed projects to occur in the vicinity of St. Augustine and Flagler Beach. The research goals outlined above, if achieved, will facilitate the further investigation of the shore and near shore coastal areas of:

- southern Duval County to evaluate and quantify offshore sand resources for the purpose of beach restoration in the immediate future,
- Nassau, northern Duval, St. Johns and Flagler Counties to evaluate potential offshore sand resources for anticipated future need, and
- Flagler and Volusia Counties to characterize the sediments on their respective beaches.

Acknowledgements (back to TOC)

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