MASHES SANDS
Wakulla County, Florida

Feasibility Study and Beach Management Plan

August 1, 2008

Prepared For:

Wakulla County

DEPARTMENT OF ENVIRONMENTAL PROTECTION
FLORIDA

Bureau of Beaches and
Coastal Systems
Beach Erosion Control Program

Prepared By:

mrd
mrd associates, inc.
Coastal, Marina & Water Resources Engineering

In Association With:

THE LPA GROUP
ENGINEERS • ARCHITECTS • PLANNERS

EXECUTIVE SUMMARY

1.0. INTRODUCTION

The primary objective of this investigation and the subsequent report is to provide a "blueprint" for beach management and implementation guidance to Wakulla County for this section of shoreline as identified in DEP's "*Strategic Beach Management Plan*" as the Mashes Sands County Park. This investigation will develop a preliminary design(s) which may mitigate for long-term erosion, provide an increased level of storm protection, enhance recreation, and preserve natural resources.

2.0. COASTAL PROCESSES

Since the construction of the Park revetment in the late 60's to early 70's, the erosion rate south of the revetment has been reduced from -3 ft/yr (1856 to 1976) to -0.8 ft/yr (1976 to 2007) which indicates this structure may be acting as a groin by impounding sediment on the south side of the structure and reducing the flow of sediment to the north. As a result, the northern "downdrift" side of the structure has experienced an accelerated shoreline erosion rate ranging between -3 and -10 ft/yr, with an average of -6 ft/yr. The increase in the documented shoreline recession rates may reflect the impacts from recent hurricanes. It was reported in the post-Hurricane Dennis report that approximately 0.5 miles of this shoreline was translated 50 feet landward resulting in a washover into the back-barrier wetlands.

3.0. NATURAL RESOURCES ASSESSMENT

A Natural Resource Assessment documented the existing natural communities including sea grasses, emergent shoreline vegetation, marine vertebrates, marine fauna and avian species that are present along the Mashes Sands project limits. The field investigations identified large sea grass beds consisting of approximately 275 acres which are located within 100 feet of the shoreline and extend at least 3,000 feet offshore. In addition, *Spartina alterniflora* (cordgrass) was found to exist along the project shoreline.

4.0. ALTERNATIVE DESIGNS

Four (4) design alternatives were evaluated to develop the most cost effective and feasible project to yield maximum benefits and meet the project goals. The alternatives included: 1) No New Action; 2) Beach and Dune Restoration; 3) Beach Restoration with a Terminal Groin; and, 4) Beach Restoration with T-Groins. A detailed geotechnical investigation will be required to identify possible sand sources.

5.0. BEACH ACCESS

There are two (2) "Secondary Accesses" at Mashes Sands for a total of 4,280 feet of "Eligible" shoreline. One access is located in the County Park at the east end of Mashes Sand Road and the second access is located along the east side of the boat ramp canal. Each beach access has 50+ parking spaces.

6.0. FUNDING OPTIONS

The State may only cost share for the project shoreline that is designated as "critically eroding" which for Mashes Sands is 1,600 feet (0.3 miles) of shoreline. Based on existing beach access and parking, the <u>minimum</u> State cost share is 50% and the County cost share is 50%, but because the State of Florida is the upland owner, the State <u>may</u> pay for up to 100% of an erosion control project.

7.0. RECOMMENDATIONS

Based on the findings of this investigation, input and discussions with DEP staff and the presentation made before the Wakulla County BCC, it is recommended the Wakulla BCC advance Alternative 3 – Beach Restoration with a Terminal Groin. The County should apply to the Bureau of Beaches and Coastal Systems for Erosion Control Program funding on an annual basis which is due by August of every year.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0. INTRODUCTION

1.1. BACKGROUND

Mashes Sands is located in Wakulla County, Florida situated along the Big Bend segment bordering the Gulf of Mexico (Figure 1-1). The Florida Department of Environmental Protection (DEP), Bureau of Beaches and Coastal Systems (BBCS) has designated the southern half of the shoreline of Mashes Sands (approximately 0.3 miles) between Monuments 4A and 6A (Figure 2-2, Section 2.0.) as “critically eroding” (DEP, 2008a). Tanner (1960) classified the shoreline at Mashes Sands as a chenier, which is subject to frequent overwashing depositing sediment into the nearby marsh system. The other notable storm related occurrence is the large storm surge associated with this part of the state. This is explained further in Section 2.0. - Coastal Processes.

1.2. PROJECT GOALS

It is the intent of Wakulla County and the DEP-BBCS to develop a feasibility study and beach management plan for this section of shoreline as identified in the “*Strategic Beach Management Plan*” (DEP, 2008b) as the Mashes Sands County Park. Specifically, this study will assess alternatives to meet the following five (5) goals:

1) Mitigate for long-term erosion;
2) Provide upland storm protection;
3) Provide a recreational beach;
4) Preserve and/or enhance natural resources, and;
5) Provide a “blueprint” for beach management and implementation guidance to the County.

In addition, sediment infilling of the Mashes Sands Boat Ramp and Sunrise Canal’s is discussed and is presented at the end of Section 4.0 of this report.

1.3. SCOPE OF WORK AND REPORT ORGANIZATION

The basic approach for this investigation is to provide the Wakulla County Board of Commissioners (BCC) with economically feasible and sound engineering alternatives in order for the County to select a “locally-preferred” project. The management plan is developed by collecting and analyzing all available data within the confines of the study limits and utilizing it to create effective solutions to the intermittent storm induced erosion and upland vulnerability occurring along the study area shoreline. This enables effective and informative decisions to be made by the BCC. This report presents the findings of a comprehensive investigation to the effectiveness of various erosion control alternatives and includes:

- **Section 2.0** Coastal Processes analysis within the study limits to document the physical processes that affect and impact the shoreline along Mashes Sands;
- **Section 3.0** Natural Resources Assessment of the upland and offshore environment;
- **Section 4.0** Alternative Designs - evaluation and comparisons to address the design goals;
- **Section 5.0** an inventory of the available public beach access points within the study limits;
- **Section 6.0** funding options for the implementation of an erosion control project;
- **Section 7.0** Recommendations to provide guidance to the County; and,
- **Section 8.0** References used in the development of this report.

1.4. AUTHORIZATION

This *Mashes Sands Feasibility Study and Beach Management Plan* is authorized between Wakulla County Board of Commissioners, a political subdivision of Florida, and MRD Associates, Inc. of Destin, Florida through a cooperative agreement with the LPA Group of Tallahassee, Florida. The funding for this investigation was provided through a grant from the Florida Department of Environmental Protection, Bureau of Beaches and Coastal Systems, Beach Erosion Control Program.

The Wakulla County Board of Commissioners include: Brian Langston – District 1; George N. Green – District 2 and Vice Chairman; Ed Brimner – District 3 and Chairman; Howard Kessler – District 4; and, Maxie Lawhon – District 5. The project team would like to thank Ray Gray and his staff of the Wakulla County Parks and Recreation Department for their assistance in the development of this investigation. In addition, Catherine Florko, Project Manager of the Beach Erosion Control Program and Ralph Clark, P.E. of the Coastal Engineering Section of the Bureau of Beaches and Coastal Systems.

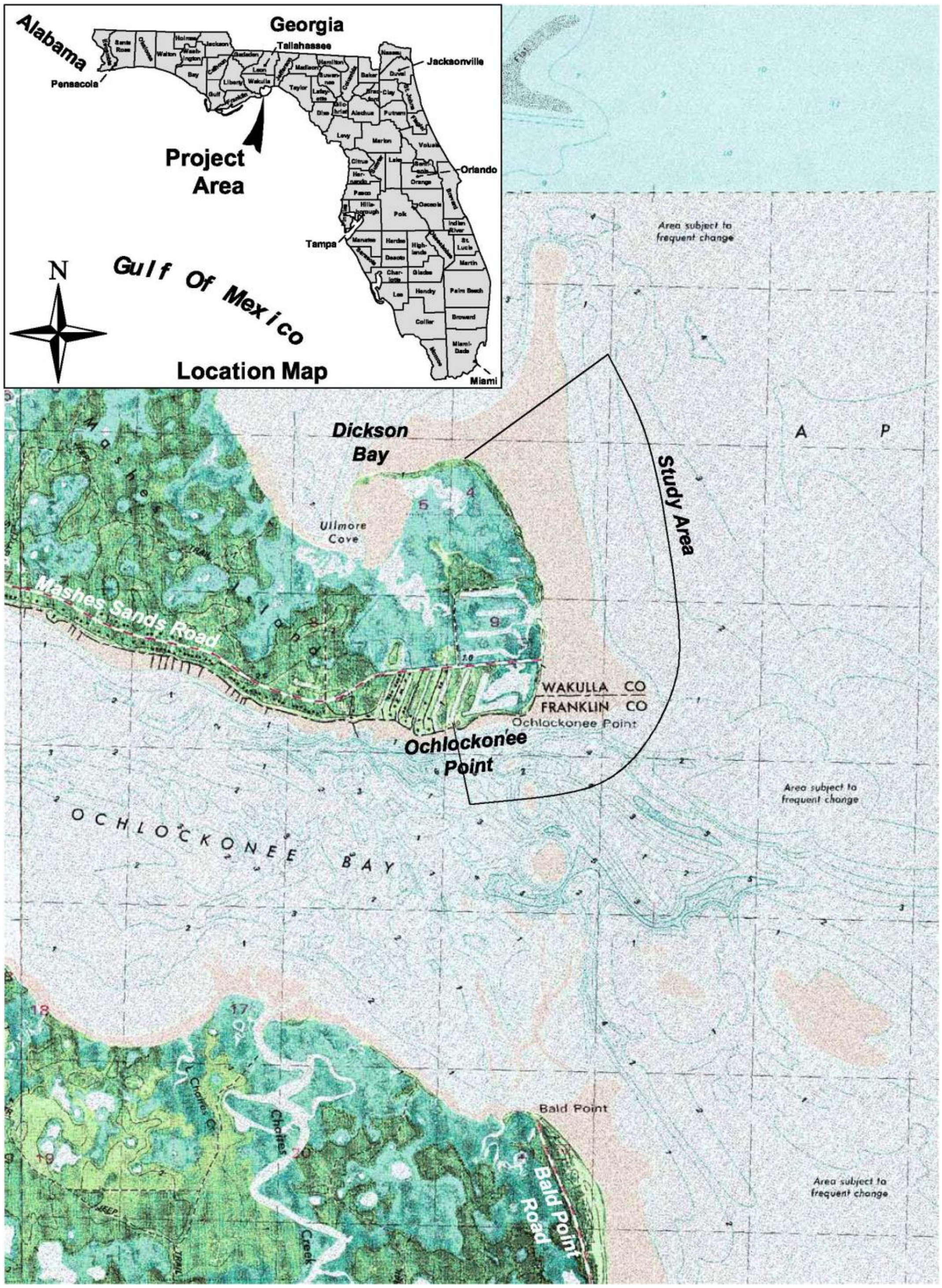


Figure 1-1. Location map for the Mashes Sands study area.

2.0. COASTAL PROCESSES

2.1. INTRODUCTION

As stated in Section 1.0, the primary purpose of this investigation is to identify, evaluate and develop alternatives which may mitigate for the erosion occurring along Mashes Sands, provide an increased level of storm protection, enhance recreational opportunities, and preserve natural resources. Evaluating the effectiveness and performance of these alternatives requires an in-depth understanding of the physical coastal processes along the project shoreline. For example, the development of the sediment budget would provide engineers and regulatory agencies with sediment volume change rates, direction, and shoaling and deposition rates. From this, a well informed assessment could be made if natural resources present in the area could be adversely impacted from a proposed beach fill project or installation of a coastal structure(s). This section provides a detailed description of the physical coastal processes along the Mashes Sands shoreline including: Oceanographic Climate; Geological Setting; Shoreline Changes; Longshore Sediment Transport; and, Sediment Budget.

2.2. OCEANOGRAPHIC CLIMATE

2.2.1. Tides and Tidal Currents

The tidal datums along the Gulf of Mexico in the project vicinity are primarily semi-diurnal, becoming mixed during the 1/4 and 3/4 moon phases. Researching the available tidal benchmarks in the area, the closest benchmark is located at Fiddlers Point (NOAA Station Number 8728258) approximately 3.1 miles north northeast of the project site. The mean high water (MHW) elevation relative to NAVD 88 is 1.37 feet, the mean low water (MLW) elevation is -1.29 feet, and having a mean tide range of 2.66 feet. It should also be noted that swift tidal currents are typically associated with the large tidal ranges and constricted waterways such as the Ochlockonee Bay. Currents were measured between October 12th and 15th, 2007 during a mean tide for both a flood and ebb tide within the project limits (Figures 2-4 and 2-5). Recorded depth averaged current speeds were approximately 1.3 feet per second (0.4 meters per second) and 2.0 ft/s (0.6 m/s), respectively.

2.2.2. Storm Surge

The Florida Department of Environmental Protection, Bureau of Beaches and Coastal Systems (formerly the Florida Department of Natural Resources, Division of Beaches and Shores) conducted a storm surge study for Wakulla County to determine the open coast combined total storm tide elevations for varying return interval storm events (Dean, 1988). The simulation was conducted along a profile line that traversed between Bald Point, Franklin County (west) and Mashes Sands (east). FEMA (1992) conducted a similar study and found that the 100 year flood elevation for this shoreline was +22.4 feet NAVD 1988 or a difference of 8 feet higher in elevation compared to the 1988 DEP study (Table 2.1). The results from the 1988 DEP report are used in this study.

Table 2.1. Combined total storm surge (10, 20, 50, and 100-year) elevations for Mashes Sands, Wakulla County, Florida.

Return Period (years)	**Combined Total Storm Tide Level above NAVD 1988 (FEMA)**[1] (feet)	**Combined Total Storm Tide Level above NAVD 1988 (DEP)**[2] (feet)
10	4.1	8.7
20	10.6	10.6
50	18.4	12.8
100	22.4	14.4

For reference, a storm tide of +9.1 feet, NAVD 1988 was measured at Mashes Sands from Hurricane Dennis which made landfall over 210 miles to the west of this area in 2005 (DEP, 2006).

2.2.3. Waves

The offshore (deepwater) wave characteristics were obtained from the United States Army Corps of Engineers (USACE) Wave Information Studies (WIS) webpage http://frf.usace.army.mil/cgi-bin/wis/atl/atl_main.html. WIS Station 221 (29.7498^{o} N, 84.0839^{o} W), located approximately 18.6 nautical miles southeast of Mashes Sands in a water depth of 11 m (36 ft) is used in this investigation. The data set excludes waves from the north counter-clockwise to the south (western plane). These waves along with calm events (seas less than 1 foot) were filtered out as they will have little to no effect on the sediment transport at Mashes Sands due to the sheltering effects of the land mass. Table 2.2 and Figure 2-1 (wave rose) summarize the wave climate that can be expected at the project site.

Table 2.2. Mean wave conditions - WIS station 221 (January 1980 to December 1999)

Directional Wave Band[3] (meteorologic)	**Mean Wave Direction** (degrees, meteorologic)	**Mean Wave Height** (meters)	**Mean Period** (seconds)	**Percent Occurrence** (%)
0-30	16.0	0.84	3.8	6.0
31-60	46.1	0.81	3.8	8.1
61-90	75.4	0.77	3.8	9.4
91-120	104.6	0.75	3.8	6.3
121-150	136.0	0.74	3.9	6.0
151-180	166.7	0.77	4.2	8.6

[1] Elevations scaled from 100-year flood elevation from FEMA flood maps in the project vicinity.
[2] Elevations found in Dean, 1988 Table IV page 83.
[3] Wave data has been filtered such that only waves affecting sediment transport and occurring from due north clockwise to due south are presented.

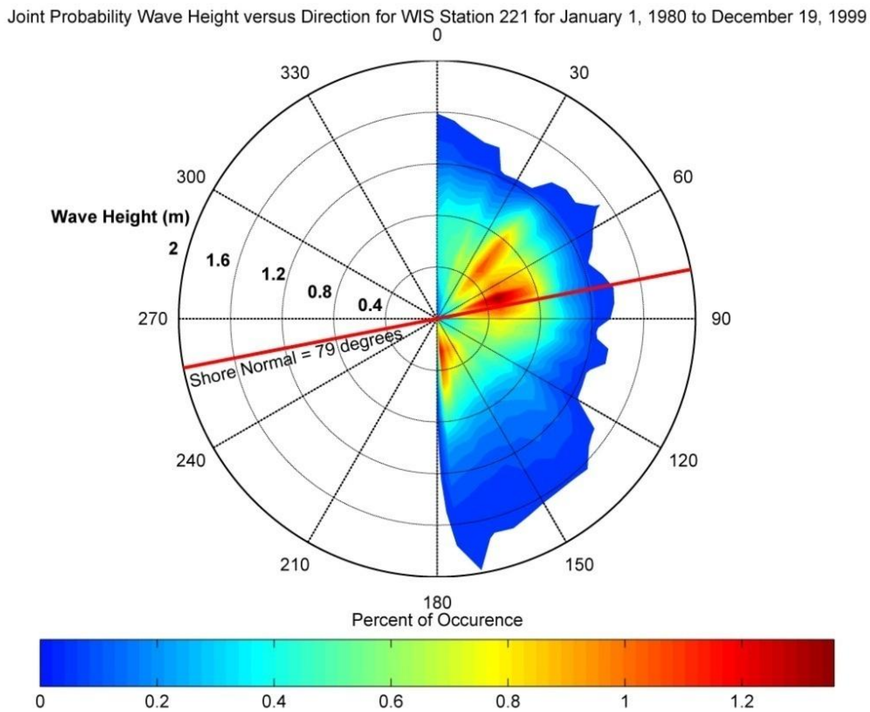


Figure 2- 1 WIS Station 221 wave rose filtered from 0^0 to 180^0

2.3. GEOLOGICAL SETTING

2.3.1. Coastal Geomorphology

Mashes Sands is described as a chenier (Tanner, 1960) which is a linear sand feature parallel to the shoreline and overlies soft material such as clay or organics (Clark, 1991). Mashes Sands is similar to the cheniers along the coast of Louisiana. Yon (1966) included Mashes Sands as part of the Silver Bluff Terrace. This is a marine geologic feature ranging between sea level and +10 feet. An extensive marsh system exists on the back barrier side of Mashes Sands which is overwashed by storm surge and sand during storm events.

2.3.2. Native Beach Sand Characteristics

Sediment samples were collected August 1, 2007 along four (4) profiles 2A, 5A, 7A and 9A (Figure 2-2) from the beach berm, mean high water line and offshore in approximately 3 feet of water to determine the native beach sediment characteristics. Only three samples were collected along a profile due to the lack of any dune feature and the relative close proximity of nearby marshlands to the observed waterline. In addition to the native beach samples, three offshore samples were collected to determine the offshore sediment characteristics as a first step to identify potential offshore borrow area(s). The native beach sample locations as well as the three borrow area samples are summarized in Table II.1. – Supplementary Information and Figure 2-2.

The sediment samples were analyzed using the DEP standard sieves and percent fines (percent passing the #230 sieve), percent carbonate, and sediment color. A composite taken of the native beach samples yielded an average grain size of 0.32 mm having a sorting of 0.74 phi, with an average percentage of 2.2% fine sediment passing the #230 sieve. The range of color for the beach was found to be between 10YR 8/2 and 10YR 6/2 with darker colored sediments located offshore. Table II.2 provides the sedimentological summary for the samples collected along the shoreline of Mashes Sands and the three potential borrow area samples. It should be noted the offshore borrow areas were determined not to be feasible for use due to the presence of extensive sea grass beds. The granularmetric curves and tables for each sample are presented in the Supplemental Information - Section II.

2.4. SHORELINE AND PROFILE DATA

Two types of historical data are used in this study to document and analyze shoreline position movement and volume changes along the Mashes Sands study area (Figure 2-2): 1) historic shoreline mean high water line (MHWL) position based on historic aerials and maps; and, 2) beach and offshore profile surveys.

2.4.1. <u>Shoreline (MHWL) Position Data</u>

A historic shoreline position documents the location of the shoreline at one particular point in time. A comparison of such shoreline positions can suggest erosional or accretional trends. For this investigation, the shoreline position was taken as the line where the plane of MHWL intersects the beach. Historic shoreline (MHWL) positions digitized by DEP are based on charts and maps dating back to 1856. The accuracy in interpreting the shoreline position of the older maps and charts is approximately ±30 feet, and this data is used in this analysis only to approximate the MHWL change rate. DEP currently does not maintain or monitor MHWL changes in Wakulla County therefore data collected from historic aerials will be used for this portion of this analysis.

2.4.2. <u>Beach and Offshore Profile Data</u>

Reference Monuments (1A to 10A) were set by MRD Associates, Inc. spaced approximately every 1,000 feet apart along the study area (Figure 2-2). Historical profile surveys have not been conducted along the Mashes Sands project site, thus comparisons of any historical profiles to the recently collected data set could not be performed. However, the beach and offshore profile surveys conducted by MRD Associates, Inc. can be compared to the historic DEP shoreline (MHWL) position drawings presented in Section 2.4.1. This recent profile data extends approximately 3,000 feet offshore and will provide a baseline data set for the evaluation of future shoreline and volume change conditions along Mashes Sands. Section II - Supplemental Information plots the profile data collected at Mashes Sands.

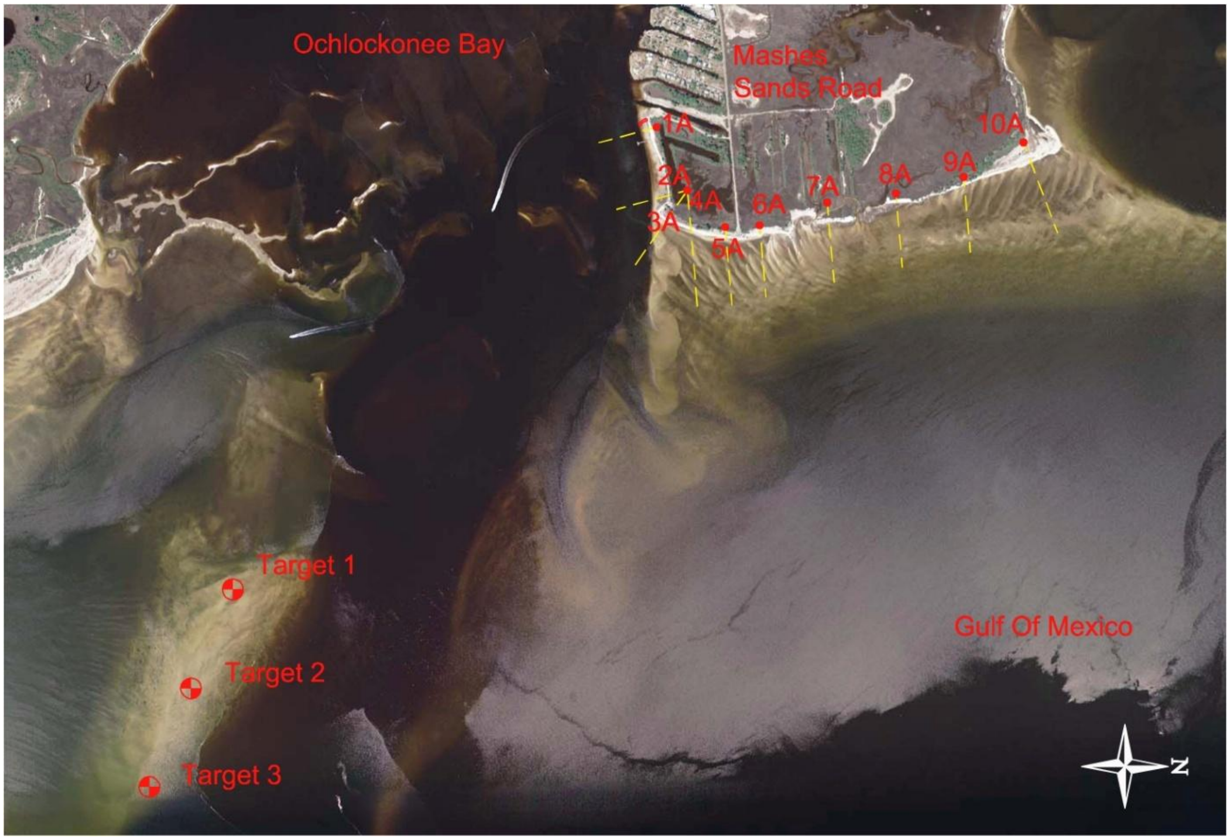


Figure 2- 2 Location of monuments, profiles and sediment sampling stations (along profiles 2A, 5A, 7A and 9A and three offshore locations).

2.5. SHORELINE CHANGES

2.5.1. Estimated "*Depth of Closure*"

"Depth of Closure" (DOC) is defined as the water depth at which no appreciable movement of sediment by wave action occurs (NRC, 1995). Understanding the location of the depth of closure on a profile is important for several reasons including interpreting survey data, estimating fill adjustment and siting potential borrow areas. For example, a proposed borrow areas should be located seaward of the estimated depth of closure to minimize or eliminate any potential adverse impact to the restored beach. Beach fill material could be transported offshore back into the borrow areas if excavated too close to the shore. Calculations were made utilizing methodologies presented by Hallermeier (1978, 1981) for a predictive means of calculating the DOC due to the absence of historical beach profile measurements (Kraus, 1998). Equation 2-1 defines the DOC as;

$$D_c = 2.28\, H_s - \left(\frac{H_s^2}{gT^2}\right) \qquad \text{Equation 2-1}$$

in which D_c is the symbol for the DOC, H_s is local significant wave height exceeded for 12 hours in duration, and T is the wave period associated with H_s (Kraus, 1998). Utilizing this equation and the hindcasted data for WIS Station 221, the local significant wave height (H_s) of 2.3 meters (7.6 feet) and an associated peak period (T) of 6.9 seconds yields a predicted depth of closure of approximately 4.2 meters (13.7 feet). Due to the shallow shoal located offshore of Mashes Sands, this would mean that the depth of closure is located approximately between 900 and 1,200 meters (3,000 and 4,000 feet) offshore of the existing shoreline.

2.5.2. Shoreline (MHWL) Changes

Mean high water line (MHWL) shoreline change rates along the Mashes Sands project limits are documented in this report based on historical shoreline position data obtained from DEP (Section 2.4.1) and surveys conducted during this investigation (Section 2.4.2) for the following time intervals: 1) 1856 to 1976; and, 2) 1976 to 2007. Figure 2-3 plots the calculated shoreline change rates for the study area. The MHW elevation for the project area is +1.4 feet NAVD 1988 (Balsillie, 1987). Because the uplands are publically owned, the project area is largely undeveloped with few structures. There are two small coastal protection structures that have been constructed with the purpose to mitigate for shoreline recession. The oldest being the revetment at the end of County Road 372 located between Monuments 5A and 6A, which is believed to have been installed in the late 1960's to early 1970's (Clark, 1991). The second is a terminal groin which was constructed in 2007 and was installed to the west of Monument 1A. The groin was constructed to prevent the infilling of the entrance channel leading to the County's boat ramp and to reduce shoreline erosion to the east of the structure.

1) **Shoreline Changes - 1856 to 1976:** Based on shoreline data from 1856 and 1976, the Mashes Sands shoreline has an erosional trend with one segment of shoreline being accretional (Figure 2-3). The MHWL data indicate that the study shoreline has been erosional with an average shoreline recession rate of -2 feet per year (ft/yr) from Monuments 1A to 9A (Figure 2-2). Between Monuments 1A and 5A the average rate is approximately -3 ft/yr and Monument 5A to 9A is approximately -1 ft/yr. The northern spit located in the vicinity of 10A has been accreting at an average rate of +2 ft/yr (Figure 2-3). During this time period, more than 50 storms have come within a 50 nautical miles radius of Wakulla County which may have resulted in varying impacts to the project shoreline and the northerly transport of sand toward the spit.

2) **Shoreline Changes - 1976 to 2007:** Since the installation of the revetment at the end of County Road 372 in the late 60's to early 70's, the erosion rate of -0.8 ft/yr measured between 1976 and 2007 for the shoreline to the south of the revetment (between 3A and 5A at the south-east end of Mashes Sands) appears to have been reduced compared to the previous documented period (1856 to 1976) of approximately -3 ft/yr. Clark (1991) observed this and indicated the revetment may be acting similar to a terminal groin by impounding sediment on the south side of the structure and reducing the flow of sediment to the north along the eastern shoreline of Mashes Sands. As a result, the north downdrift side of the structure (6A to 9A) has experienced an accelerated shoreline erosion rate ranging between -

3 and -10 ft/yr, with an average of -6 ft/y (Figure 2-3). The increase in the documented shoreline recession rates may reflect the recent impacts from Hurricanes Ivan (2004) and Dennis (2005). It was reported in the post-Hurricane Dennis report (DEP, 2006) that approximately 0.5 miles of Mashes Sands shoreline was translated 50 feet landward resulting in a washover into the back-barrier wetlands. As documented in the previous time period (1856 to 1976), the northern most spit (Monument 10A) appears to be accreting with an average shoreline change rate of approximately +11.6 ft/yr.

2.6. LONGSHORE SEDIMENT TRANSPORT

Clark (1991) analyzed the beach erosion conditions for the shoreline along Mashes Sands (between 3A and 10A) and determined that the dominant longshore sediment transport is to the north largely induced by episodic storm conditions. The results of this study made similar conclusions. This analysis calculates a normalized sediment transport along the study area by analyzing the average tidal and wave conditions experienced along the project shoreline. The results were derived from applying two numerical models coupled together simulating wave and current interactions. The use of both M2D and WABED numerical models in the SMS 9.2 model package enabled currents and water elevation to be fed into the wave model (WABED) and wave radiation stresses generated in WABED to be fed back into the hydrodynamic model (M2D), which derived water velocities based upon measured tidal curves. This process was done iteratively over the simulated time duration. Large friction coefficients were applied in the model to represent the substantial offshore sea grass beds. M2D was also applied to calculate sediment transport utilizing the advection-diffusion equation within the model. Calibration of the hydrodynamic model was completed based upon measured tidal signatures within the study area (stations shown on Figures 2-4 and 2-5). M2D and WABED model parameters are listed below in Table 2.3.

Table 2.3. M2D and WABED model parameters

Parameter	**M2D**	**WABED**
Model Time Step (seconds)	1.0	10,800.0
Simulation Duration (hours)	120.0	120.0
Sediment Transport Rate Time Step (seconds)	30.0	N/A
Morphological Time Step (hours)	0.25	N/A
Model Ramp Duration (Days)	1.0	N/A

Average tidal and wave conditions were modeled for Mashes Sands in order to achieve an understanding of the typical daily coastal processes for average conditions. This was performed in order to establish baseline conditions for the project site. Based on previous documentation, significant shoreline and volumetric erosion are induced by periodic storm events with the magnitude of the erosion dependent upon the severity of the storm. There appears to be two dominant wave directions that could potentially influence sediment transport within the project vicinity (Figure 2-1); 1) out of the east north-east; and, 2) out of the south south-east. Based on the WABED simulations, offshore waves approaching the shoreline at these angles would induce sediment transport to the north with some sediment over-washed into the back-barrier marshes as observed after Hurricanes Ivan and Dennis.

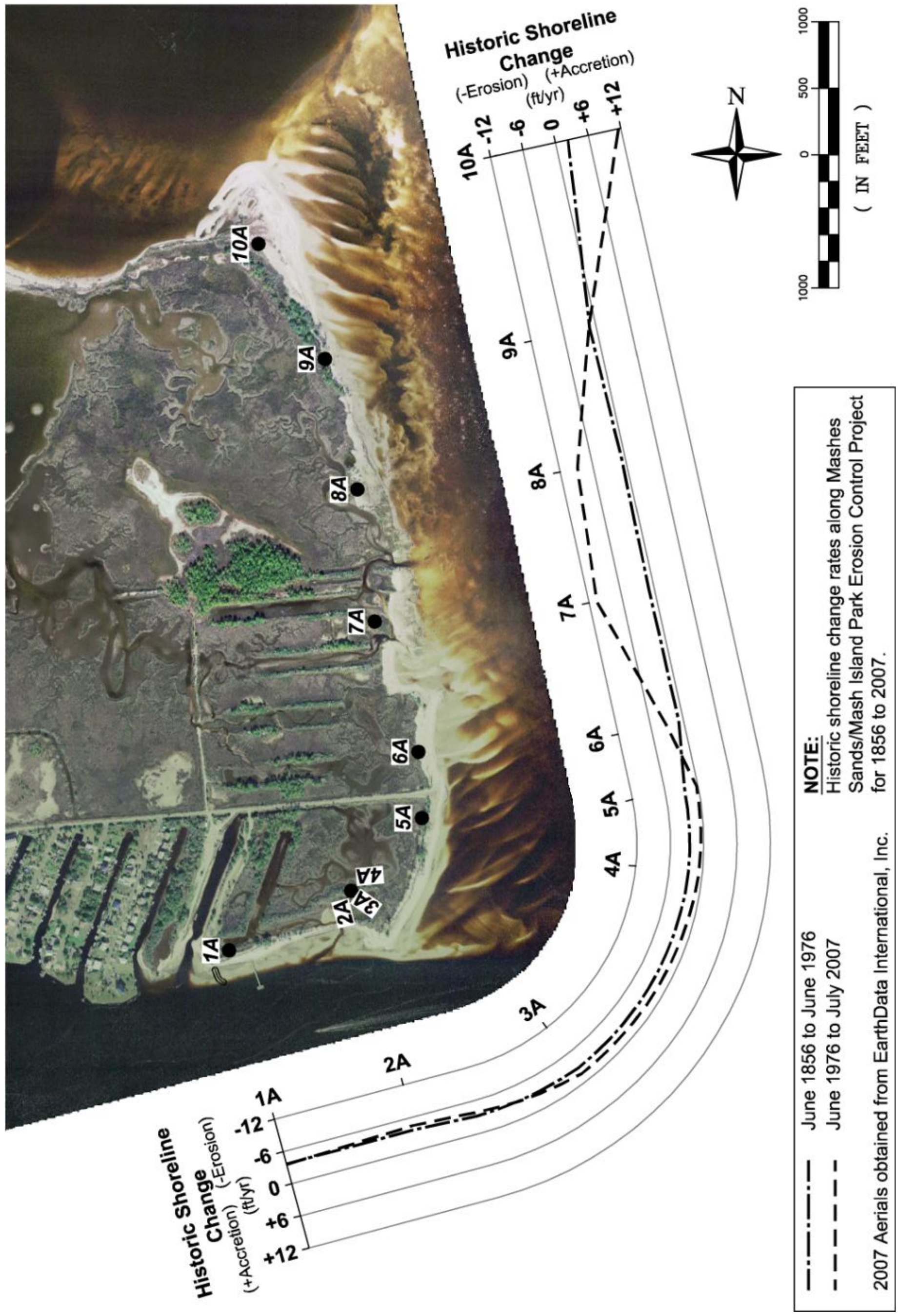


Figure 2- 3 Calculated historic shoreline change rates between 1856 and 1976, and 1976 and 2007 for Mashes Sands, Wakulla County, Florida.

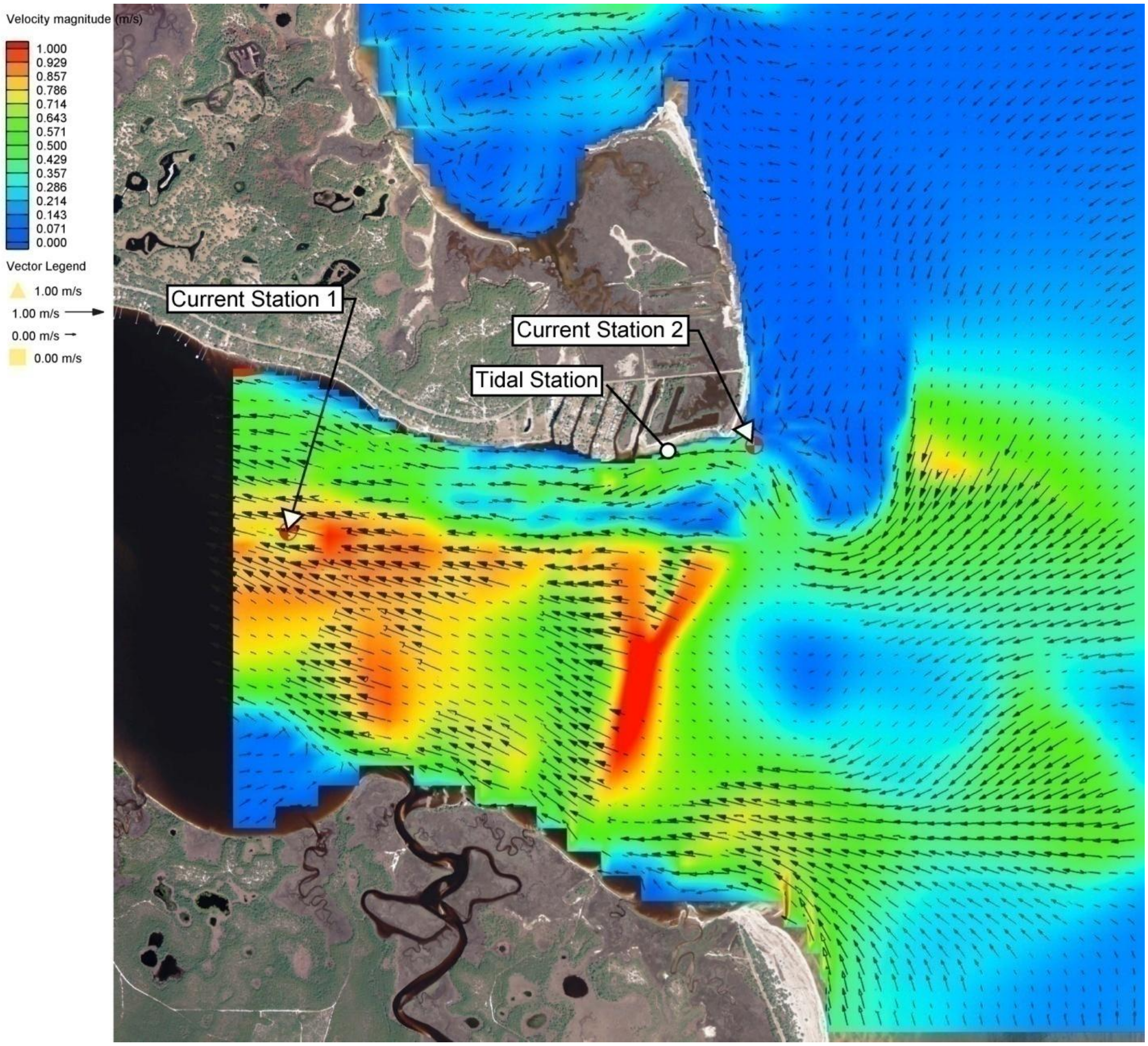


Figure 2- 4. Simulated maximum flood current vectors and ADCP current meter/tidal gage location.

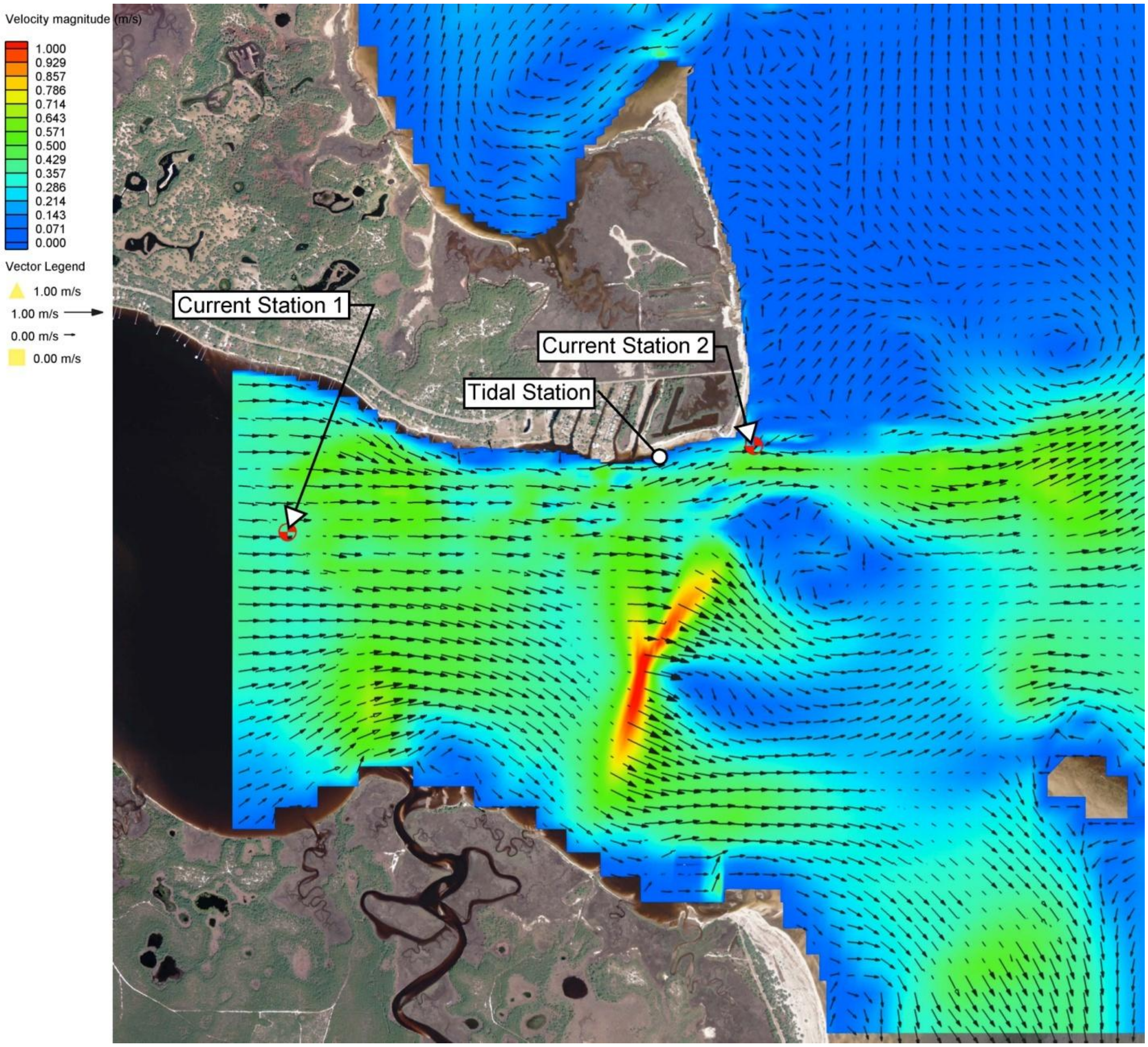


Figure 2- 5. Simulated maximum ebb current vectors and ADCP current meter/tidal gage location.

2.6.1. Potential Gross Sediment Transport

The normalized sediment transport between Monuments 1A and 3A is largely directed into the Ochlockonee Bay from the offshore shoals and traversing westward primarily on an incoming tidal cycle. Estimates of sediment transport rates and volumes were not quantified as the numerical model calibration scheme was limited due to the insufficient data and information on historic volume change rates along the project shoreline. The model results do predict sediment moving to the east with the outgoing tidal cycle. However the magnitude of the easterly transport is a small percentage compared to the incoming sediment transport.

Between Monuments 4A and 7A, gross sediment transport is primarily directed to the north with lesser gross sediment transport to the south and toward the Ochlockonee Bay. This is in agreement with observed shoreline change rates, which indicate that the spit at the northern end (near 10A) is growing toward the north. Gross sediment transport between 8A and 9A is relatively small in either direction and could be attributed to the abundance of sea grass that impinges on the shoreline in this area (Figure 2-6). Sediment transport continues to travel to the north at a reduced rate at Monument 10A indicating sediment deposition. Small amounts of sediment is shown to travel south at the northern end of the study shoreline.

2.6.2. Potential Net Longshore Sediment Transport

The overall net sediment transport is directed to the west between Monuments 1A and 3A. Figure 2-6 indicates that the peak sediment transport for the modeled conditions occurs along the southern boundary of the project shoreline near Monument 2A. The deepwater channel of the Ochlockonee Bay, the associated high current velocities (Figures 2-4 and 2-5), and the susceptibility of the shoreline to wave attack provide a means for sediment transport. In addition, Wakulla County staff have provided evidence that the spit immediately west of the study shoreline limits (and Monument 1A) has been migrating to the west and slowly shoaling in the entrance channel and canal. This further indicates sediment transport in this area is from the east to the west along the Ochlockonee Bay navigational channel.

Due to the alignment of the shoreline and its orientation with respect to the two dominant wave directions, the shoreline between Monuments 4A and 10A experiences northward migration of sediment feeding the growing spit at the north end of the study shoreline (Figures 2-3 and 2-6). This trend is also evident in aerial photography and the alignment of these visible offshore sand waves or bars. These sand features typically are aligned perpendicular to dominate wave direction which in this case appears to correspond to waves coming out of the southeast. In addition, the east-west alignment of the Ochlockonee navigational channel causes incident waves to refract around the sand shoal that extends for nearly 3,000 feet east offshore of the southeast tip of Mashes Sands (Monuments 3A to 5A). This refraction causes incoming waves to approach the shoreline at an angle inducing sediment transport to the north (Monument 4A to 10A).

2.7 SEDIMENT BUDGET

Characterizing the sediment budget in the vicinity of the study area requires knowledge of the dynamic and complex offshore and inshore shoal systems that appear to be influenced and fluctuate with the changing tide cycles. As determined by MRD (2006), sediment transport along the Bald Point shoreline of Alligator Point, Franklin County located to the south of Mashes Sands is northward into the Ochlockonee Bay entrance. The sediment is deposited along the northern tip of Bald Point and into the deep bay entrance with the remainder, yet unknown volume, being bypassed into the Mashes Sands shoals offshore of the study shoreline. The Ochlockonee Bay entrance has similarities to that of a coastal inlet, however the presence of several shoals intermixed with oyster bars makes describing sediment transport processes complex.

Numerical modeling results previously described have shown incident waves coupled with incoming (flood) tides results in a net transport of sediment along the navigational channel into the bay and canal system from the offshore shoals in an east to west direction (Monument 3A toward 1A). Aerial photography may indicate that some sediment is bypassed around the bay entrance which may supply, in part, the large shoals just offshore of the southeast tip of Mashes Sands. The sand generated from these shoals are transported toward the north spit (Monument 10A) along the south to north orientated shoreline (Monument 3A to 10A). This northerly transported sediment is then deposited into this accreting northern spit and was found to be consistent with the MHWL analysis conducted in Section 2.5.2. The majority of the sediment eroded from this spit appears to be transported further to the northern side of Mashes Sands by storm and tidal influences. It is also noted there is a sand component lost from the active coastal system from the over-washing of the low-lying beaches during storm events and into the back-barrier marsh. Normalized sediment transport magnitudes were derived from the modeling effort and are summarized in Figure 2-6. However, because there are not any historic beach and offshore profiles, or shoal surveys, a comparison of historic data to recent surveys could not be conducted to quantify volume changes and only a qualitative description could be provided.

Figure 2- 6. Normalized longshore sediment transport for the shoreline along Mashes Sands

Section II

Supplemental Information

Native Beach Sediment Sample Granularmetric Curves
Native Beach Sediment Sample Granularmetric Tables
Beach and Offshore Profiles

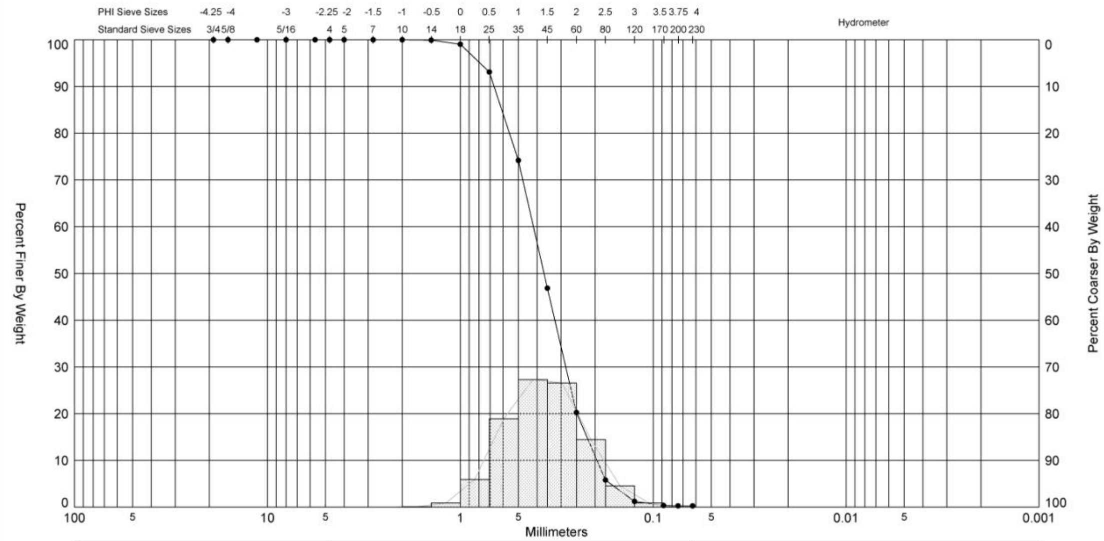
Table II. 1. Summary of sediment sample locations for Mashes Sands, Wakulla County.

Sampling Date	Sample Name	Latitude	Longitude	Notes
8/1/2007	2A Offshore	29 58.2	084 20.6	Collected offshore in about 3 feet of water
7/30/2007	2A MHW	29 58.2	084 20.6	Peat layers present at waterline
7/30/2007	2A Dune	29 58.3	084 20.6	Collected on landward side of "dune"
8/1/2007	5A Offshore	29 58.4	084 20.4	Collected in 3 feet of water
7/30/2007	5A MHW	29 58.4	084 20.4	Collected at wrack line
7/30/2007	5A Upland	29 58.4	084 20.5	Collected at crest of dune, sand may have been trucked in
7/30/2007	7A Dune	29 58.6	084 20.5	Collected at crest of dune system
7/30/2007	7A Mid-Berm	29 58.6	084 20.5	Collected along mid berm/tidal berm
8/1/2007	7A Offshore	29 58.6	084 20.5	Collected offshore in 3 feet of water
8/1/2007	9A Upland	29 59.0	084 20.6	Collected near set monument at edge of pine trees
8/1/2007	9A MHW	29 59.0	084 20.59	Collected at wrack line
8/1/2007	9A Offshore	29 59.0	084 20.58	Collected offshore in 3 feet of water
9/14/2007	Target 1	29 57.2	084 19.47	Potential offshore borrow area #1
9/14/2007	Target 2	29 57.1	084 19.20	Potential offshore borrow area #2
9/14/2007	Target 3	29 57.0	084 18.93	Potential offshore borrow area #3

Table II.2. Sedimentological summary for sediment samples collected at Mashes Sands

Sample	gINt Granularmerics							USC	Composition (wt%)			Munsell Color	
	Size Class (wt%)				Descriptive Statistics								
	Gravel	*Sand*	*<#200*	*<#230*	*Mean (mm)*	*Verbal*	*Std. DEv. (phi)*		*Organic*	*Carbonate*	*Siliciclastic*	*Verbal*	*Value*
Mashes Sands SAMPLES													
2A Back Dune	0.00	99.72	0.28	0.27	0.37	F	0.67	SP	0.1	0.0	99.92	White	10YR 8/1
2A MHW	0.00	99.62	3.38	3.13	0.20	F	0.56	SP	0.4	0.5	99.12	Lt. gray	10YR 7/2
2A Offshore	0.00	99.41	0.59	0.34	0.23	F	0.78	SP	0.4	0.9	98.68	Pale Brn	10YR 6/3
5A MHW	0.00	99.76	0.24	0.20	0.23	F	0.54	SP	0.1	0.1	99.80	White	10YR 8/1
5A Offshore	0.00	99.45	0.55	0.39	0.31	F	0.98	SW	0.4	0.9	98.75	V. Pale Brn	10YR 7/3
5A Upland	0.18	99.32	0.50	0.35	0.29	F	0.73	SP	0.6	0.7	98.76	Lt. Gray	10YR 7/2
7A Dune	0.00	99.53	0.47	0.45	0.42	F	0.71	SP	0.0	0.0	99.96	White	10YR 8/1
7A Mid-Dune	0.00	99.50	0.50	0.43	0.48	M	0.68	SP	0.2	0.2	99.52	V. Pale Brn	10YR 8/2
7A Offshore	0.00	88.48	11.52	10.12	0.18	F	0.89	SW-SM	4.5	3.5	92.00	Dark Gray	10YR 4/1
9A MHW	0.00	99.80	0.20	0.18	0.29	F	0.56	SP	0.1	0.3	99.62	White	10YR 8/1
9A Offshore	0.00	86.11	13.89	10.15	0.25	F	1.24	SM	4.5	3.0	92.44	Dark Gray	10Yr 4/1
9A Upland	0.00	99.75	0.25	0.23	0.53	M	0.55	SP	0.1	0.0	99.92	White	10YR 8/1
Borrow Target 1	0.00	99.50	0.50	0.47	0.47	M	0.79	SP	0.4	1.3	98.36	V. Pale Brn	10YR 7/3
Borrow Target 2	0.00	99.49	0.51	0.44	0.46	M	0.75	SP	0.3	0.6	99.09	Lt. Gray	10YR 7/2
Borrow Target 3	0.00	99.74	0.26	0.25	0.36	F	0.52	SP	0.5	1.6	97.94	Lt. Gray	10YR 7/2

SIEVE ANALYSIS WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Mashes 2A Back Dune	—•—		SP	#200 - 0.28 #230 - 0.27	0.10	0.00	1.44	1.45	0.08	2.88	0.67

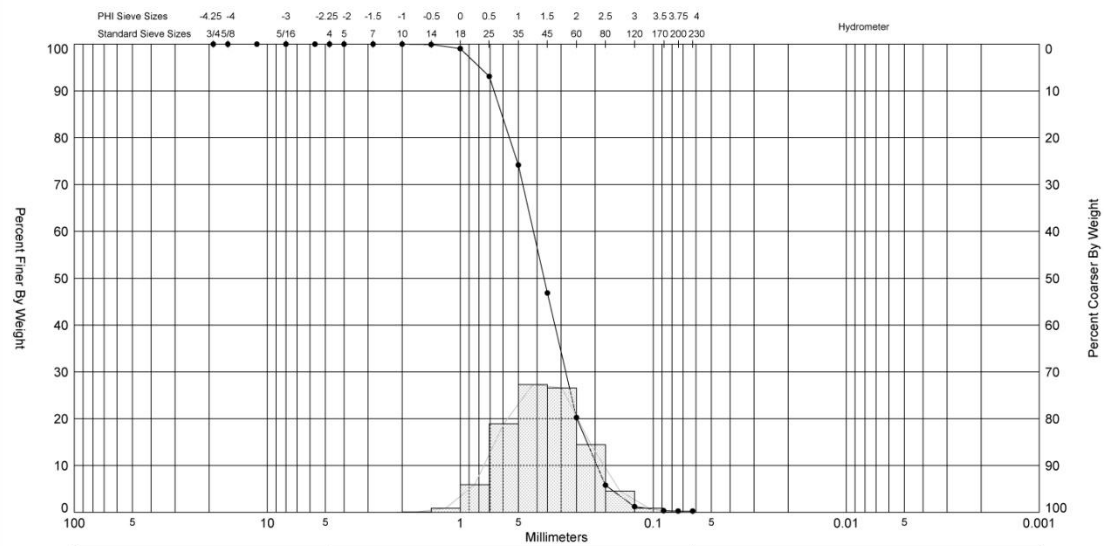
Comments:

Depths and elevations based on measured values

Sample Information	
Project Name:	Wakulla Sediment Analysis
Analysis Date:	01-02-08
Analyzed By:	LA
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

COASTAL TECH
Coastal Geology & Sediments Laboratory

715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343



SIEVE ANALYSIS WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08

Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Mashes 2A Back Dune	—•—		SP	#200 - 0.28 #230 - 0.27	0.10	0.00	1.44	1.45	0.08	2.88	0.67

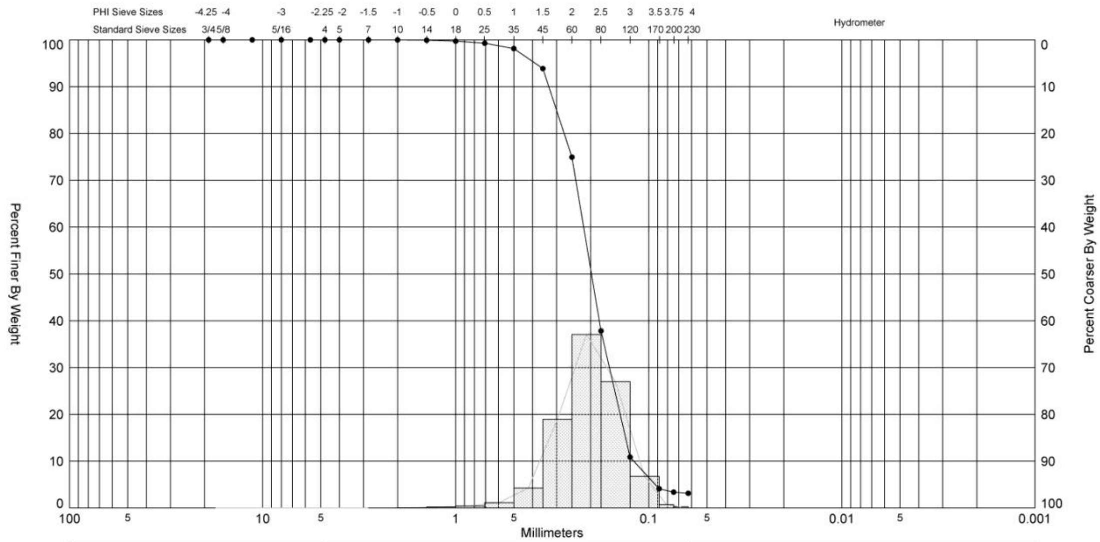
Comments:

Depths and elevations based on measured values

Sample Information	
Project Name:	Wakulla Sediment Analysis
Analysis Date:	01-02-08
Analyzed By:	LA
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

COASTAL TECH
Coastal Geology & Sediments Laboratory

715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Mashes 2A MHW	—•—		SP	#200 - 3.38 #230 - 3.13	0.40	0.50	2.34	2.3	-0.6	4.82	0.56

Comments:

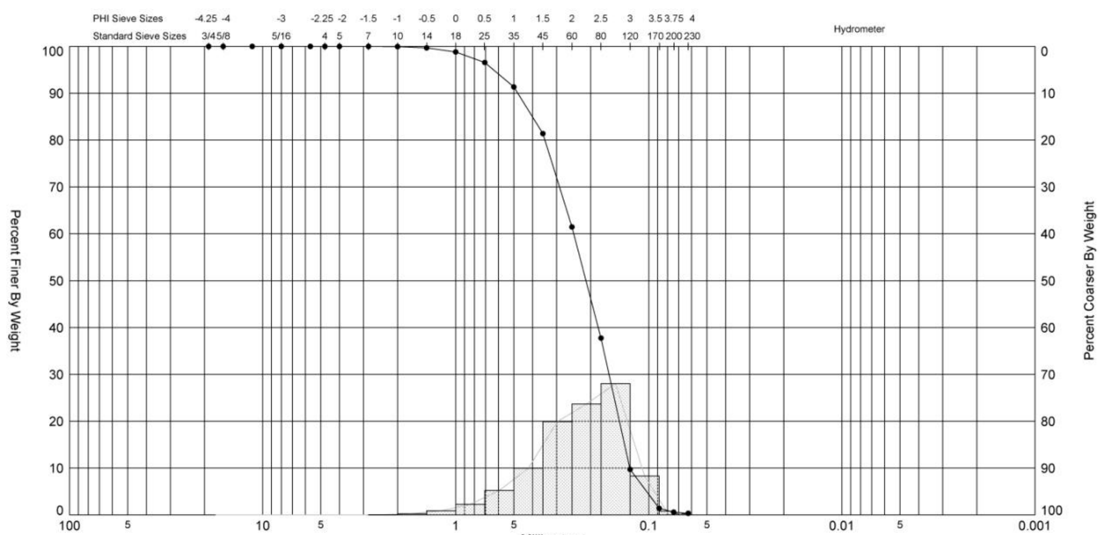
Depths and elevations based on measured values

Sample Information	
Project Name:	Wakulla Sediment Analysis
Analysis Date:	01-02-08
Analyzed By:	LA
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

COASTAL TECH
Coastal Geology & Sediments Laboratory

715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343

SIEVE ANALYSIS WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Mashes 2A Offshore	—•—		SP	#200 - 0.59 #230 - 0.34	0.40	0.90	2.24	2.13	-0.74	3.54	0.78

Comments:

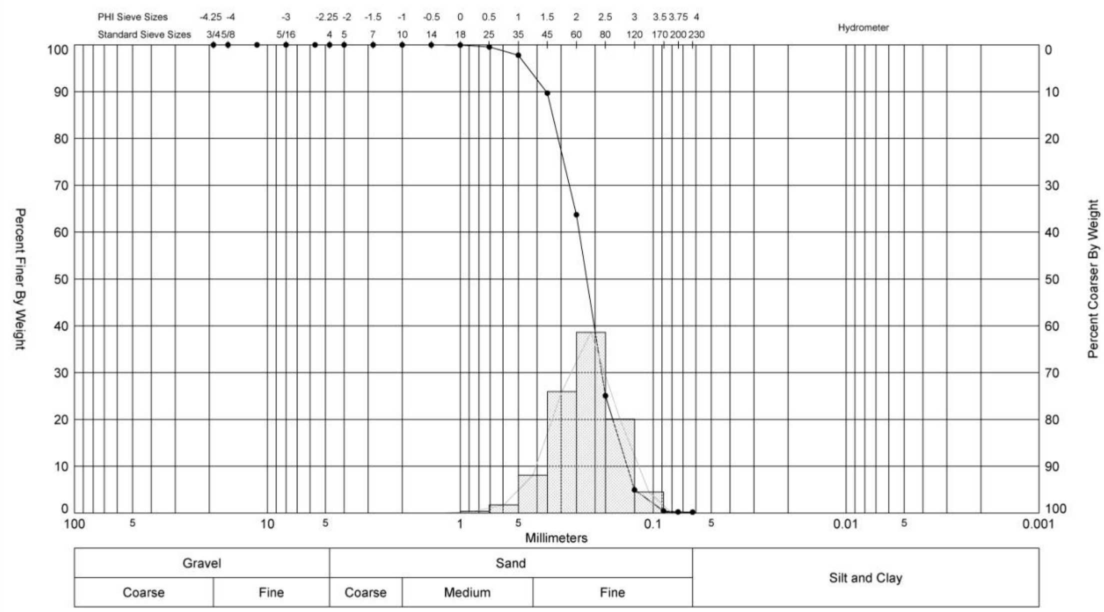
Depths and elevations based on measured values

Sample Information	
Project Name:	Wakulla Sediment Analysis
Analysis Date:	01-02-08
Analyzed By:	LA
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

COASTAL TECH
Coastal Geology & Sediments Laboratory

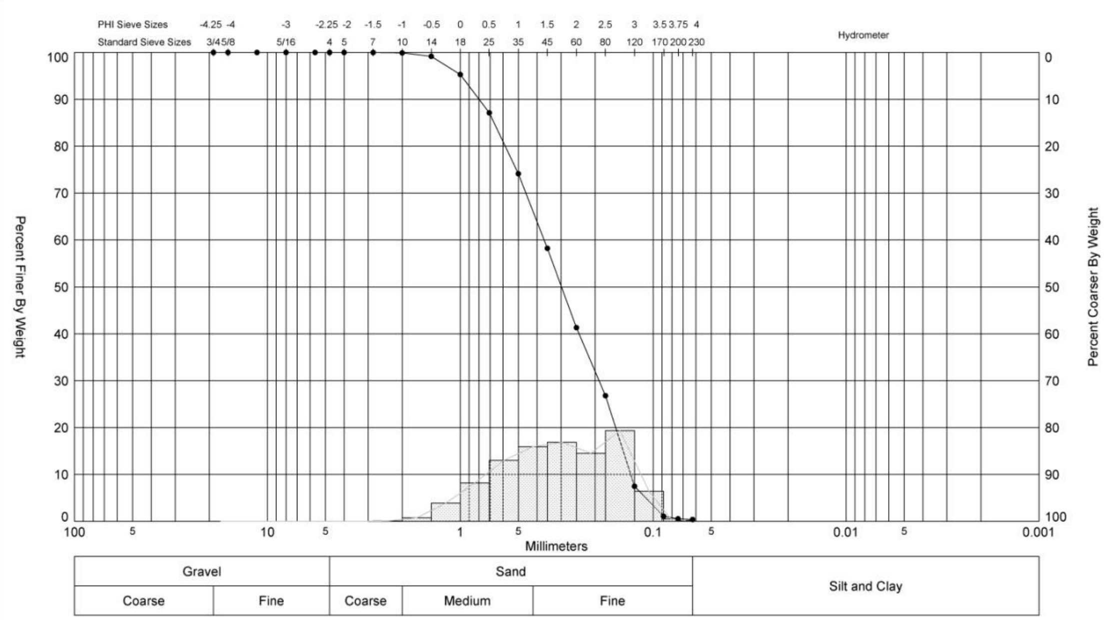
715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343

SIEVE ANALYSIS WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
Mashes 5A MHW	—•—		SP	#200 - 0.24 #230 - 0.20	0.10	0.10	2.18	2.15	-0.3	3.49	0.54	Project Name:	Wakulla Sediment Analysis
Comments:												Analysis Date:	01-02-08
Depths and elevations based on measured values												Analyzed By:	LA
												Easting (X, ft):	
COASTAL TECH Coastal Geology & Sediments Laboratory					715-E North Dr. Melbourne, Fl. 32934 Phone (321) 751-1135 Fax (321) 751-2343							Northing (Y, ft):	
												Horizontal System:	
												Vertical System:	

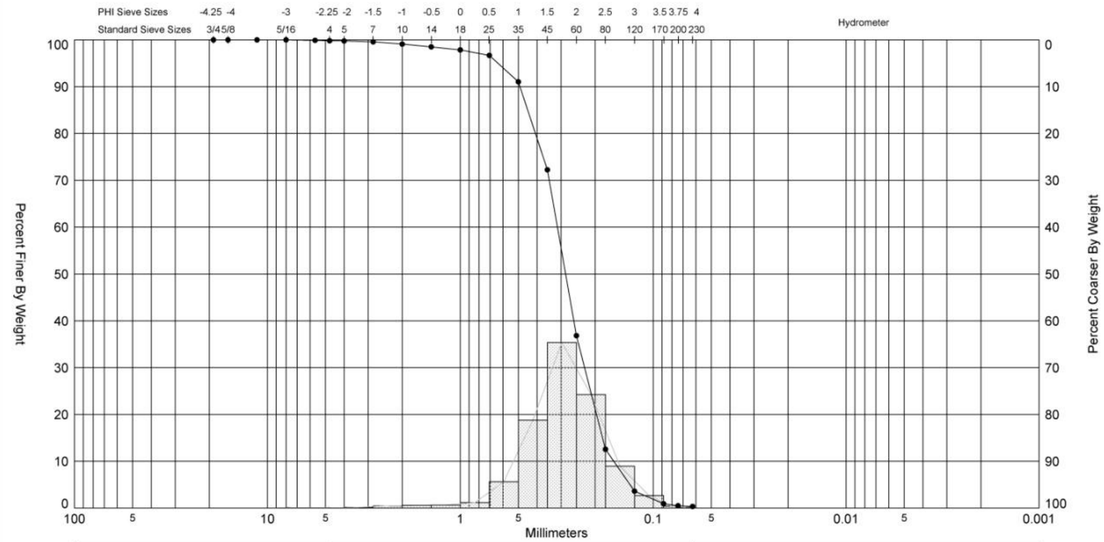
SIEVE ANALYSIS WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
Mashes 5A Offshore	—•—		SW	#200 - 0.55 #230 - 0.39	0.40	0.90	1.74	1.69	-0.25	2.27	0.98	Project Name:	Wakulla Sediment Analysis
Comments:												Analysis Date:	01-02-08
Depths and elevations based on measured values												Analyzed By:	LA
												Easting (X, ft):	
COASTAL TECH Coastal Geology & Sediments Laboratory					715-E North Dr. Melbourne, Fl. 32934 Phone (321) 751-1135 Fax (321) 751-2343							Northing (Y, ft):	
												Horizontal System:	
												Vertical System:	

SIEVE ANALYSIS WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08

SIEVE ANALYSIS WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Mashes 5A Upland	—•—		SP	#200 - 0.50 #230 - 0.35	0.60	0.70	1.81	1.79	-1.18	8.06	0.73

Sample Information	
Project Name:	Wakulla Sediment Analysis
Analysis Date:	01-02-08
Analyzed By:	LA
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

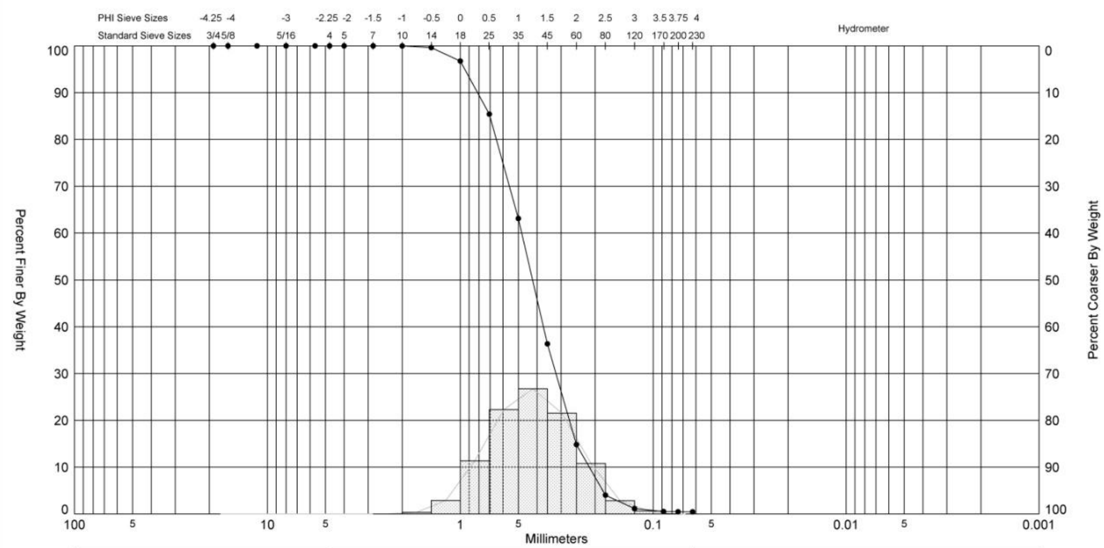
Comments:

Depths and elevations based on measured values

COASTAL TECH
Coastal Geology & Sediments Laboratory

715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343

SIEVE ANALYSIS WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Mashes 7A Dune	—•—		SP	#200 - 0.47 #230 - 0.45	0.00	0.00	1.25	1.25	0.08	2.84	0.71

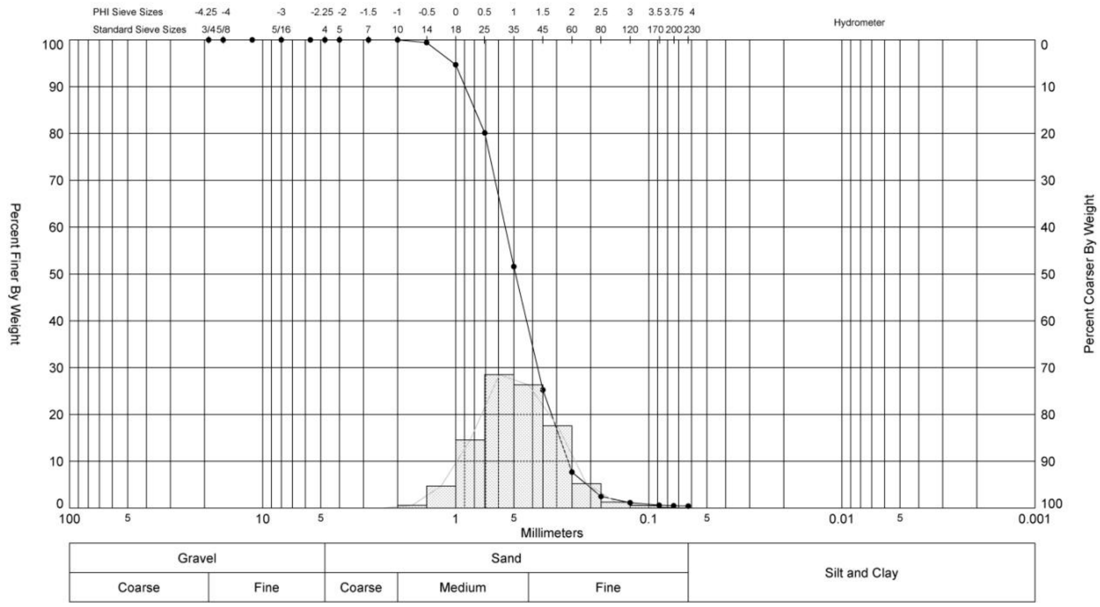
Sample Information	
Project Name:	Wakulla Sediment Analysis
Analysis Date:	01-02-08
Analyzed By:	LA
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

Comments:

Depths and elevations based on measured values

COASTAL TECH
Coastal Geology & Sediments Laboratory

715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Mashes 7A Mid-Dune	—•—		SP	#200 - 0.50 #230 - 0.43	0.20	0.20	1.03	1.05	0.27	3.39	0.68

Comments:

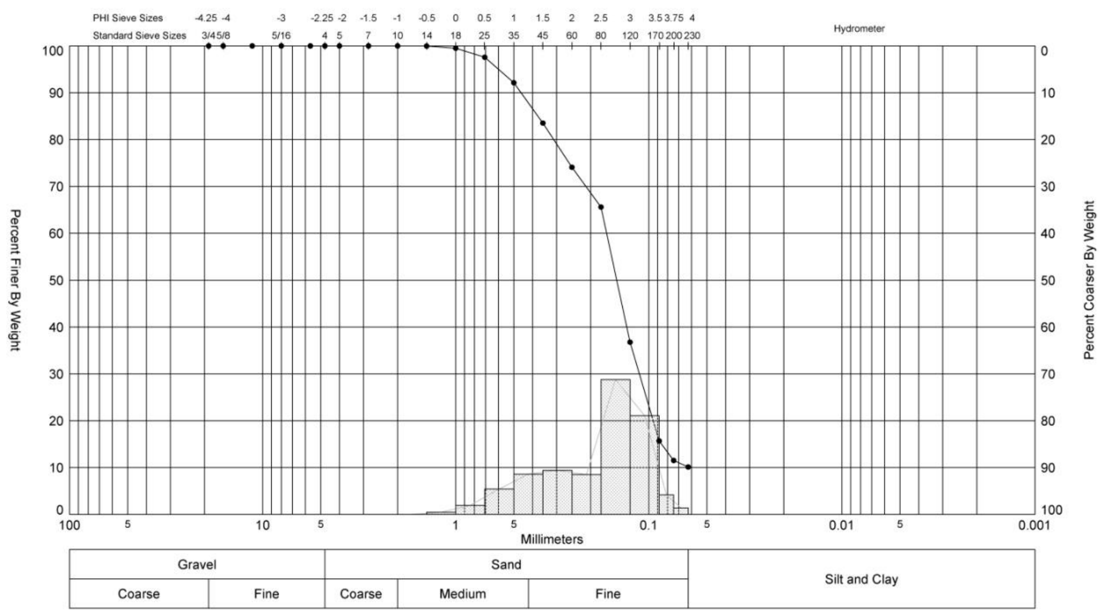
Depths and elevations based on measured values

Sample Information	
Project Name:	Wakulla Sediment Analysis
Analysis Date:	01-02-08
Analyzed By:	LA
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

COASTAL TECH
Coastal Geology & Sediments Laboratory

715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343

SIEVE ANALYSIS WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Mashes 7A Offshore	—•—		SW-SM	#200 - 11.52 #230 - 10.12	4.50	3.50	2.77	2.44	-0.8	2.84	0.89

Comments:

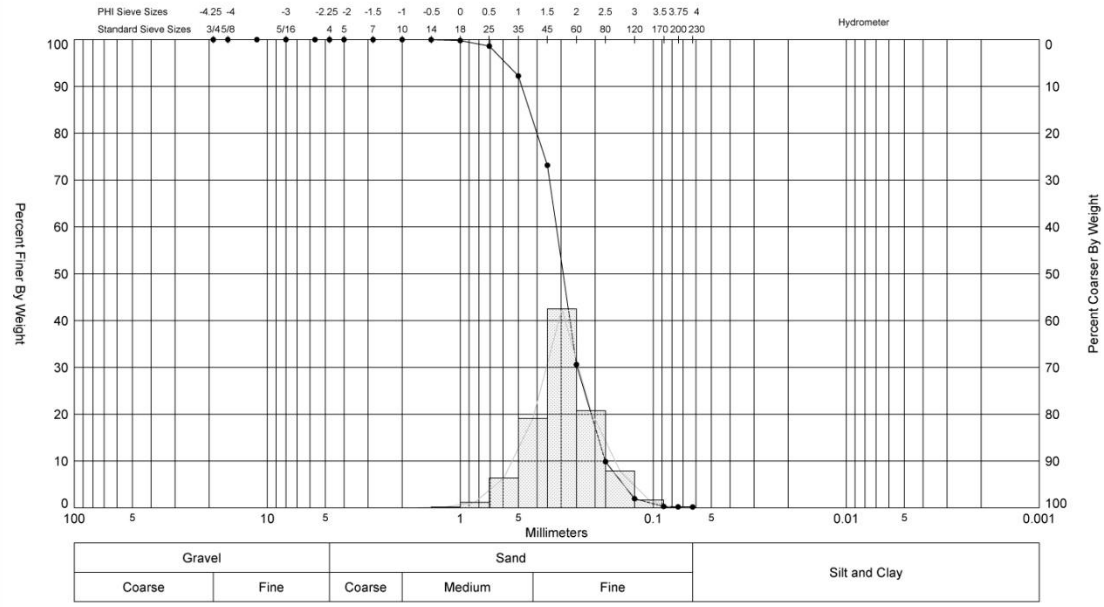
Depths and elevations based on measured values

Sample Information	
Project Name:	Wakulla Sediment Analysis
Analysis Date:	01-02-08
Analyzed By:	LA
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

COASTAL TECH
Coastal Geology & Sediments Laboratory

715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343

SIEVE ANALYSIS WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Mashes 9A MHW	—•—		SP	#200 - 0.20 #230 - 0.18	0.10	0.30	1.77	1.78	-0.02	3.58	0.56

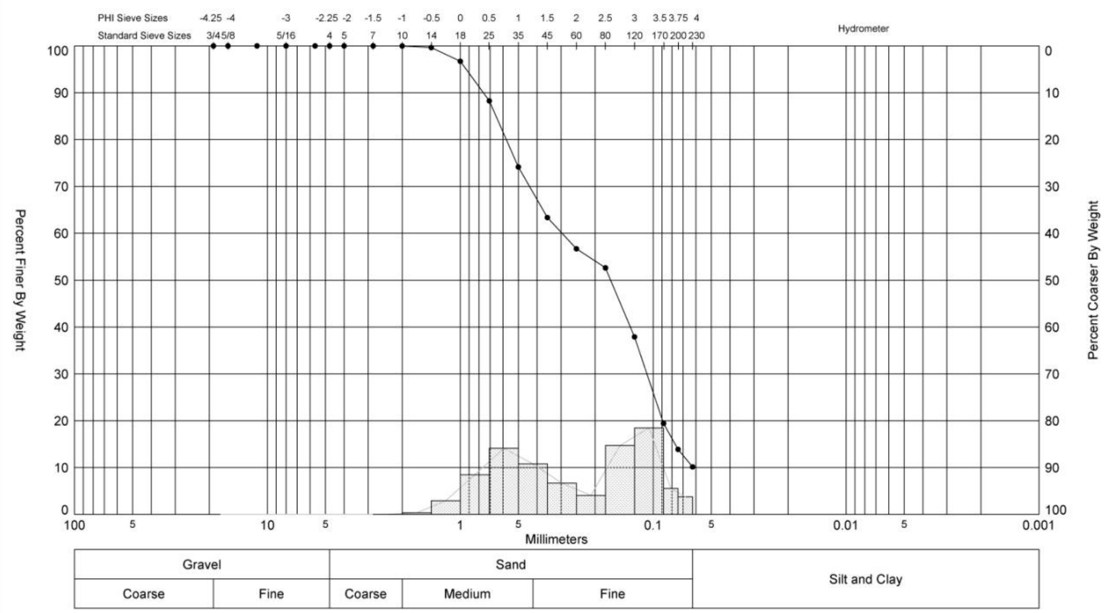
Sample Information	
Project Name:	Wakulla Sediment Analysis
Analysis Date:	01-02-08
Analyzed By:	LA
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

Comments:

Depths and elevations based on measured values

COASTAL TECH
Coastal Geology & Sediments Laboratory

715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Mashes 9A Offshore	—•—		SM	#200 - 13.89 #230 - 10.15	4.50	3.00	2.59	2.02	-0.2	1.67	1.24

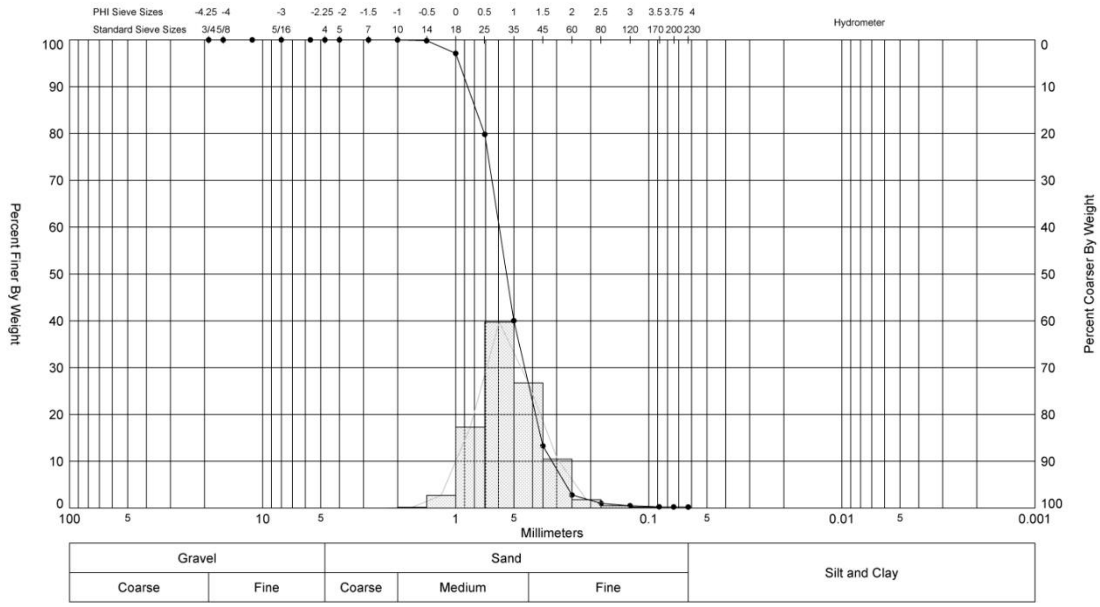
Sample Information	
Project Name:	Wakulla Sediment Analysis
Analysis Date:	01-02-08
Analyzed By:	LA
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

Comments:

Depths and elevations based on measured values

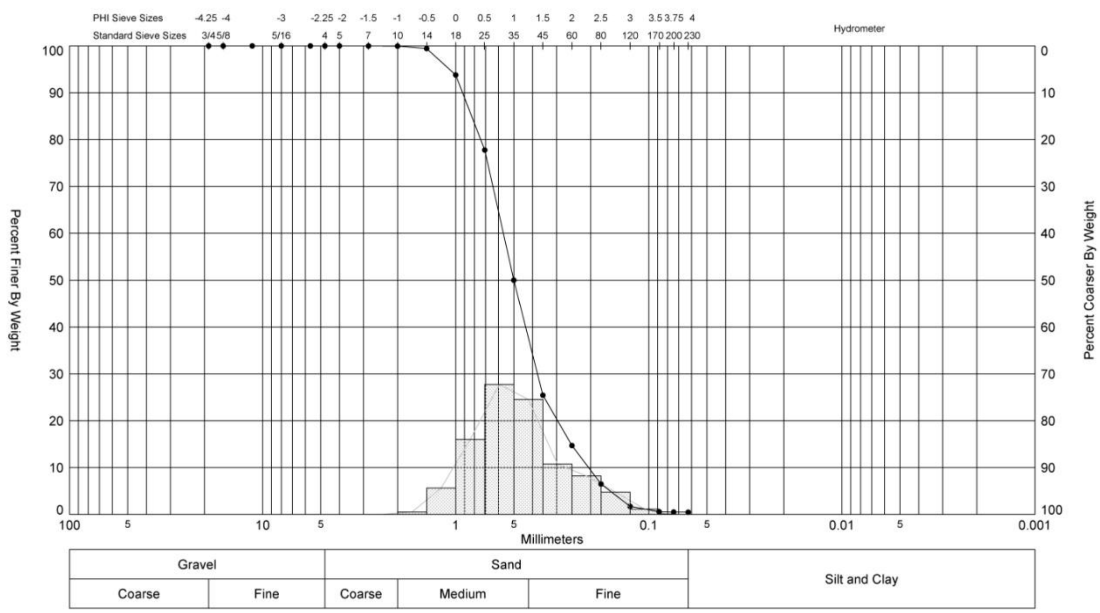
COASTAL TECH
Coastal Geology & Sediments Laboratory

715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343



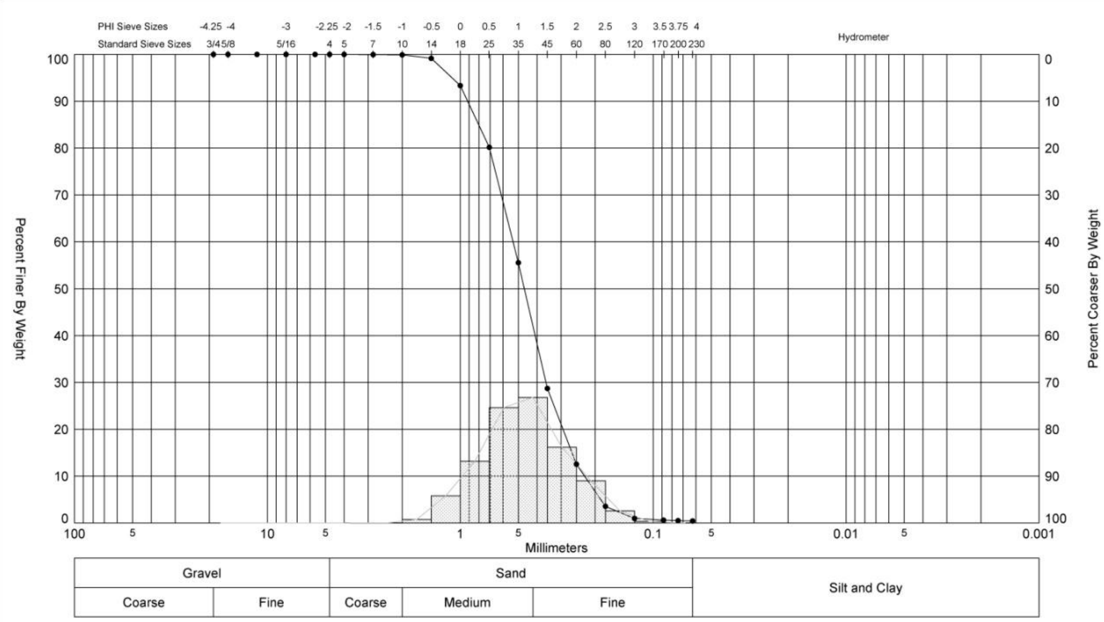
Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
Mashes 9A Upland	—•—		SP	#200 - 0.25 #230 - 0.23	0.10	0.00	0.87	0.92	0.49	4.09	0.55	Project Name:	Wakulla Sediment Analysis
Comments:												Analysis Date:	01-02-08
Depths and elevations based on measured values												Analyzed By:	LA
COASTAL TECH Coastal Geology & Sediments Laboratory					715-E North Dr. Melbourne, Fl. 32934 Phone (321) 751-1135 Fax (321) 751-2343							Easting (X, ft):	
												Northing (Y, ft):	
												Horizontal System:	
												Vertical System:	

SIEVE ANALYSIS WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08



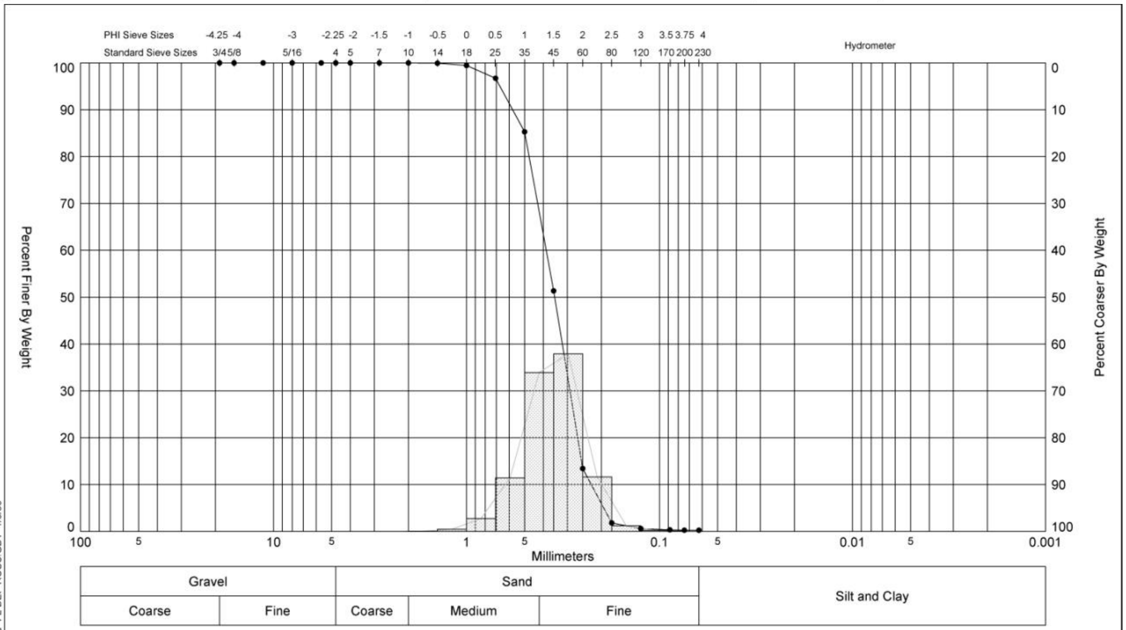
Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
Mashes Target 1	—•—		SP	#200 - 0.50 #230 - 0.47	0.40	1.30	1	1.09	0.48	3.02	0.79	Project Name:	Wakulla Sediment Analysis
Comments:												Analysis Date:	01-02-08
Depths and elevations based on measured values												Analyzed By:	LA
COASTAL TECH Coastal Geology & Sediments Laboratory					715-E North Dr. Melbourne, Fl. 32934 Phone (321) 751-1135 Fax (321) 751-2343							Easting (X, ft):	
												Northing (Y, ft):	
												Horizontal System:	
												Vertical System:	

SIEVE ANALYSIS WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
Mashes T2			SP	#200 - 0.51 #230 - 0.44	0.30	0.60	1.1	1.11	0.12	3	0.75	Project Name:	Wakulla Sediment Analysis
Comments:												Analysis Date:	01-02-08
Depths and elevations based on measured values												Analyzed By:	LA
COASTAL TECH Coastal Geology & Sediments Laboratory						715-E North Dr. Melbourne, Fl. 32934 Phone (321) 751-1135 Fax (321) 751-2343						Easting (X, ft):	
												Northing (Y, ft):	
												Horizontal System:	
												Vertical System:	

SIEVE ANALYSIS WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
Mashes T3			SP	#200 - 0.26 #230 - 0.25	0.50	1.60	1.52	1.49	-0.21	3.88	0.52	Project Name:	Wakulla Sediment Analysis
Comments:												Analysis Date:	01-02-08
Depths and elevations based on measured values												Analyzed By:	LA
COASTAL TECH Coastal Geology & Sediments Laboratory						715-E North Dr. Melbourne, Fl. 32934 Phone (321) 751-1135 Fax (321) 751-2343						Easting (X, ft):	
												Northing (Y, ft):	
												Horizontal System:	
												Vertical System:	

SIEVE ANALYSIS WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08

Granularmetric Report
Depths and elevations based on measured values

COASTAL TECH
Coastal Geology & Sediments Laboratory
715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343

Project Name: Wakulla Sediment Analysis
Sample Name: Mashes 2A Back Dune
Analysis Date: 01-02-08
Analyzed By: LA

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):

USCS:	Munsell:	Comments:
SP	Wet - 10YR-8/1	

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
227.62	227.62	0.02	0.26	#200 - 0.28 #230 - 0.27	0.10	0.00	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
11/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.01	0.00	0.01	0.00
7	-1.50	2.83	0.00	0.00	0.01	0.00
10	-1.00	2.00	0.00	0.00	0.01	0.00
14	-0.50	1.41	0.18	0.08	0.19	0.08
18	0.00	1.00	1.97	0.87	2.16	0.95
25	0.50	0.71	13.51	5.94	15.67	6.89
35	1.00	0.50	43.08	18.93	58.75	25.82
45	1.50	0.35	62.17	27.31	120.92	53.13
60	2.00	0.25	60.56	26.61	181.48	79.74
80	2.50	0.18	32.92	14.46	214.40	94.20
120	3.00	0.13	10.41	4.57	224.81	98.77
170	3.50	0.09	2.00	0.88	226.81	99.65
200	3.75	0.07	0.16	0.07	226.97	99.72
230	4.00	0.06	0.03	0.01	227.00	99.73

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.59	2.15	1.91	1.44	0.98	0.74	0.34

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	1.45	0.37	0.67	0.08	2.88

GRANULARMETRIC REPORT WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08

Granularmetric Report
Depths and elevations based on measured values

COASTAL TECH
Coastal Geology & Sediments Laboratory
715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343

Project Name: Wakulla Sediment Analysis
Sample Name: Mashes 2A MHW
Analysis Date: 01-02-08
Analyzed By: LA

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):

USCS:	Munsell:	Comments:
SP	Wet - 10YR-7/2	

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
146.01	142.08	0.27	0.25	#200 - 3.38 #230 - 3.13	0.40	0.50	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
11/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.01	0.01	0.01	0.01
14	-0.50	1.41	0.09	0.06	0.10	0.07
18	0.00	1.00	0.29	0.20	0.39	0.27
25	0.50	0.71	0.64	0.44	1.03	0.71
35	1.00	0.50	1.67	1.14	2.70	1.85
45	1.50	0.35	6.25	4.28	8.95	6.13
60	2.00	0.25	27.64	18.93	36.59	25.06
80	2.50	0.18	54.16	37.09	90.75	62.15
120	3.00	0.13	39.41	26.99	130.16	89.14
170	3.50	0.09	9.85	6.75	140.01	95.89
200	3.75	0.07	1.07	0.73	141.08	96.62
230	4.00	0.06	0.36	0.25	141.44	96.87

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.43	2.90	2.74	2.34	2.00	1.76	1.37

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	2.3	0.20	0.56	-0.6	4.82

GRANULARMETRIC REPORT WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08

Granularmetric Report
Depths and elevations based on measured values

COASTAL TECH
Coastal Geology & Sediments Laboratory
715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343

Project Name: Wakulla Sediment Analysis
Sample Name: Mashes 2A Offshore
Analysis Date: 01-02-08
Analyzed By: LA

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):

USCS:	Munsell:	Comments:
SP	Wet - 10YR-6/3	

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
240.96	240.96	0.34	0.20	#200 - 0.59 #230 - 0.34	0.40	0.90	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
11/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.09	0.04	0.09	0.04
14	-0.50	1.41	0.64	0.27	0.73	0.31
18	0.00	1.00	2.10	0.87	2.83	1.18
25	0.50	0.71	5.42	2.25	8.25	3.43
35	1.00	0.50	12.58	5.22	20.83	8.65
45	1.50	0.35	24.01	9.96	44.84	18.61
60	2.00	0.25	48.04	19.94	92.88	38.55
80	2.50	0.18	57.09	23.69	149.97	62.24
120	3.00	0.13	67.57	28.04	217.54	90.28
170	3.50	0.09	20.02	8.31	237.56	98.59
200	3.75	0.07	1.97	0.82	239.53	99.41
230	4.00	0.06	0.61	0.25	240.14	99.66

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.28	2.89	2.73	2.24	1.66	1.37	0.65

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	2.13	0.23	0.78	-0.74	3.54

GRANULARMETRIC REPORT WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08

Granularmetric Report
Depths and elevations based on measured values

COASTAL TECH
Coastal Geology & Sediments Laboratory
715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343

Project Name: Wakulla Sediment Analysis
Sample Name: Mashes 5A MHW
Analysis Date: 01-02-08
Analyzed By: LA

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):

USCS:	Munsell:	Comments:
SP	Wet - 10YR-8/1	

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
159.26	159.26	0.07	0.14	#200 - 0.24 #230 - 0.20	0.10	0.10	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
11/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.00	0.00	0.00	0.00
14	-0.50	1.41	0.02	0.01	0.02	0.01
18	0.00	1.00	0.05	0.03	0.07	0.04
25	0.50	0.71	0.64	0.40	0.71	0.44
35	1.00	0.50	2.81	1.76	3.52	2.20
45	1.50	0.35	12.92	8.11	16.44	10.31
60	2.00	0.25	41.37	25.98	57.81	36.29
80	2.50	0.18	61.54	38.64	119.35	74.93
120	3.00	0.13	32.03	20.11	151.38	95.04
170	3.50	0.09	7.16	4.50	158.54	99.54
200	3.75	0.07	0.35	0.22	158.89	99.76
230	4.00	0.06	0.07	0.04	158.96	99.80

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.00	2.73	2.50	2.18	1.78	1.61	1.17

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	2.15	0.23	0.54	-0.3	3.49

GRANULARMETRIC REPORT WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08

Granularmetric Report
Depths and elevations based on measured values

COASTAL TECH
Coastal Geology & Sediments Laboratory

715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343

Project Name: Wakulla Sediment Analysis
Sample Name: Mashes 5A Offshore
Analysis Date: 01-02-08
Analyzed By: LA

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):

USCS:	Munsell:	Comments:
SW	Wet - 10YR-7/3	

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
217.70	217.70	0.33	0.23	#200 - 0.55 #230 - 0.39	0.40	0.90	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
11/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.03	0.01	0.03	0.01
10	-1.00	2.00	0.17	0.08	0.20	0.09
14	-0.50	1.41	1.61	0.74	1.81	0.83
18	0.00	1.00	8.42	3.87	10.23	4.70
25	0.50	0.71	17.81	8.18	28.04	12.88
35	1.00	0.50	28.28	12.99	56.32	25.87
45	1.50	0.35	34.66	15.92	90.98	41.79
60	2.00	0.25	36.75	16.88	127.73	58.67
80	2.50	0.18	31.61	14.52	159.34	73.19
120	3.00	0.13	42.09	19.33	201.43	92.52
170	3.50	0.09	13.96	6.41	215.39	98.93
200	3.75	0.07	1.14	0.52	216.53	99.45
230	4.00	0.06	0.35	0.16	216.88	99.61

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.19	2.78	2.55	1.74	0.97	0.62	0.02

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	1.69	0.31	0.98	-0.25	2.27

GRANULARMETRIC REPORT WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08

Granularmetric Report
Depths and elevations based on measured values

COASTAL TECH
Coastal Geology & Sediments Laboratory

715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343

Project Name: Wakulla Sediment Analysis
Sample Name: Mashes 5A Upland
Analysis Date: 01-02-08
Analyzed By: LA

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):

USCS:	Munsell:	Comments:
SP	Wet - 10YR-7/2	

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
196.05	196.05	0.56	0.06	#200 - 0.50 #230 - 0.35	0.60	0.70	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
11/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.20	0.10	0.20	0.10
4	-2.25	4.76	0.16	0.08	0.36	0.18
5	-2.00	4.00	0.10	0.05	0.46	0.23
7	-1.50	2.83	0.38	0.19	0.84	0.42
10	-1.00	2.00	0.94	0.48	1.78	0.90
14	-0.50	1.41	1.15	0.59	2.93	1.49
18	0.00	1.00	1.27	0.65	4.20	2.14
25	0.50	0.71	2.29	1.17	6.49	3.31
35	1.00	0.50	11.06	5.64	17.55	8.95
45	1.50	0.35	36.88	18.81	54.43	27.76
60	2.00	0.25	69.39	35.39	123.82	63.15
80	2.50	0.18	47.61	24.28	171.43	87.43
120	3.00	0.13	17.54	8.95	188.97	96.38
170	3.50	0.09	5.27	2.69	194.24	99.07
200	3.75	0.07	0.84	0.43	195.08	99.50
230	4.00	0.06	0.30	0.15	195.38	99.65

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.92	2.43	2.24	1.81	1.43	1.19	0.65

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	1.79	0.29	0.73	-1.18	8.06

GRANULARMETRIC REPORT WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08

Granularmetric Report
Depths and elevations based on measured values

COASTAL TECH
Coastal Geology & Sediments Laboratory

715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343

Project Name: Wakulla Sediment Analysis
Sample Name: Mashes 7A Dune
Analysis Date: 01-02-08
Analyzed By: LA

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):

USCS:	Munsell:	Comments:
SP	Wet - 10YR-8/1	

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
223.35	223.35	0.06	0.43	#200 - 0.47 #230 - 0.45	0.00	0.00	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
11/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.02	0.01	0.02	0.01
14	-0.50	1.41	0.81	0.36	0.83	0.37
18	0.00	1.00	6.40	2.87	7.23	3.24
25	0.50	0.71	25.34	11.35	32.57	14.59
35	1.00	0.50	49.81	22.30	82.38	36.89
45	1.50	0.35	59.75	26.75	142.13	63.64
60	2.00	0.25	48.12	21.54	190.25	85.18
80	2.50	0.18	24.15	10.81	214.40	95.99
120	3.00	0.13	6.38	2.86	220.78	98.85
170	3.50	0.09	1.41	0.63	222.19	99.48
200	3.75	0.07	0.11	0.05	222.30	99.53
230	4.00	0.06	0.04	0.02	222.34	99.55

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.45	1.97	1.76	1.25	0.73	0.53	0.08

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	1.25	0.42	0.71	0.08	2.84

GRANULARMETRIC REPORT WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08

Granularmetric Report
Depths and elevations based on measured values

COASTAL TECH
Coastal Geology & Sediments Laboratory

715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343

Project Name: Wakulla Sediment Analysis
Sample Name: Mashes 7A Mid-Dune
Analysis Date: 01-02-08
Analyzed By: LA

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):

USCS:	Munsell:	Comments:
SP	Wet - 10YR-8/2	

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
178.58	178.58	0.14	0.35	#200 - 0.50 #230 - 0.43	0.20	0.20	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
11/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.00	0.00	0.00	0.00
14	-0.50	1.41	1.03	0.58	1.03	0.58
18	0.00	1.00	8.44	4.73	9.47	5.31
25	0.50	0.71	26.01	14.56	35.48	19.87
35	1.00	0.50	50.93	28.52	86.41	48.39
45	1.50	0.35	47.03	26.34	133.44	74.73
60	2.00	0.25	31.40	17.58	164.84	92.31
80	2.50	0.18	9.32	5.22	174.16	97.53
120	3.00	0.13	2.34	1.31	176.50	98.84
170	3.50	0.09	0.96	0.54	177.46	99.38
200	3.75	0.07	0.22	0.12	177.68	99.50
230	4.00	0.06	0.13	0.07	177.81	99.57

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.26	1.76	1.51	1.03	0.59	0.37	-0.03

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	1.05	0.48	0.68	0.27	3.39

GRANULARMETRIC REPORT WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08

Granularmetric Report
Depths and elevations based on measured values

COASTAL TECH Coastal Geology & Sediments Laboratory

715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343

Project Name: Wakulla Sediment Analysis
Sample Name: Mashes 7A Offshore
Analysis Date: 01-02-08
Analyzed By: LA

Easting (ft): | Northing (ft): | Coordinate System: | Elevation (ft):

USCS: SW-SM | Munsell: Wet - 10YR-4/1 | Comments:

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
111.98	101.60	0.97	0.00	#200 - 11.52 #230 - 10.12	4.50	3.50	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
11/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.00	0.00	0.00	0.00
14	-0.50	1.41	0.03	0.03	0.03	0.03
18	0.00	1.00	0.51	0.46	0.54	0.49
25	0.50	0.71	2.16	1.93	2.70	2.42
35	1.00	0.50	6.09	5.44	8.79	7.86
45	1.50	0.35	9.64	8.61	18.43	16.47
60	2.00	0.25	10.57	9.44	29.00	25.91
80	2.50	0.18	9.52	8.50	38.52	34.41
120	3.00	0.13	32.26	28.81	70.78	63.22
170	3.50	0.09	23.60	21.08	94.38	84.30
200	3.75	0.07	4.68	4.18	99.06	88.48
230	4.00	0.06	1.57	1.40	100.63	89.88

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
	3.49	3.28	2.77	1.95	1.47	0.74

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	2.44	0.18	0.89	-0.8	2.84

GRANULARMETRIC REPORT WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08

Granularmetric Report
Depths and elevations based on measured values

COASTAL TECH Coastal Geology & Sediments Laboratory

715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343

Project Name: Wakulla Sediment Analysis
Sample Name: Mashes 9A MHW
Analysis Date: 01-02-08
Analyzed By: LA

Easting (ft): | Northing (ft): | Coordinate System: | Elevation (ft):

USCS: SP | Munsell: Wet - 10YR-8/1 | Comments:

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
179.25	179.25	0.07	0.15	#200 - 0.20 #230 - 0.18	0.10	0.30	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
11/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.00	0.00	0.00	0.00
14	-0.50	1.41	0.03	0.02	0.03	0.02
18	0.00	1.00	0.33	0.18	0.36	0.20
25	0.50	0.71	2.12	1.18	2.48	1.38
35	1.00	0.50	11.44	6.38	13.92	7.76
45	1.50	0.35	34.21	19.09	48.13	26.85
60	2.00	0.25	76.23	42.53	124.36	69.38
80	2.50	0.18	37.21	20.76	161.57	90.14
120	3.00	0.13	14.16	7.90	175.73	98.04
170	3.50	0.09	2.97	1.66	178.70	99.70
200	3.75	0.07	0.18	0.10	178.88	99.80
230	4.00	0.06	0.04	0.02	178.92	99.82

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.81	2.35	2.14	1.77	1.45	1.22	0.78

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	1.78	0.29	0.56	-0.02	3.58

GRANULARMETRIC REPORT WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08

Granularmetric Report
Depths and elevations based on measured values

COASTAL TECH Coastal Geology & Sediments Laboratory

715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343

Project Name: Wakulla Sediment Analysis
Sample Name: Mashes 9A Offshore
Analysis Date: 01-02-08
Analyzed By: LA

Easting (ft): | Northing (ft): | Coordinate System: | Elevation (ft):

USCS: SM | Munsell: Wet - 10YR-4/1 | Comments:

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
156.26	143.24	2.52	0.20	#200 - 13.89 #230 - 10.15	4.50	3.00	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
11/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.03	0.02	0.03	0.02
14	-0.50	1.41	0.53	0.34	0.56	0.36
18	0.00	1.00	4.57	2.92	5.13	3.28
25	0.50	0.71	13.21	8.45	18.34	11.73
35	1.00	0.50	22.06	14.12	40.40	25.85
45	1.50	0.35	16.87	10.80	57.27	36.65
60	2.00	0.25	10.43	6.67	67.70	43.32
80	2.50	0.18	6.35	4.06	74.05	47.38
120	3.00	0.13	22.99	14.71	97.04	62.09
170	3.50	0.09	28.88	18.48	125.92	80.57
200	3.75	0.07	8.65	5.54	134.57	86.11
230	4.00	0.06	5.84	3.74	140.41	89.85

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
	3.65	3.35	2.59	0.97	0.65	0.10

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	2.02	0.25	1.24	-0.2	1.67

GRANULARMETRIC REPORT WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08

Granularmetric Report
Depths and elevations based on measured values

COASTAL TECH Coastal Geology & Sediments Laboratory

715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343

Project Name: Wakulla Sediment Analysis
Sample Name: Mashes 9A Upland
Analysis Date: 01-02-08
Analyzed By: LA

Easting (ft): | Northing (ft): | Coordinate System: | Elevation (ft):

USCS: SP | Munsell: Wet - 10YR-8/1 | Comments:

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
186.74	186.74	0.06	0.20	#200 - 0.25 #230 - 0.23	0.10	0.00	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
11/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.01	0.01	0.01	0.01
14	-0.50	1.41	0.29	0.16	0.30	0.17
18	0.00	1.00	5.06	2.71	5.36	2.88
25	0.50	0.71	32.30	17.30	37.66	20.18
35	1.00	0.50	74.29	39.78	111.95	59.96
45	1.50	0.35	49.96	26.75	161.91	86.71
60	2.00	0.25	19.57	10.48	181.48	97.19
80	2.50	0.18	3.35	1.79	184.83	98.98
120	3.00	0.13	0.97	0.52	185.80	99.50
170	3.50	0.09	0.41	0.22	186.21	99.72
200	3.75	0.07	0.06	0.03	186.27	99.75
230	4.00	0.06	0.03	0.02	186.30	99.77

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
1.90	1.45	1.28	0.87	0.56	0.38	0.06

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	0.92	0.53	0.55	0.49	4.09

GRANULARMETRIC REPORT WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08

Granularmetric Report
Depths and elevations based on measured values

COASTAL TECH
Coastal Geology & Sediments Laboratory

715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343

Project Name: Wakulla Sediment Analysis
Sample Name: Mashes Target 1
Analysis Date: 01-02-08
Analyzed By: LA

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):

USCS:	Munsell:	Comments:
SP	Wet - 10YR-7/3	

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
196.37	196.37	0.14	0.40	#200 - 0.50 #230 - 0.47	0.40	1.30	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
11/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.02	0.01	0.02	0.01
10	-1.00	2.00	0.05	0.03	0.07	0.04
14	-0.50	1.41	1.03	0.52	1.10	0.56
18	0.00	1.00	11.07	5.64	12.17	6.20
25	0.50	0.71	31.48	16.03	43.65	22.23
35	1.00	0.50	54.49	27.75	98.14	49.98
45	1.50	0.35	48.24	24.57	146.38	74.55
60	2.00	0.25	21.11	10.75	167.49	85.30
80	2.50	0.18	16.13	8.21	183.62	93.51
120	3.00	0.13	9.37	4.77	192.99	98.28
170	3.50	0.09	2.23	1.14	195.22	99.42
200	3.75	0.07	0.16	0.08	195.38	99.50
230	4.00	0.06	0.06	0.03	195.44	99.53

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.66	1.94	1.52	1.00	0.55	0.31	-0.11

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	1.09	0.47	0.79	0.48	3.02

GRANULARMETRIC REPORT WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08

Granularmetric Report
Depths and elevations based on measured values

COASTAL TECH
Coastal Geology & Sediments Laboratory

715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343

Project Name: Wakulla Sediment Analysis
Sample Name: Mashes T2
Analysis Date: 01-02-08
Analyzed By: LA

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):

USCS:	Munsell:	Comments:
SP	Wet - 10YR-7/2	

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
83.86	83.86	0.09	0.36	#200 - 0.51 #230 - 0.44	0.30	0.60	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
11/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.03	0.04	0.03	0.04
10	-1.00	2.00	0.04	0.05	0.07	0.09
14	-0.50	1.41	0.63	0.75	0.70	0.84
18	0.00	1.00	4.87	5.81	5.57	6.65
25	0.50	0.71	11.05	13.18	16.62	19.83
35	1.00	0.50	20.66	24.64	37.28	44.47
45	1.50	0.35	22.48	26.81	59.76	71.28
60	2.00	0.25	13.56	16.17	73.32	87.45
80	2.50	0.18	7.55	9.00	80.87	96.45
120	3.00	0.13	2.16	2.58	83.03	99.03
170	3.50	0.09	0.29	0.35	83.32	99.38
200	3.75	0.07	0.09	0.11	83.41	99.49
230	4.00	0.06	0.06	0.07	83.47	99.56

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.42	1.89	1.62	1.10	0.60	0.35	-0.14

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	1.11	0.46	0.75	0.12	3

GRANULARMETRIC REPORT WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08

Granularmetric Report
Depths and elevations based on measured values

COASTAL TECH
Coastal Geology & Sediments Laboratory

715-E North Dr.
Melbourne, Fl. 32934
Phone (321) 751-1135
Fax (321) 751-2343

Project Name: Wakulla Sediment Analysis
Sample Name: Mashes T3
Analysis Date: 01-02-08
Analyzed By: LA

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):

USCS:	Munsell:	Comments:
SP	Wet - 10YR-7/2	

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
84.18	84.18	0.05	0.19	#200 - 0.26 #230 - 0.25	0.50	1.60	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
11/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.00	0.00	0.00	0.00
14	-0.50	1.41	0.05	0.06	0.05	0.06
18	0.00	1.00	0.40	0.48	0.45	0.54
25	0.50	0.71	2.31	2.74	2.76	3.28
35	1.00	0.50	9.62	11.43	12.38	14.71
45	1.50	0.35	28.55	33.92	40.93	48.63
60	2.00	0.25	31.93	37.93	72.86	86.56
80	2.50	0.18	9.78	11.62	82.64	98.18
120	3.00	0.13	1.03	1.22	83.67	99.40
170	3.50	0.09	0.22	0.26	83.89	99.66
200	3.75	0.07	0.07	0.08	83.96	99.74
230	4.00	0.06	0.01	0.01	83.97	99.75

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.36	1.97	1.85	1.52	1.15	1.02	0.58

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	1.49	0.36	0.52	-0.21	3.88

GRANULARMETRIC REPORT WAKULLA COUNTY.GPJ FL DEP ROSS.GDT 1/8/08

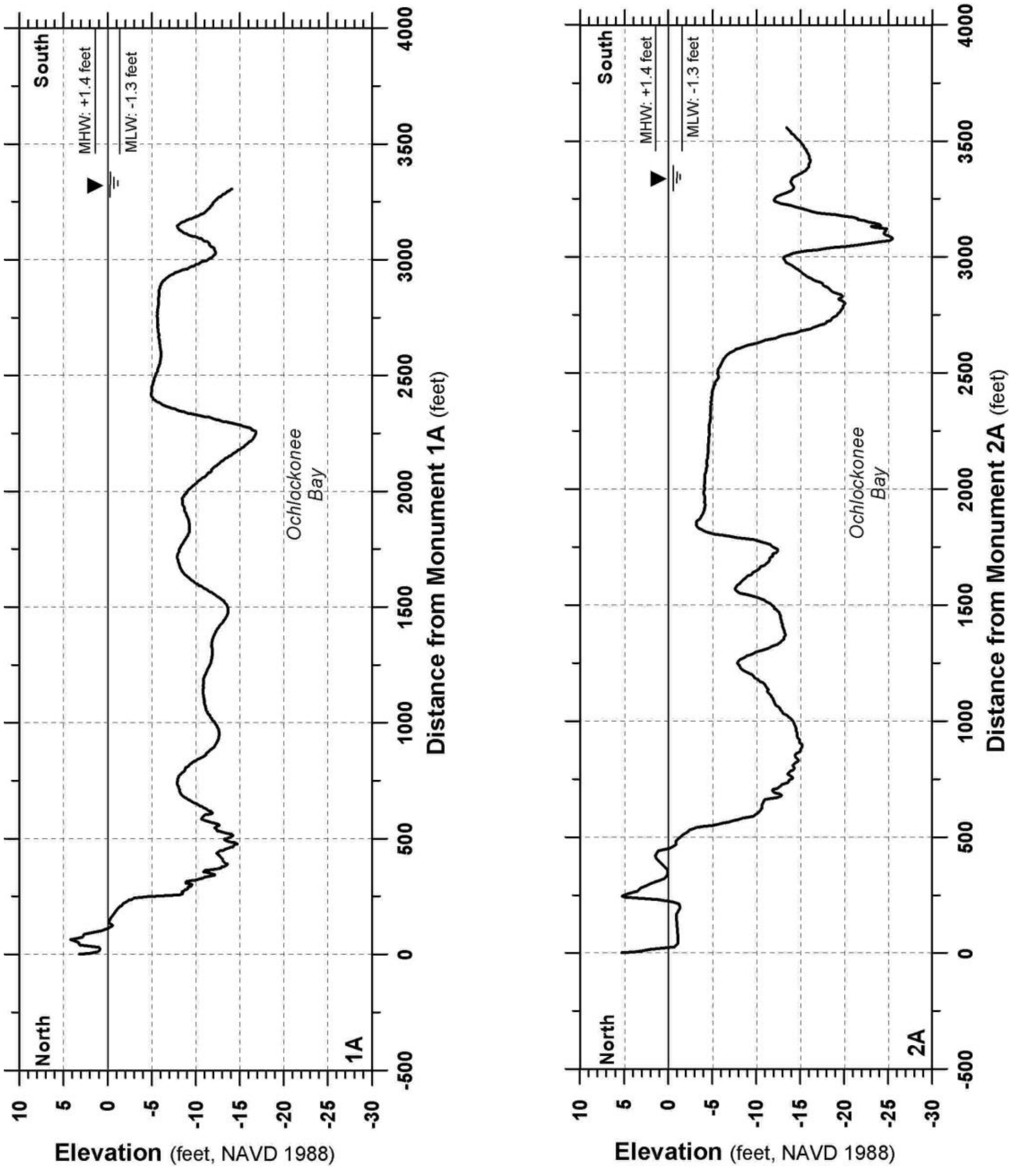


Figure II- 1 Mashes Sands Profile data for Monuments 1A and 2A

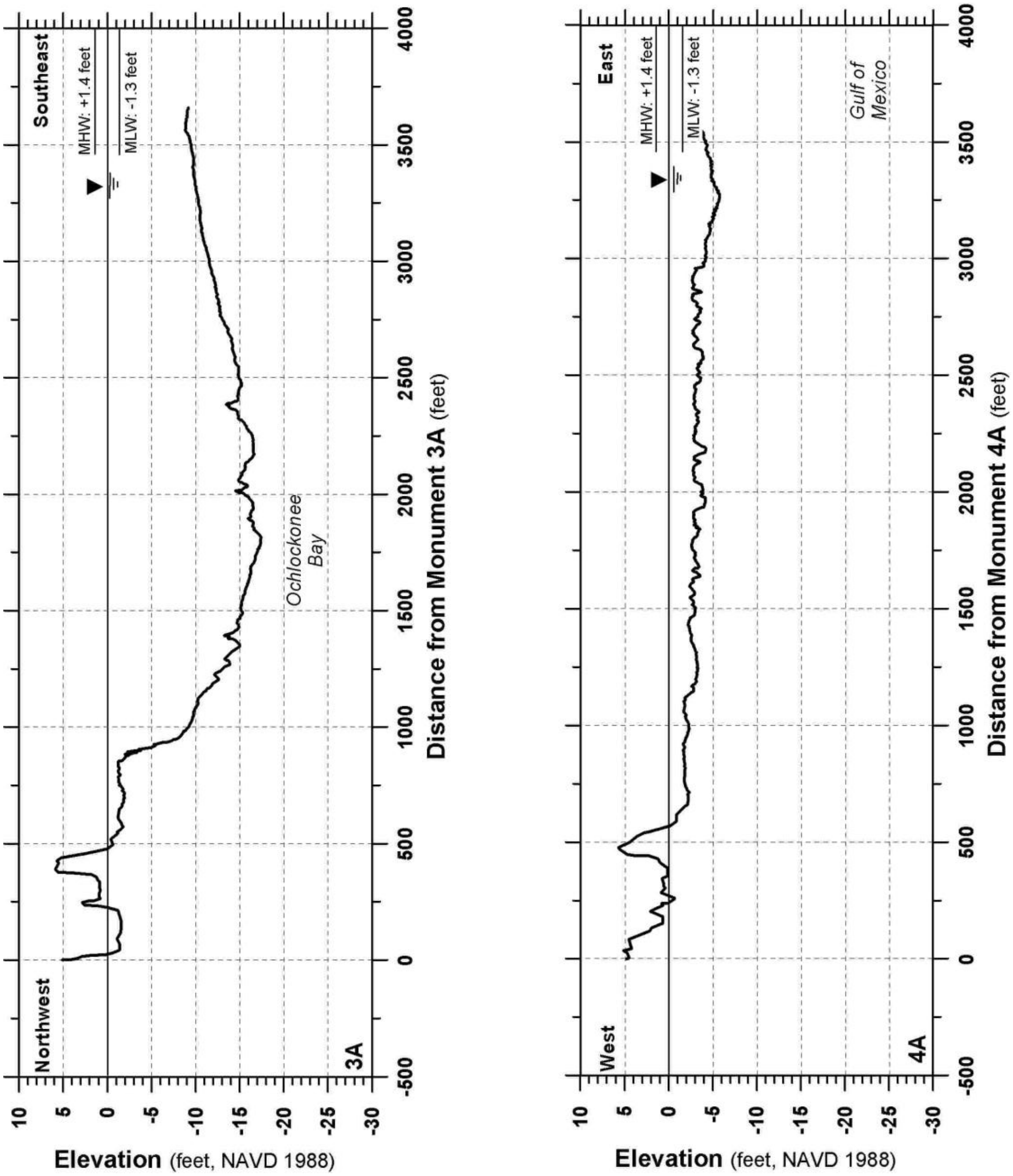


Figure II- 2 Mashes Sands profile data for monuments 3A and 4A

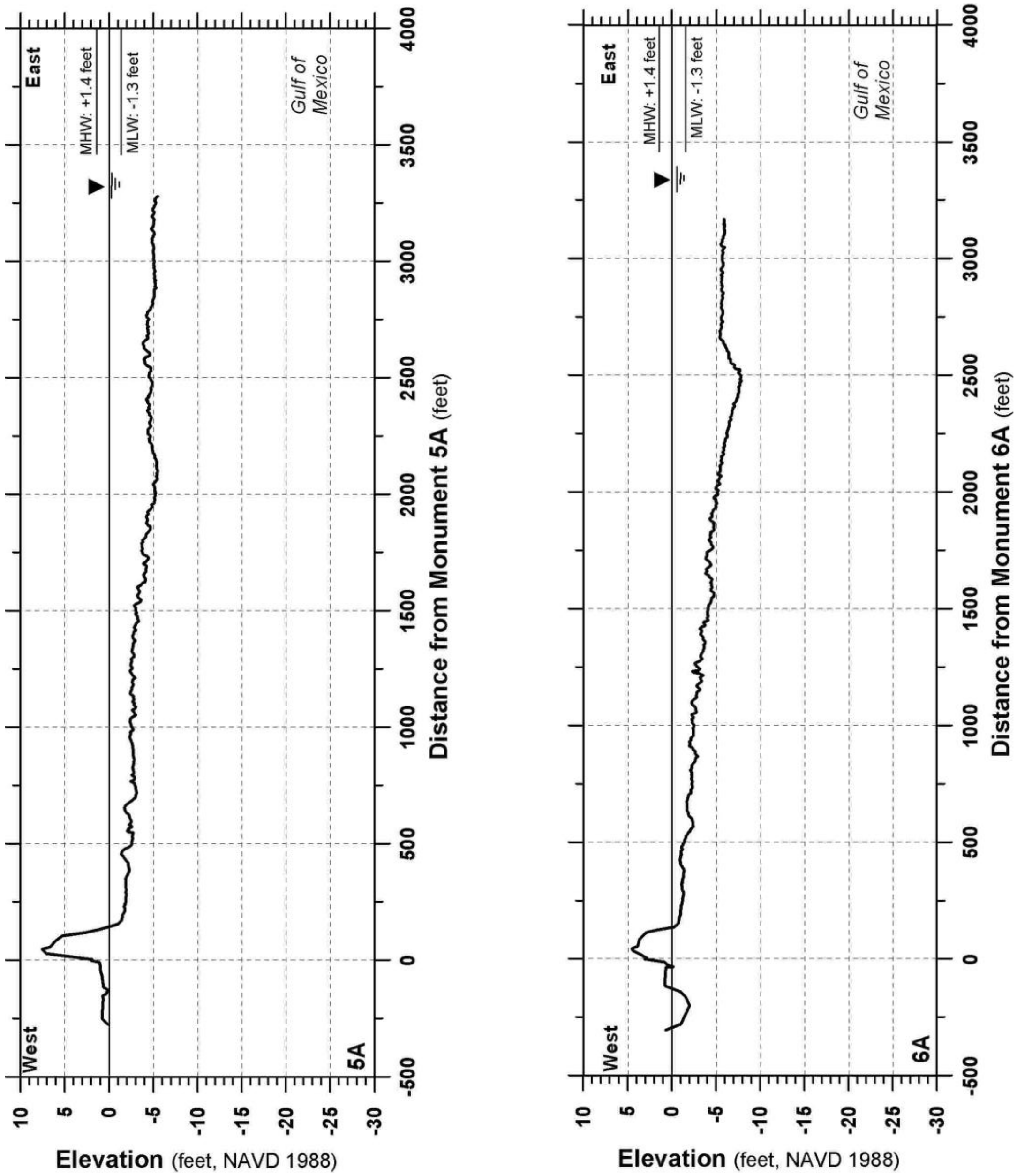


Figure II- 3 Mashes Sands profile data for Monuments 5A and 6A

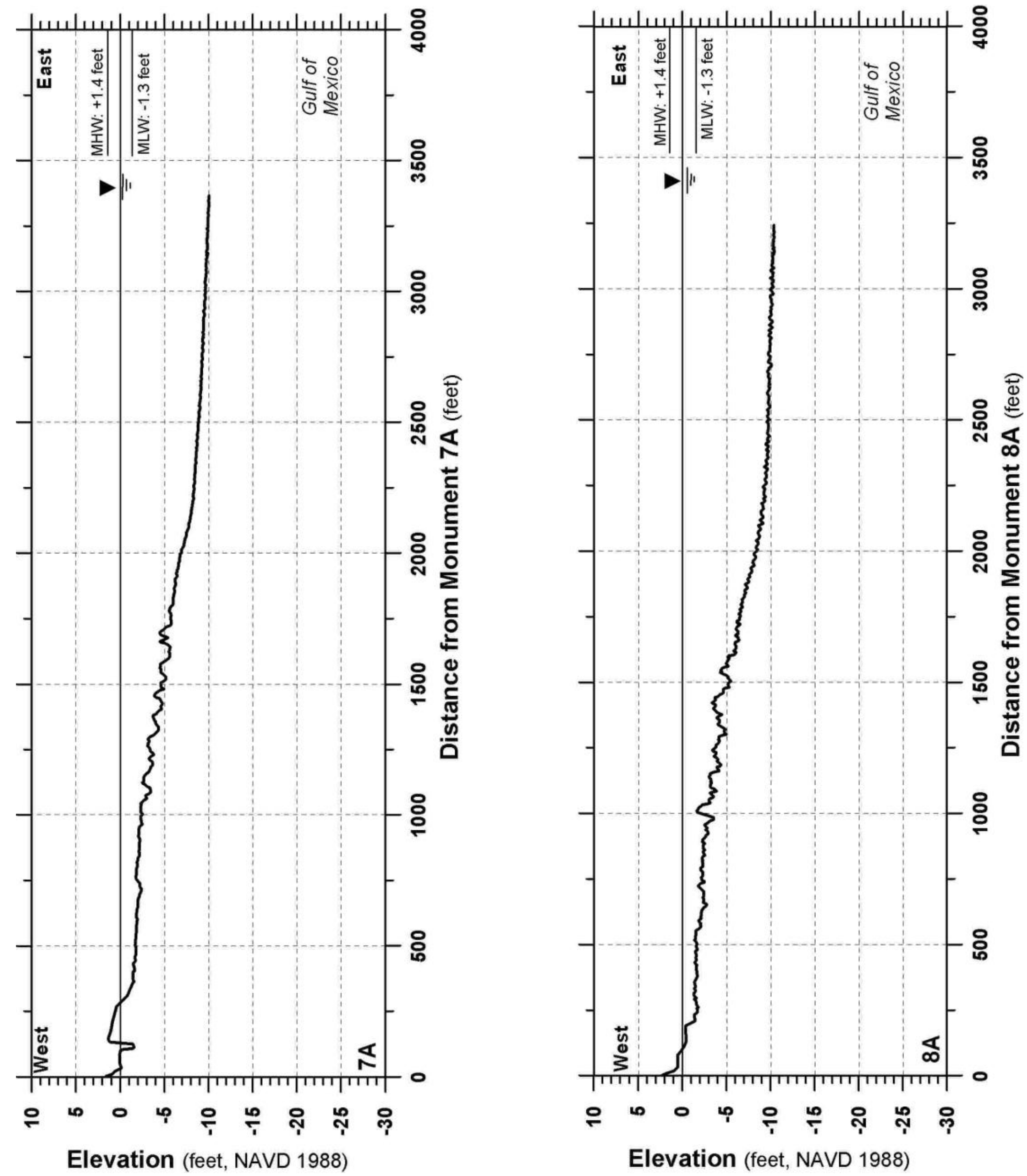


Figure II- 4 Mashes Sands profile data for Monuments 7A and 8A

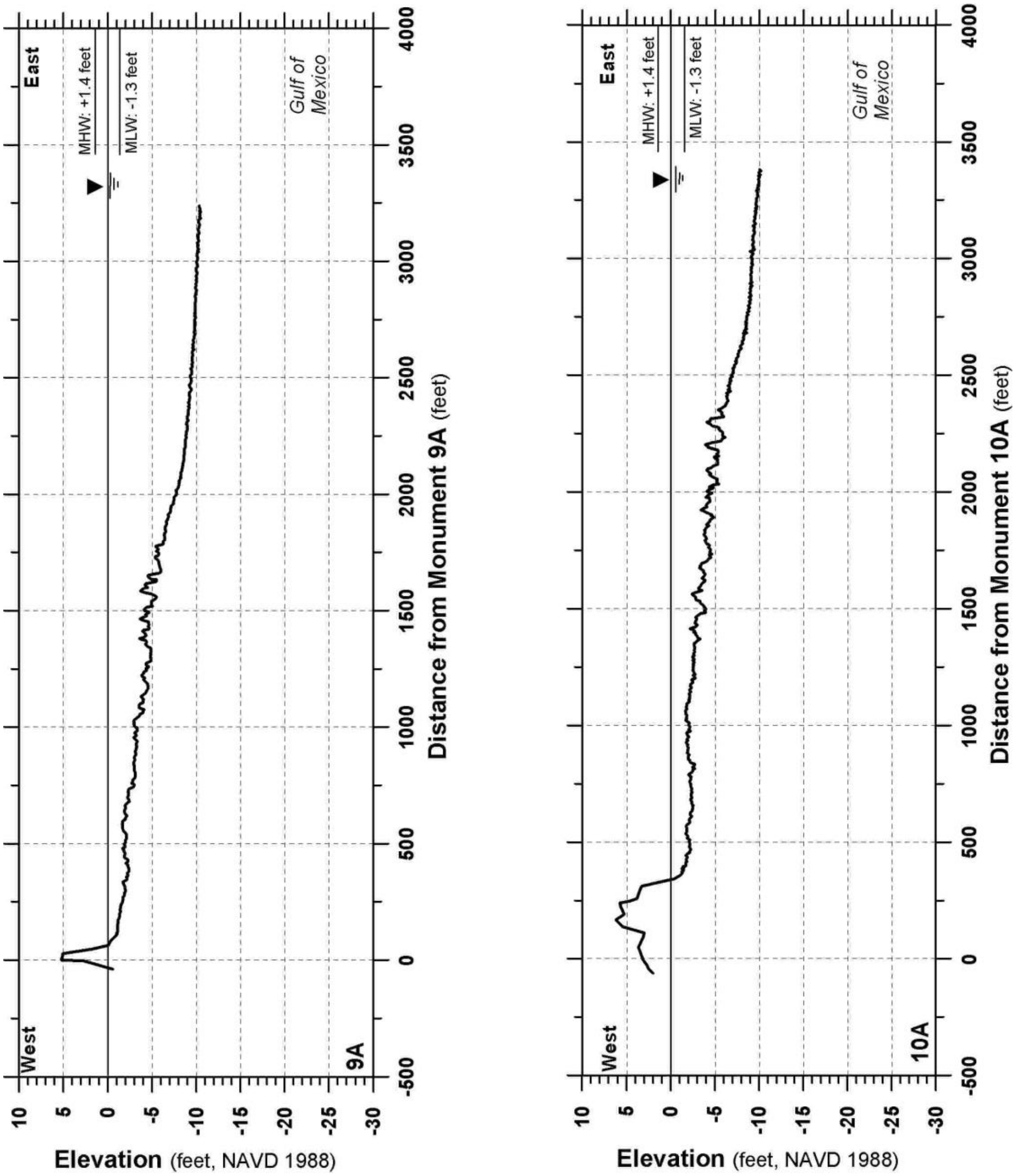


Figure II- 5 Mashes Sands profile data for Monuments 9A and 10A

3.0. NATURAL RESOURCE ASSESSMENT

A Natural Resource Assessment was conducted within the project limits during the time period between September 11th and 13th, 2007. The report entitled "*Mashes Sands Aquatic Habitat Assessment*" dated October 2007 was prepared by Biological Research Associates, Inc. and is found at the end of this section in the Supplemental Information. The assessment included the documentation of existing natural communities including sea grasses, emergent shoreline vegetation, marine vertebrates, marine fauna and avian species (i.e., shorebirds) that are present at Mashes Sands.

The field investigations found that several large sea grass beds containing several species of sea grasses are present within the study area. The sea grass beds consist of approximately 275 acres and are located within 100 feet of the 2007 shoreline and extend at least 3,000 feet offshore (BRA, 2007). In addition, Smooth Cordgrass *(Spartina altenrflora)* was found to exist along the project shoreline.

Section III

Supplemental Information

Mashes Sands Aquatic Habitat Assessment
Biological Research Associates, Inc.
October 2007

TABLE OF CONTENTS

1.0 INTRODUCTION

Biological Research Associates (BRA), LLC conducted a natural resource assessment of the Mashes Sands project area between 11 September 2007 and 13 September 2007. This assessment included an evaluation of seagrasses and associated benthic community, emergent vegetation and their extents. Protected species associated with this type of system were also assessed that include marine turtles, manatees, shorebirds and wading birds.

2.0 SITE LOCATION

The Mashes Sands project area is located in Wakulla County, FL within Sections 04 & 09, Township 06 South, Range 01 West. The project area is located immediately north of where the Ochlockonee River outfalls to the Gulf of Mexico. The majority of the assessment area is comprised of near-shore open waters.

3.0 METHODS

Prior to field surveys, BRA reviewed available electronic data to assess the potential occurrence of both seagrasses and listed birds within and near the project area based on documented occurrence data and known species-habitat associations. Seagrass and benthic community field surveys were conducted by arranging transects perpendicular to the shoreline throughout the project area. Emergent vegetation boundaries were delineated by walking and recording line data with a sub-meter GPS. Shorebird and wading birds observations were made using binoculars and field identification guides at several locations throughout the project area during early morning, mid-day, and late afternoon hours.

Ten (10) transects were arranged throughout the project area utilizing a sub-meter GPS unit loaded with best available aerial photography and project boundaries. Depending on tidal conditions and water depths at the time of assessment, transects were either walked or traversed using a boat. When conditions allowed (shallow, clear water), seagrass communities were delineated by walking with a sub-meter GPS. Point observations were generally made at every 200 feet along a transect by snorkeling within an approximate 50 foot radius around the point. Seagrass and algal species composition and visual estimates of relative abundance were recorded at each transect point. Relative abundance values taken at each point were averaged to arrive at relative abundance values for each seagrass species throughout the project area. Benthic fauna that were observable to the unaided eye were also recorded.

4.0 RESULTS

A systematic survey of the project area resulted in the identification of two (2) species of seagrass, one (1) algal species, one terrestrial mammalian species, and numerous avian and marine faunal species.

The seagrass community within the project area is comprised of shoal grass (*Halodule wrightii*) and manatee grass (*Syringodium filiforme*). Relative abudance of *H. wrightii* and *S. filiforme* is approximately 85% and 15%, respectively. A red algal species (*Gracilaria* sp.) co-occurred with these species nearly 100% of the time. The attached "Seagrass and Emergent Vegetation map" shows that the areal extent of the seagrass community encompasses approximately 274 acres. Within the seagrass community, minor, non-contiguous patches of apparently uncolonized substrate do occur. It is possible that non-visible seagrass rhizomes occur below the sediment surface in these areas given the proximity to thriving seagrass communities. In general, the seagrass community occurs within the < 1 ft. to 8 ft. depth range.

Preparation Date: 10/12/07 Revision Date: xx/xx/xx Project Manager: RGB GIS Analyst: RGB Map Document: Wakulla Seagrass.mxd Project Number: 7824-0010-Y84 PDF Document: Seagrass Map.pdf

Sec 04 & 09 Twp 06S Rng 01W

0 600 1,200 2,400 Feet

Image: March 2006 Aerial Express Map Scale: 1:14,400

Seagrass & Emergent Vegetation
Mashes Sands
Wakulla County, FL

Biological Research Associates
PO Box 69
Destin, Florida 32540
ph 850.837.8004 fx 850.837.8039
www.biologicalresearch.com

Smooth cordgrass (*Spartina alterniflora*) is the only emergent vegetative species identified along the shoreline of the project area. Approximately 2.1 acres of this emergent vegetative species occur within the project area. The locations of this species are shown on the attached Seagrass and Emergent Vegetation map.

Numerous avian species occur within and near the project area. The following species were observed near the shoreline of the project area: marbled godwit (*Limosa fedoa*), willet (*Catoptrophorus semipalmatus*), semipalmated sandpiper (*Calidris pusilla*), snowy egret (*Egretta thula*), royal tern (*Sterna maxima*), sandwich tern (*Sterna sandvicensis*), laughing gull (*Larus atricilla*), bald eagle (*Haliaeetus leucocephalus*), yellow-crowned night heron (*Nyctanassa violacea*), great blue heron (*Ardea herodias*), purple martin (*Progne subis*), great egret (*Ardea alba*), brown pelican (*Pelecanus occidentalis*), seaside sparrow (*Ammodramus maritimus*), osprey (*Pandion haliaetus*), glossy ibis (*Plegadis falcinellus*), white ibis (*Eudocimus albus*), American oystercatcher (*Haematopus palliates*), and black skimmer (*Rynchops niger*). Accurate estimates of species diversity, abundance, and nesting frequency would require a more intensive sampling protocol throughout each season and are, therefore, not included in this report. The location of an active bald eagle nest with a 660 ft. buffer is depicted on the attached "Listed Species map".

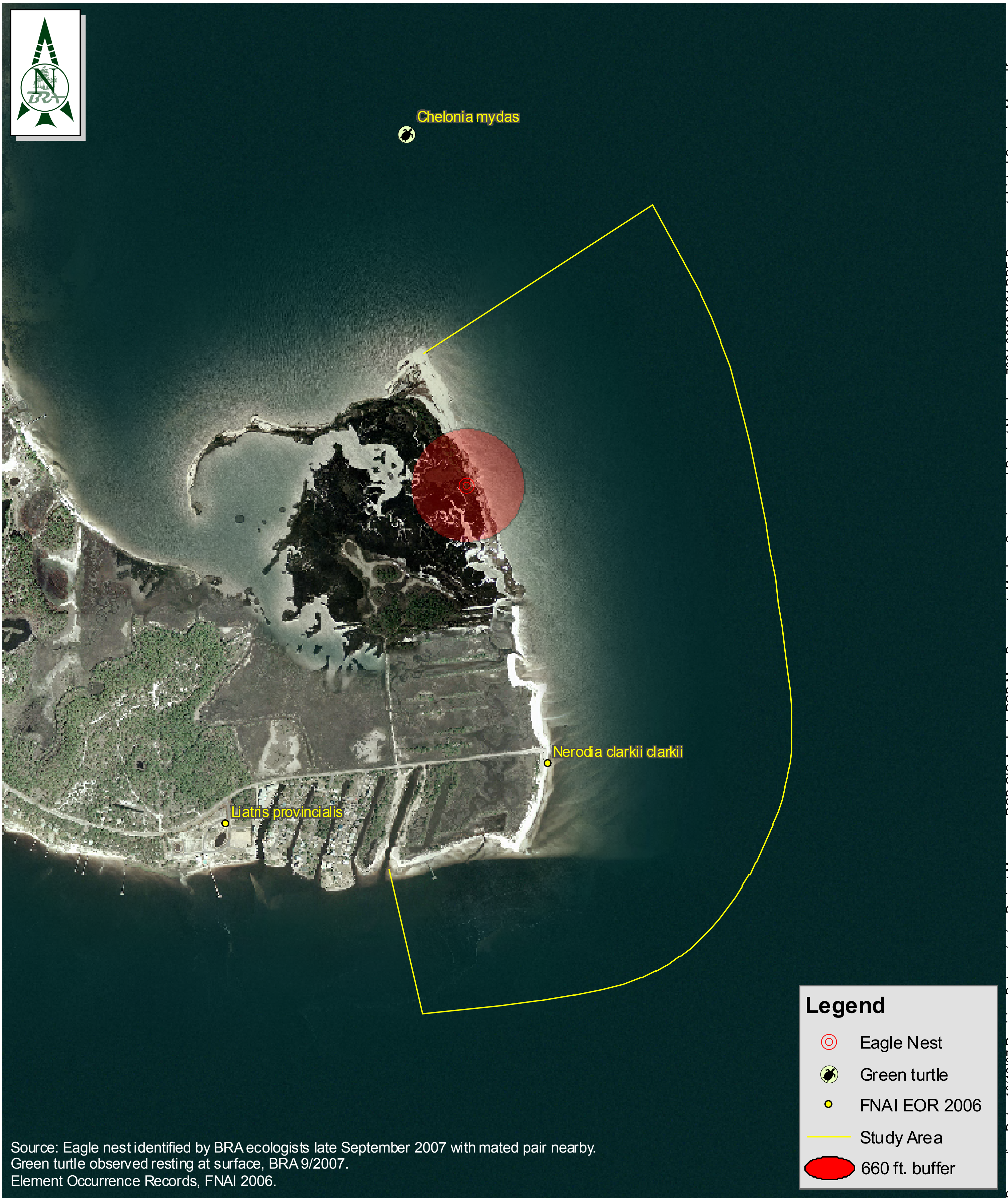
Six (6) of the bird species observed have been assigned a regulatory designation based on applicable state and federal law. The snowy egret, white ibis, American oystercatcher, brown pelican, and black skimmer are state-designated as a "species of special concern". The bald eagle is currently listed as "threatened" in the State of Florida and has been recently removed from the federal list of threatened and endangered species. The bald eagle is also expected to be removed from the State of Florida threatened and endangered species list following final approval of a bald eagle management plan, expected to occur in December 2007. It should be emphasized that activities potentially affecting the bald eagle are still regulated under the both the Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act. Based on the 2007 National Bald Eagle Management Guidelines, nest monitoring may be required for any activities occurring within 660 feet of an active bald eagle nest. Further consideration of how activities associated with the Mashes Sands beach renourishment project may affect bald eagles is suggested.

Marine fauna documented to occur by observation include the bottlenose dolphin (*Tursiops truncatus*), green turtle (*Chelonia mydas*), unidentified shark, horseshoe crab (*Limulus polyphemus*), blue crab (*Callinectes sapidus*), and sand dollar (echinoderm). The green turtle was observed outside of the project area, as depicted on the attached Listed Species map. The green turtle is listed as "endangered" under both federal and State of Florida law. Further consideration of how activities associated with the Mashes Sands beach renourishment project may affect green turtles is suggested.

Manatees (*Trichechus manatus*) are currently listed as endangered under federal and State of Florida law. According to Florida Marine Research Institute (FMRI) data, manatees have not been documented to occur within the project area, nor were any observed during the field review. It should be noted that manatees have been routinely documented within the Wakulla Springs system, located north of the project area. Therefore, based on the project's proximity to Wakulla Springs, it is possible that manatees utilize the project area.

One red fox (*Vulpes vulpes*) was documented to occur by observation along the shoreline in the northern project area.

A search of the Florida Natural Areas Inventory database revealed that the salt marsh snake (*Nerodia clarkii clarkii*) has been documented within the project area.



Preparation Date: 10/12/07 Revision Date: xx/xx/xx Project Manager: RGB GIS Analyst: RGB Map Document: Mashes Species.mxd Project Number: 7824-0010-Y84 PDF Document: Listed Species Map.pdf

Sec 04 & 09 Twp 06S Rng 01W

0 750 1,500 3,000 Feet

Image: March 2006 Aerial Express

Map Scale: 1:18,000

Listed Species Map
Mashes Sands
Wakulla County, FL

Biological Research Associates

PO Box 69
Destin, Florida 32540
ph 850.837.8004 fx 850.837.8039
www.biologicalresearch.com

5.0 DISCUSSION

Results of the field review indicate that a significant portion of the project area is comprised of seagrass communities. In general, these communities are confined to a depth range of < 1 ft. to 8 feet. Any impacts to seagrasses related to the beach renourishment project will require permitting under applicable regulatory law.

Final project design and timing will dictate the level of analysis and permitting that may be required for those listed species present within the project area. It is suggested that coordination with the appropriate state and federal agencies occur prior to project initiation to ensure compliance with applicable state and federal law.

4.0. ALTERNATIVE DESIGNS

4.1. OVERVIEW OF ALTERNATIVE DESIGNS

There are four primary alternatives that have been evaluated as potentially feasible for beach management along Mashes Sands. The alternatives focus on the shoreline from Monuments 3A to 7A (Figure 2-2). The primary objective of the design analysis is to identify feasible alternatives which mitigate for shoreline erosion, provide an increased level of storm protection, enhance recreation, and preserve natural resources. The advantages and disadvantages for each alternative are discussed in their relevant sections. Four (4) alternatives that have been evaluated are as follows:

Alternative 1: No New Action;
Alternative 2: Beach and Dune Restoration;
Alternative 3: Beach Fill with Terminal Groin; and,
Alternative 4: Beach Fill with T-Groins.

Each of the above alternatives has been evaluated to establish the feasible alternative most likely to yield maximum economic benefits while addressing natural resource preservation. The following were included for each alternative assessment:

- Project description;
- Performance evaluation; and,
- Value engineering assessment (benefits and first opinion of probable initial costs).

In addition, sediment infilling of the Mashes Sands Boat Ramp and Sunrise Canals are evaluated and presented in Section 4.6.

4.2. ALTERNATIVE 1: NO NEW ACTION

"No New Action" is always an alternative and can often compare favorable in a purely economic analysis. However, there can also be significant non-economic impacts from such an approach which makes a straight forward evaluation more difficult. This alternative preserves the existing "*status quo*" by reacting to storm erosion after the fact rather than taking a proactive approach. The alternative would consist of taking no physical action to mitigate historical erosional trends or reduce the over washing of the beach into the back-barrier marsh environment.

4.2.1. Performance Evaluation

"No New Action" preserves the existing *status quo* of environmental impacts versus benefit, whatever that balance might be. The parking lot and revetment located at the end of Mashes Sands Road, and the park facilities would continue to be vulnerable to damage from storms less than a 10-year storm event and the recreational beach would continue to be lost as a result of shoreline erosion. In addition, natural habitat would continue to be impacted by storm-induced tide surge and overwash.

4.2.2. Construction Costs

There are no direct costs associated with new construction for the "No New Action" alternative. Upland infrastructure would continue to be vulnerable to damage from storms of greater than a 10-year storm event and periodic costs would result from post-storm recovery efforts by local, State and Federal (FEMA) interests.

4.2.3. Benefits

The benefits of the "No New Action" alternative include no direct impacts to existing sea grass beds, marsh or expenditure of public funds associated with the implementation of this alternative. However, over time the back-barrier marsh will continue to be covered with sand overwashed from the beach and the width of the beach will continue to be reduced resulting in a diminished recreational beach and coastal habitat.

4.2.4. Conclusion

The "No New Action" alternative does not successfully meet the project goals. It is anticipated that additional costs may be incurred by Wakulla County, State and Federal government due to unimpeded storm surge and wave attack against the existing shoreline causing the loss of usable recreational beach and damage to upland park facilities. The following alternatives may provide a solution that enhances the recreational appeal of the beach, increasing storm protection of the upland infrastructure while minimizing in-direct impacts to existing environmental resources.

4.3. ALTERNATIVE 2: BEACH AND DUNE RESTORATION

This alternative consists of the construction of a beach "berm" to widen the dry beach to provide additional area for recreational and habitat use, and the construction of a dune feature, which would increase storm protection. The proposed beach fill limits are between Monuments 3A and 7A for a total length of approximately 1,800 feet (Figure 4-1). The restored beach would be created by placing approximately 130,000 cubic yards (yds^3) of beach compatible sand, with a minimum berm width of 60 feet at elevation +5 feet NAVD 88. The seaward foreshore slope would be constructed at 10 horizontal to 1 vertical tying into the -2 to -3 foot contour (Figure 4-2, top). A dune would be constructed to provide a reserve of "sacrificial" sand for erosive storm events and reduces the frequency and extent of waves and storm surge penetrating the uplands. Based on an iterative process conducted in Section 4.3.1, the dune would have a crest elevation of +14 feet NAVD 88 and crest width of 40 feet. Approximately 55,000 sea oats would be installed on the constructed dune at a spacing of 18-inchs on-center.

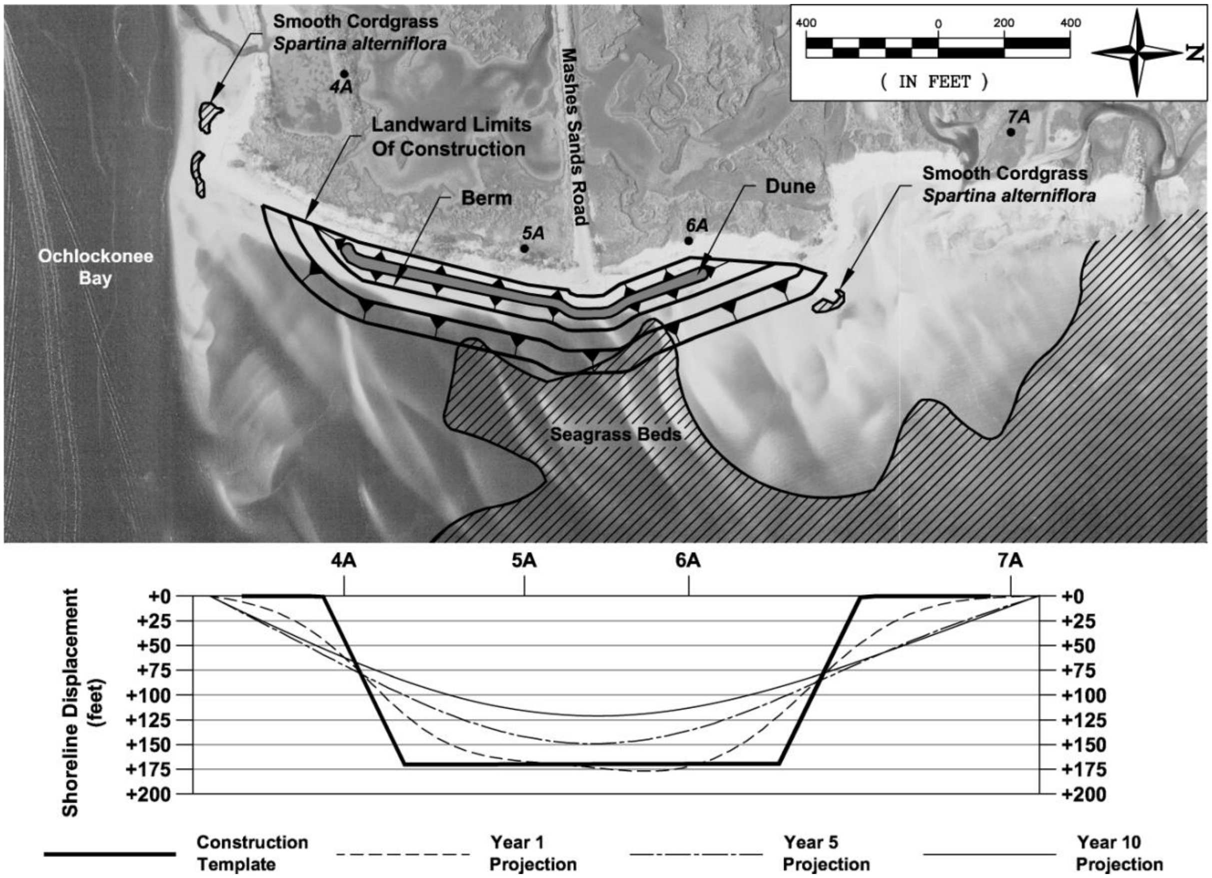


Figure 4-1. Alternative 2 – Beach and dune restoration

4.3.1. <u>Performance Evaluation</u>

The existing beach provides less than a 10-year level of storm protection to the uplands. The proposed beach and dune as described above was developed through an iterative process and would provide upland protection up to a 20-year storm event while mitigating for the historic erosional trends. Based on the numerical model DNR-BS (Dean and Grant, 1989), the predicted life of the initial beach berm project is between 12 and 15 years before re-nourishment is required with approximately 70 percent of the material remaining after 10 years (Figure 4-1, bottom). However, the re-nourishment intervals do not consider the frequency and severity of storm events impacting this shoreline. The life of the project is anticipated to decrease with increasing storm events.

The addition of a dune feature would further increase the level of storm protection. However, as documented in Section 2.2.2, the DEP storm surge elevation for a 10-year return interval is +8.7 feet, and based on a SBEACH analysis would inundate and overtop a dune with a crest elevation of less than +10 feet. The +14 foot dune crest elevation and 40 foot width presented above would be required to provide the desired level of storm protection (20-year event) within the fill limits. However, there is not an existing adjacent dune for the proposed dune project to tie into to in order to have a continuous storm protection barrier. The relatively low-lying (elevation) shoreline adjacent to and outside of the beach and dune limits may be flanked and overwashed by storm surge. This may result in a portion of the beach fill sediment to be eroded, transported and deposited onto the back-barrier marsh during a storm event. To offset for this, a greater volume of sand than as proposed would be needed. However, the resulting larger beach fill footprint would encroach onto the identified sea grass beds. It is estimated that approximately 0.44 acres (19,000 ft^2) of sea grasses <u>may</u> be impacted from the construction of this project which may require the creation of 2.18 acres (95,000 ft^2) of sea grass mitigation area.

4.3.2. <u>Construction Costs</u>

Potential borrow areas within the offshore area were investigated on a preliminary basis. As presented in Section 2.3, surface sediment samples were collected from three (3) offshore locations. However, the sea grass beds identified in Section 3.0 covered this area and appeared to extend beyond the limits of the field investigations. The potential of locating a suitable offshore borrow close to the fill area due to the extensive shallow waters and sea grass beds are low, thus the beach fill material may have to be trucked in from an upland borrow source. This alternative is estimated to require approximately 130,000 yds^3 of sand. Approximately 110 days are estimated to construct this project. This assumes using a standard dump truck with a load capacity of 20 yds^3 delivered every 10 minutes for 10 hours per day, 7 days a week for a total of 6,500 trips or 60 truck trips per day - every day. This would make the project cost prohibitive plus truck traffic may severely impact Mashes Sands Road requiring costly road repairs. Further offshore investigations would be necessary to identify a suitable borrow site that would not impact existing natural resources and be close enough to the fill area to cost-effectively hydraulically pump sand via a dredge.

The total preliminary opinion of probable costs is estimated to be **$7,302,000** (Table IV.1 – Supplementary Tables). These costs include design, permitting, construction phase services, placement of sand, removal of debris, sea grass mitigation and sea oats. If an offshore sand source investigation is conducted and is successful in identifying a suitable borrow area that within one or two miles of the fill area, construction costs may be reduced by about $3,000,000 to approximately **$4,250,000**. These costs do not include any long-term monitoring services or re-nourishment.

4.3.3. <u>Benefits</u>

Constructing a beach and dune restoration project would provide beach users with a recreational beach constructed of clean beach compatible sand. In addition, the constructed dune feature in combination with the proposed beach will provide storm protection up to a 20-year storm event. The proposed vegetation on the dune will trap wind-blown sediments as well as stabilize the dune face potentially increasing the size of the dune and provide dune habitat.

4.3.4. Discussion

Alternative 2 has permitting issues with the potential impacts to sea grasses. The Departments staff has cited that Tanner (1960) has classified the beach at Mashes Sands as a Chenier, which means that it is constantly subjected to frequent overwashing. Implementing this Alternative provides storm protection from a storm up to a 20-year event, however due to the large deviation seaward from the existing shoreline, the relative short length of the project, project life is expected to be minimized due to storm surge and wave attack flanking the project. In addition, high end losses may potentially impact adjacent and nearby environmental resources which would contradict the goals of this project. This Alternative does not successfully meet all the goals of this Project.

It is estimated that approximately 0.44 acres of sea grasses may be impacted. Mitigating for direct and indirect burial of sea grass beds could be very extensive and costly and could make this alternative cost prohibitive.

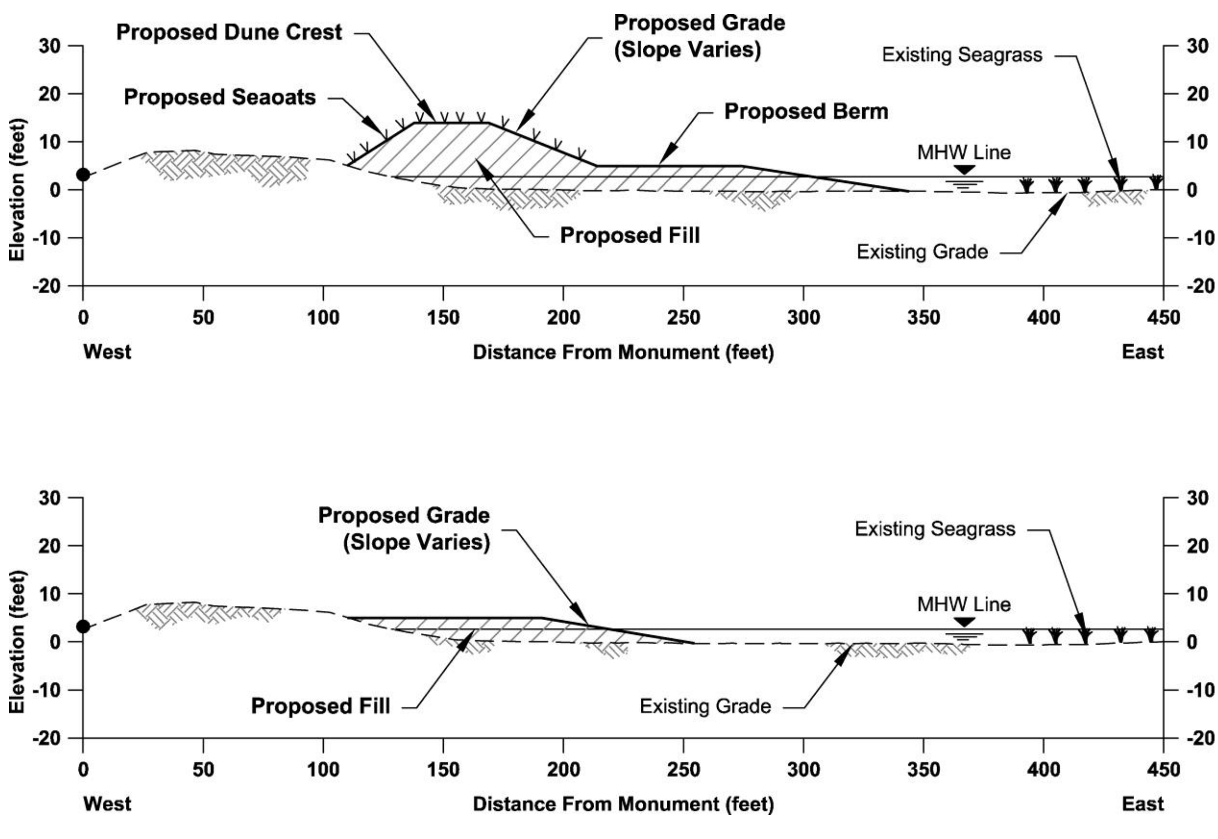


Figure 4-2. Typical construction templates for Alternative 2 (top) and Alternative 3 (bottom)

4.4. ALTERNATIVE 3: BEACH FILL WITH TERMINAL GROIN

The proposed beach fill would consist of placing approximately 30,000 cubic yards (yds^3) of beach compatible sand between Monuments 3A and 6A+400 (Figure 4-3, top). All or a portion of the required beach fill volume could be generated from the dredging of the Mashes Sands boat ramp and Sunrise canals (Section 4.6). However, due to the limited supply of sand from the canal dredging, this material may need to be stock-piled at the boat ramp park and transported to the fill area either once a sufficient volume is obtained or over a period of time as sand becomes available through the dredging operations. The construction template would have a berm width of 100-feet at elevation +4.0 feet NAVD 88 and the seaward foreshore slope of 10 horizontal to 1 vertical would tie into the -2 to -3 foot contour (Figure 4-2, bottom). This alternative also considers the installation of a shore-perpendicular terminal groin at the northern end of the beach fill limits in the vicinity of Monument 6A+400 (Figure 4-3). The low-lying rock structure is included to stabilize (“anchor”) the northern fill limits and reduce the infill of the existing tidal inlet and marsh (located to the north) during storm events and the spreading of the beach fill (Figure 4-3, bottom). The terminal groin is proposed to be approximately 100 feet in length, +5.0 feet in height, crest width of 9 feet and side slopes of 2 horizontal to 1 vertical. The average armor stone would be 2.3 tons having a thickness of at least 3 armor units. The toe of the structure will be placed at an approximate elevation of -4.0 feet NAVD 1988. Figure 4-4 provides a typical detail of the proposed terminal groin.

4.4.1. Performance Evaluation

The placement of beach compatible sand would provide a recreational beach and slightly increase the level of upland storm protection from the existing (less than) 10-year to about a 10-year storm event by translating the MHWL seaward. The terminal groin would be installed at the northern beach fill limits to minimize spreading losses; reduce storm related beach erosion (to the north); and, reduce the infilling of the inlet located to the north of the proposed beach fill. As presented in Section 4.3.1, the life of the initial beach restoration project without structures (before re-nourishment is required) is predicted to be between 10 and 12 years, and 13 to 15 years with the proposed terminal groin (Figure 4-3, bottom). However, these estimated re-nourishment intervals do not consider the frequency and severity of storm events impacting this shoreline. The life of the project is anticipated to decrease with increasing storm events.

Sea grass beds have the potential to be directly and in-directly buried from the placement of sand contained in this alternative. The equilibration and spreading of the beach fill template has the potential to cover less than 300 ft^2 of sea grass beds and emergent vegetation which may require the creation of 0.03 acres (1,500 ft^2) of sea grass mitigation area. Minimization and/or avoidance would need to be further considered during the preliminary and final design of this alternative. It is possible a mitigation plan and monitoring program would be required for any direct or indirect impacts, and would need to be approved through the DEP and USACE permitting process.

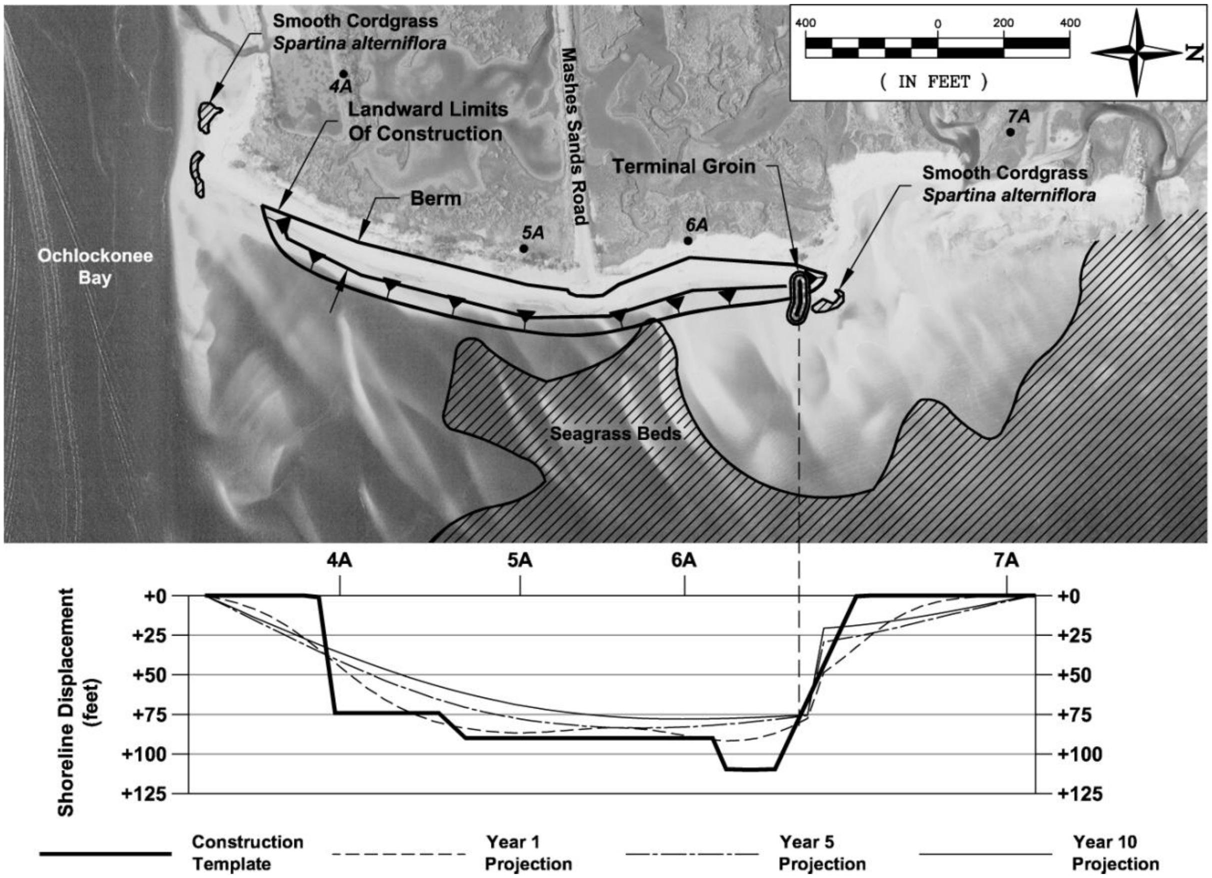


Figure 4-3. Alternative 3 – Beach restoration with terminal groin

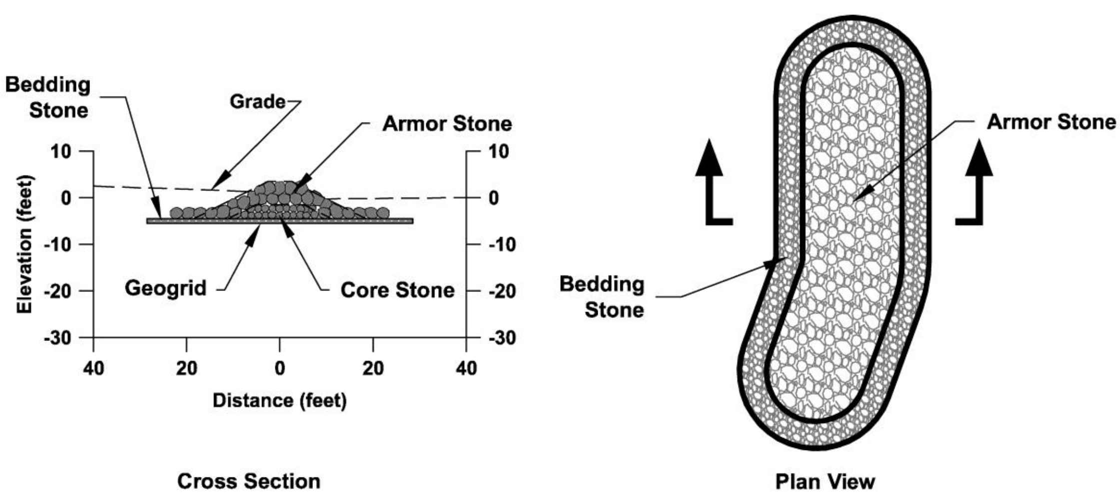


Figure 4-4. Alternative 3 - Typical cross-section and plan view of the proposed terminal groin

4.4.2. Construction Costs

The preliminary opinion of probable costs for the truck-haul and placement of the 30,000 yds^3 of beach fill obtained from an upland borrow source is estimated to be **$2,376,500**. The costs of sand could be reduced by approximately **$600,000** if the material generated from the dredging of the Mashes Sands boat ramp and Sunrise canals (Section 4.6) is used to meet the required beach fill volume rather than using an upland borrow area. Of this total cost, the addition of the terminal groin at the northern end of the beach fill limits is estimated at $480,000 assuming the project is constructed under one contract. Table IV.2 summarizes the breakdown in the preliminary opinion of probable costs.

4.4.3. Benefits

The benefit of implementing this alternative is that it provides additional recreational usage to the existing beach with minimal encroachment on the existing natural resources. Alternative 2 provides an approximately 100 feet wide beach berm (Figure 4-2, bottom) of clean beach compatible sediment that would be available for recreational use. Translation of the MHWL seaward will provide an additional buffer for mitigating current erosive trends within the proposed project limits.

4.4.4. Discussion

Alternative 3 successfully mitigates for current erosive trends within the proposed project limits. A small increase in the current storm capacity of the shoreline is created by translating the MHWL seaward. Overwashing and inundation will continue unabated during high frequency storm events causing sediment to be overwashed into the marshes behind the existing beach.

Preliminary comments from DEP indicate that this Alternative is likely to be constructed and permitted with the Departments official approval. Installation of the northern terminal groin may not be implemented at first and potentially will have to undergo monitoring for approval of construction.

4.5. ALTERNATIVE 4: BEACH FILL WITH T-GROINS

Alternative 4 incorporates the installation of ten (10) “T-groins” pre-filled with approximately 30,000 yds^3 of sand to create a recreational beach while increasing the storm capacity of the beach (Figures 4-5 and 4-6). The potential for indirectly burying sea grasses is minimized as one of the main functions of the T-groins is their ability to retain sediment within the footprint of the structures.

The T-groins would be placed in a parallel configuration along the project shoreline between Monuments 3A and 7A (Figure 4-5). The 100-foot long T-groin heads would have gaps between each structure at 100 foot spacing, with a crest elevation of +5.0 feet NAVD 88, and crest width of 9 feet. The trunks consisting of composite sheetpile and stone would extend landward from the head and be approximately 50 feet long (Figure 4-6). Approximately 15,000 tons of stone will be required to construct the ten (10) T-groins and each armor stone would have an average weight of 2.3 tons.

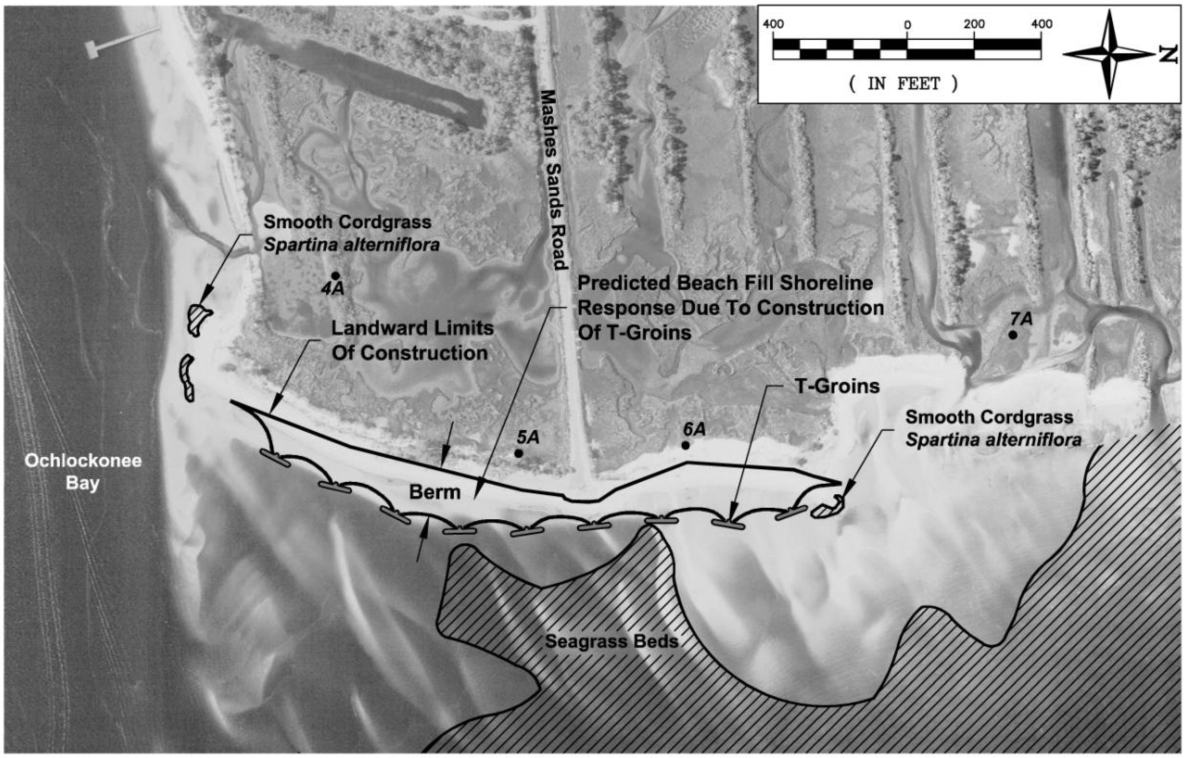
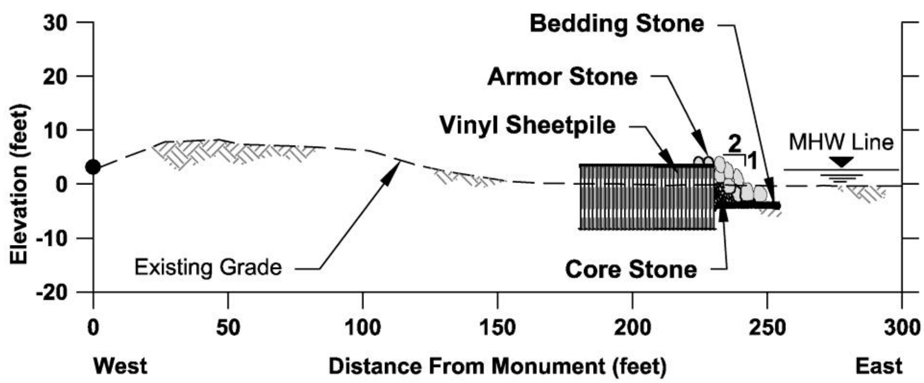


Figure 4-5. Alternative 4 – Beach restoration with T-groins

The structures would be backfilled with clean beach compatible sand at a construction berm width of approximately 100 feet at elevation +4.0 feet NAVD 1988. The slope between the seaward edge of the berm and the toe of fill is 1V:10H. . All or a portion of the required beach fill volume could be generated from the dredging of the Mashes Sands boat ramp and Sunrise canals (Section 4.6). However, due to the limited supply of sand from the canal dredging, this material may need to be stock-piled at the boat ramp park and transported to the fill area either once a sufficient volume is obtained or over a period of time as sand becomes available through the dredging operations.

4.5.1. Performance Evaluation

The T-groins would be added to provide additional storm protection while "shaping" the placed beach fill material. The shape of the equilibrated shoreline is dependent upon the incident wave angle with the T-groin and the distance or a gap between the heads of the structures and is predicted based on the empirical rule developed by Silvester and Hsu (1993). Based on the simulated wave climate and proposed T-groin spacing and size, the shoreline would have an indentation of approximately 35 feet.



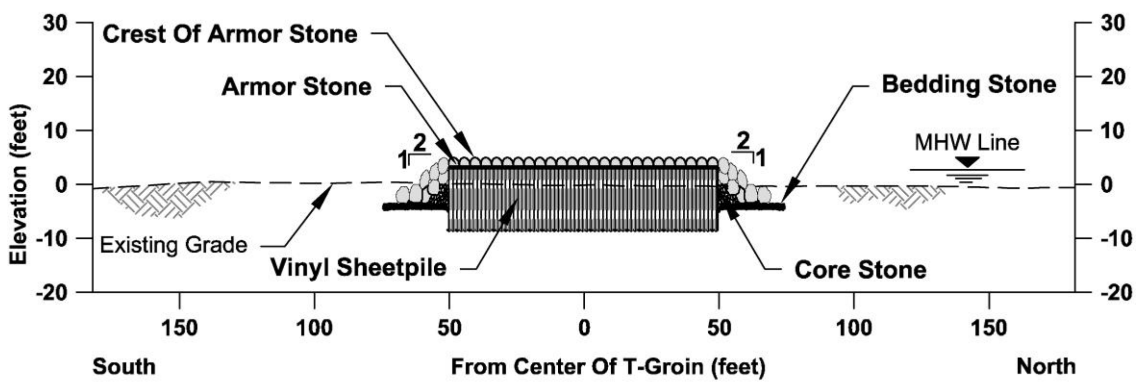


Figure 4-6. Typical T-groin details

The T-groins at the ends are intended to minimize spreading losses and reduce the erosion of the placed sand from within the project limits. The trunks are not proposed to be sand tight to minimize the adverse impacts to the existing sediment processes thus should not translate erosion further to the north or south of the project limits. It has been found that T-groins may not completely trap sand from the littoral system. Rather, they stabilize the "design volume while allowing the "overfill" volume to "re-nourish" the beach downdrift of the structures (Moore, 1999). Humiston and Moore (2002) also found that approximately 20% of the potential net sediment transport rate is "captured" and retained within the T-groin field while the remaining 80% is bypassed around the structures.

The life of the initial beach restoration project with “T-groins” is predicted to be between 10 and 12 years. However, these estimated re-nourishment intervals do not consider the frequency and severity of storm events impacting this shoreline nor do they account for the benefit of having terminal structures and T-groins which minimizes the sediment transport within the nourishment area. The life of the project is anticipated to decrease with increasing storm events.

4.5.2. Construction Costs

The total preliminary opinion of probable costs for this alternative is expected to be **$5,593,000**. A large majority of the costs is the construction of the T-groins (Table IV.3). The costs of sand could be reduced by approximately **$600,000** if the material generated from the dredging of the Mashes Sands boat ramp and Sunrise canals (Section 4.6) is used to meet the required beach fill volume rather than using an upland borrow area.

4.5.3. Benefits

The benefits of this alternative include increasing the size of the recreational beach and storm capacity of the beach. Including T-groins in the project design will reduce the loss of beach fill within the footprint of the T-groin structures thereby reducing the re-nourishment intervals.

4.5.4. Discussion

Based on a preliminary review of this proposed alternative, it was indicated by DEP, Bureau of Beaches and Coastal Systems staff that this alternative would not likely to be funded through the Department’s Beach Management Funding Assistance Program due to the high initial costs and the permitting process to obtain all authorizations would be long due to the potential adverse impacts the structures may have to the beach and dune system.

4.6. SEDIMENT INFILLING OF THE BOAT LAUNCH AND SUNRISE CANALS

Sediment infilling of the Mashes Sands boat ramp canal navigational channel and the nearby Sunrise Canal has been occurring for several years. A shoal, located at the entrances of the canals, encroaches into the waterway causing Wakulla County to periodically dredge the navigational channel in order to maintain navigability. Based on conversations with Wakulla County staff and research of previously issued permits, the Sunrise Canal does not appear to have been dredged since the original creation of the canal system.

4.6.1. Description of Historic Coastal Processes

The direction of the shoaling indicates that sediment is predominately transported from the east to the west and is being deposited within the mouth of the canal entrances. Modeling results from the M2D numerical model (Section 2.0.) also support that the dominant sediment transport direction in the vicinity of Monument 1A is from east to west. Construction of a terminal groin in 2007 located to the east of the boat ramp canal appears to have reduced the shoaling rate in the canal entrance by impounding sediment along the updrift (east) side of the structure. The canal has not been dredged since the construction of the terminal groin, but it appears that the groin may be having an influence on the coastal processes along this shoreline segment.

The construction of the terminal groin does not appear to be the immediate cause of the erosion along the southern end of the peninsula located between the Sunrise and the Boat Ramp canals. Based on a review of historic aerials, it appears the erosion along the peninsula and the canal shoaling has been occurring prior to 2007. However, the existing public fishing pier and the shoreline to the east of the canal (with erosion resistant underlying "peat" layer) may have a greater influence on these incipient waves. These features may have caused the wave rays from the east to diffract around the pier and refract along the shoreline. This has the potential of focusing waves toward the southern end of the peninsula, eroding the shoreline, and depositing this sand in the Sunrise Canal. The sand eroded from the peninsula appears to be similar in physical characteristics as the sand deposited into the Sunrise Canal which would support this assessment.

The combination of the "pre-groin" shoreline refracting waves, episodic storm events transporting sand toward the canal and small tidal flows within the canals that are not sufficient to scour sand are the likely causes of the canal shoaling. As shown in the 2007 aerial, the entrance to the Boat Ramp Canal and to the eastern shoreline of the Sunrise Canal have narrowed in width and water depths have decreased (Figure 4-7), further hindering safe navigation of the canals.

4.6.2. Recommendations

It is recommended that maintenance dredging of the boat ramp canal continue in order to maintain adequate waterway width and water depths to provide for safe navigation to the Ochlockonee Bay. Dredging of the Sunrise Canal is also recommended to re-open the canal to boat traffic. A new permit for the dredging and disposal of the dredge spoil from Sunrise Canal will be required to be applied for and obtained from the Florida Department of Environmental Protection and the U.S. Army Corps of Engineers. The dredged material from both of these canals should be stockpiled on-site for potential use as a source of beach fill material for the proposed alternatives described in this section. If the sand will be placed along Mashes Sands Park located at the end of Mashes Sands Road, either a Coastal Construction Control Line permit or Joint Coastal Permit will be required. It is also recommended that detailed modeling effort be conducted to further refine the theory presented above.

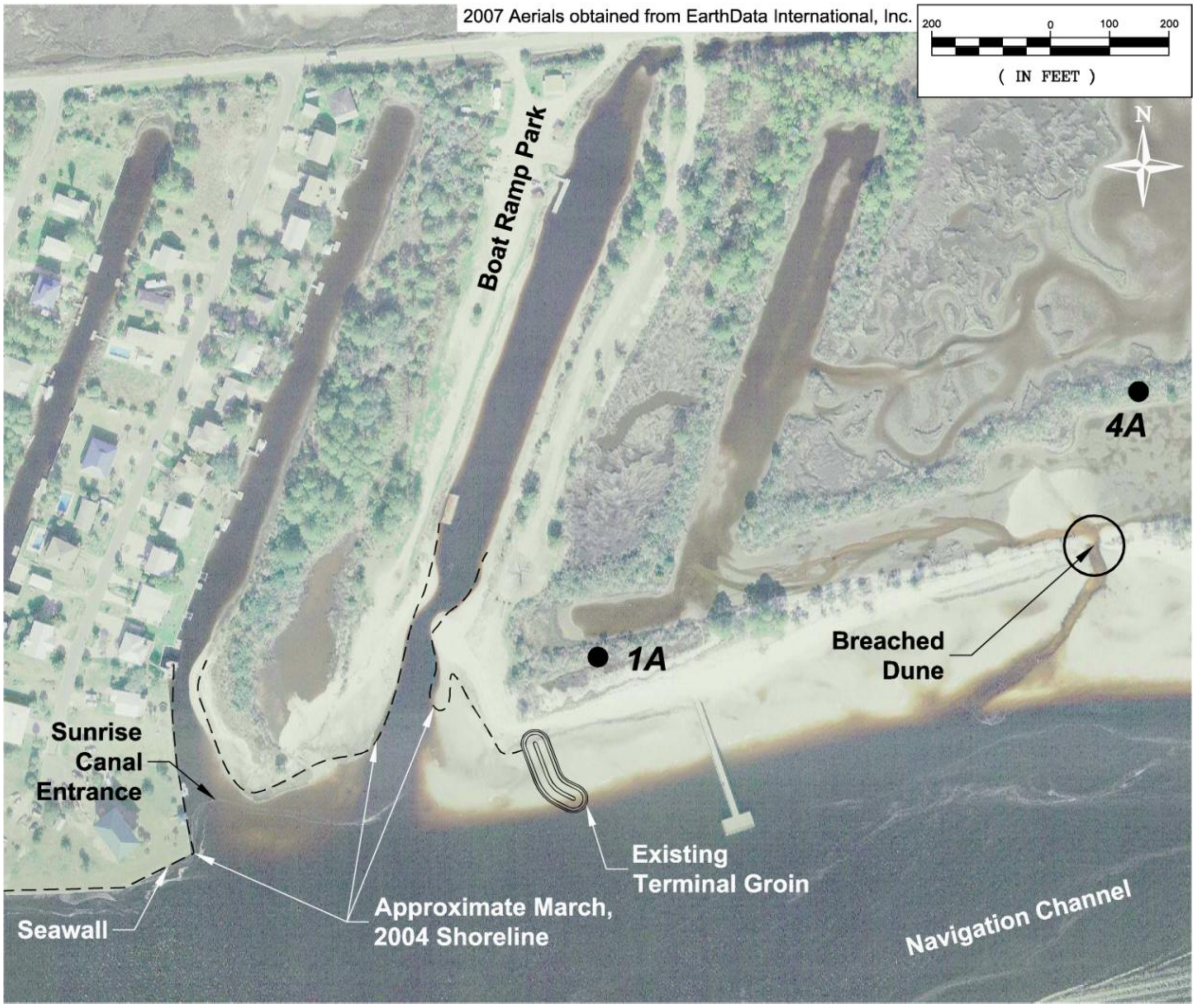


Figure 4-7. Location map for the Mashes Sands Boat Ramp Canal and Sunrise Canal

4.7. SUMMARY OF DESIGN ALTERNATIVES

Table 4.1 summarizes the design Alternatives 1 through 4 with the associated costs, advantages and disadvantages of each alternative for the Mashes Sands.

Table 4.1. Summary of costs, advantages, and disadvantages for the four (4) design alternatives

Alternative Description	Advantages	Disadvantages
1. No Action • The No Action alternative does not implement any new changes to what is currently occurring	• No initial capital outlay.	• No storm protection provided to upland infrastructure. • Shoreline will continue to recede unabated. • Increased costs to infrastructure as the shoreline continues to retreat landward. • Overwashing will continue unabated.
2. Beach and Dune Restoration • Place approximately 130,000 yds^3 of beach compatible sand trucked in from upland source. • Add dune feature constructed to +14 feet, NAVD 1988. • Create a 95,000 ft^2 (2.18 acre) mitigation area. • Remove 267 yds^3 of rubble and debris. • Estimated initial cost of $7,302,000.	• Immediately provides storm protection for up to a 20+ year storm event. • Provides an increased recreational beach for beach users and additional wildlife habitat. • Mitigates for erosive trends along the "critically eroded" shoreline. • Should be eligible for State cost-sharing funds. • Re-nourishment in 12 to 15 years – storm dependent.	• Beach fill will be susceptible to flanking causing sediment to be overwashed into nearby wetlands. • Large end losses of beach fill are expected due to fill perturbation and relative short project length. • Creation of large dune will require expensive crossovers leaving limited access to beach. • Large volume of sand required to construct project with an unknown borrow source. • Costly mitigation ($1.5 million) of sea grass impacts will be required. • May not be eligible to receive State cost-sharing funds or be permittable due to sea grass impacts.
3. Beach Fill with Terminal Groin • Place approximately 30,000 yds^3 of beach compatible sand trucked in from upland source. • 100-foot groin, 2,400 tons of stone. • Create a 95,000 ft^2 (2.18 acre) mitigation area. • Remove 267 yds^3 of rubble and debris. • Estimated initial cost of $2,376,500.	• Increases the size of the recreational beach. • Immediately provides storm protection for up to a 20-year storm event. • Mitigates for erosion along the shoreline between Monument 4A and 7A. • Minimizes the impacts to sea grass beds to be buried by equilibrating and spreading beach fill. • Should be eligible for State cost-sharing funds. • May obtain permits in less than 2-years. • Re-nourishment in 13 to 15 years – storm dependent.	• The overwashing of the uplands will continue due to the high storm surge and low topography. • Small impact to sea grass beds from the equilibrating and spreading of the beach fill. • Mitigation of sea grass impacts will be required and estimated to cost approximately $22,500.
4. Beach Fill with "T-Groins" • Construct ten (10)" T-Groin" structures consisting of 15,000 tons of stone. • Place approximately 30,000 yds^3 of beach compatible sand from an upland source. • Remove 267 yds^3 of rubble and debris. • Estimated initial cost of $5,593,000.	• Increases the size of the recreational beach. • Minimizes the potential impacts to sea grass beds to be buried by equilibrating and spreading beach fill. • Beach fill and structures increase the level of storm protection to uplands and infrastructure. • Structures will retain beach fill while allowing the bypassing of sand around the structures thereby minimizing "down-drift" impacts. • Re-nourishment in 10 to 12 years – storm dependent.	• Lower level of storm protection provided compared to Alternatives 2 and 3. • Overwashing of the uplands will continue due to the high storm surge and low topography. • Large initial costs due to amount of stone. • Unlikely to receive State cost-sharing due to high initial costs. • May take 2 to 3 years to receive permits.

Section IV

Supplemental Tables

- First Preliminary Opinion of Probable Costs

Table IV.1. Preliminary opinion of probable costs [1] for Alternative 2: Beach and Dune Restoration.

ITEM NUMBER	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1.	Design, Permitting and Construction Phase Services	1	Lump Sum	$500,000	$500,000
2.	Mobilization/Demobilization	1	Lump Sum	$100,000	$100,000
3.	Beach Fill – Truck Haul	130,000	Cubic Yards	$35.00	$4,550,000
4.	Debris Removal	267	Cubic Yards	$30.00	$8,000
5.	Sea grass Mitigation (5:1)	95,000	Square Feet	$15.00	$1,425,000
6.	Sea oats Installation	55,000	Plants	$1.00	$55,000
				SUB-TOTAL	$6,638,000
				10% CONTINGENCY	$664,000
				FIRST PRELIMINARY OPINION OF PROBABLE COSTS	**$7,302,000**

Table IV.2. Preliminary opinion of probable costs [1] for Alternative 3: Beach Fill with Terminal Groin

ITEM NUMBER	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1.	Design, Permitting and Construction Phase Services	1	Lump Sum	$500,000	$500,000
2.	Mobilization/Demobilization	1	Lump Sum	$100,000	$100,000
3.	Beach Fill – Truck Haul	30,000	Cubic Yards	$35.00	$1,050,000
4.	Terminal Groin	2,400	Tons	$200.00	$480,000
5.	Debris Removal	267	Cubic Yards	$30.00	$8,000
6.	Sea grass Mitigation	1,500	Square Feet	$15.00	$22,500
				SUB-TOTAL	$2,160,500
				10% CONTINGENCY	$216,000
				FIRST PRELIMINARY OPINION OF PROBABLE COSTS	**$2,376,500**

Table IV.3. Preliminary opinion of probable costs [(1)] for Alternative 4: Beach Fill with T-Groins.

ITEM NUMBER	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1.	Design, Permitting and Construction Phase Services	1	Lump Sum	$750,000	$750,000
2.	Mobilization/Demobilization	1	Lump Sum	$250,000	$250,000
3.	Beach Fill - Truck Haul	30,000	Cubic Yards	$35.00	$1,050,000
4.	Ten (10) T-Groins	15,000	Tons	$200.00	$3,000,000
5.	Composite Sheet-pile Trunk	500	Feet	$50.00	$25,000
6.	Debris Removal	267	Cubic Yards	$30.00	$8,000
				SUB-TOTAL	$5,083,000
				10% CONTINGENCY	$510,000
				FIRST PRELIMINARY OPINION OF PROBABLE COSTS	**$5,593,000**

NOTES:

(1.) The estimated materials and unit costs represent MRD Associates, Inc. best judgment as a professional design firm familiar with the type of construction. MRD Associates, Inc. has no control over the availability or cost of fuel, labor, equipment or materials, or over market conditions or the Contractor's method pricing. Accordingly, MRD Associates, Inc. makes no warranty, express or implied, that the actual bids or negotiated prices will not vary from this Preliminary Opinion of Probable Costs.

5.0. PUBLIC BEACH ACCESS

5.1. OVERVIEW OF PUBLIC BEACH ACCESS

The quality and quantity of public beach access along Mashes Sands will have a direct effect on the amount of state matching funds the local government can receive from the Florida Department of Environmental Protection (DEP) through the Bureau of Beach and Coastal Systems, Beach Erosion Control Program. Chapter 62B-36, Florida Administrative Code (FAC) Beach Management Funding Assistance Program will be used by DEP staff as a basis to evaluate the public beach access on Mashes Sands. Under Chapter 62B-36.002, a

> *(11) "Public Beach Access" is an entry zone adjacent to a sandy beach under public ownership or control which is specifically used for providing access to the beach for the general public. The access must be signed, maintained and clearly visible from the adjacent roadway. The types of public beach access sites are:*
> *(a) "Primary Beach Access" is a site with at least 100 public parking spaces and public restrooms.*
> *(b) "Secondary Beach Access" is a site that may have parking and amenities, but does not qualify as a primary beach access.*

This section will:

1) Inventory existing public beach access facilities;
2) Prepare maps to illustrate the location, parking and shoreline length;
3) Determine State cost-share percentages eligible under existing State rules; and,
4) Identify ways to increase public access and thereby increase the amount of State funds the local government would be eligible to receive.

5.2. EXISTING PUBLIC BEACH ACCESS INVENTORY AND CLASSIFICATION

Field visits were conducted in August 2007 by MRD Associates, Inc. to inventory existing public beach accesses, existing parking capacity, and potential areas to increase parking facilities along Mashes Sands.

There are two (2) "Secondary Accesses" at Mashes Sands for a total of 4,280 feet of "Eligible" shoreline (Figure 5-1). Each beach access has 50+ parking spaces. The total project length is 1,600 feet (0.3 miles).

5.3. ACCESSIBLE SHORELINE AND COST-SHARE PERCENTAGES

Under Chapter 62B-36.007,(FAC),

(1) The Department will cost share up to 50% of the non-federal share of projects subject to adjustment for the level of public accessibility calculated using the following criteria:
(a) Primary beach access sites shall be granted eligibility for one-half mile in each shore-parallel direction from the access site plus the shoreline length of the access site.
(b) Public lodging establishments shall be granted eligibility based upon the percentage of units available to the public, rounded to the nearest 10%, times the property's beachfront footage.
(c) Secondary beach access sites shall be granted eligibility for the shoreline length of the access site. Additional eligibility shall be granted for up to one-quarter mile in each shore parallel direction at a rate of 52.8 linear feet per parking space, provided:
1. Parking is located within ¼ mile of the secondary beach access site; and,
2. Parking is clearly signed or otherwise clearly designated as parking for the general public on an equal basis.

In August 1984 the Mashes Sands property was purchased by the State of Florida and the Board of Trustees from McMillan Realty. The subject property was purchased through the "Save Our Coast Program" and in 1985, the property was subleased to Wakulla County for the "*development, operation and maintenance ... for public recreational uses*". As the upland landowner, the State of Florida **<u>may pay for up to 100%</u>** of design, permitting and construction of an erosion control project. The State may not pay for the maintenance dredging of the Mashes Sands Boat Ramp canal, but may pay for the transport and placement of the dredged beach compatible sand along the beach.

At a minimum, the sum of the eligible shoreline lengths, as defined above, is divided by the total project length to determine the percentage of the total project that is eligible for cost sharing. The State may only cost share for project shoreline that is designated as "critically eroding" and along Mashes Sands the total project length is 1,600 feet (0.3 miles) of shoreline. Based on existing beach access and parking, the **<u>minimum</u> State cost share is 50% and the County cost share is 50%, but because the State of Florida is the upland owner, the State <u>may</u> pay for up to 100% of an erosion control project.**

5.4. APPROACH TO INCREASE PUBLIC BEACH ACCESS PARKING

No additional beach accesses or parking is required.

5.5. DISCUSSION AND RECOMMENDATIONS

Although no additional beach accesses or parking is required, a public restroom located at the east end of Mashes Sands Road within the County Park is suggested.

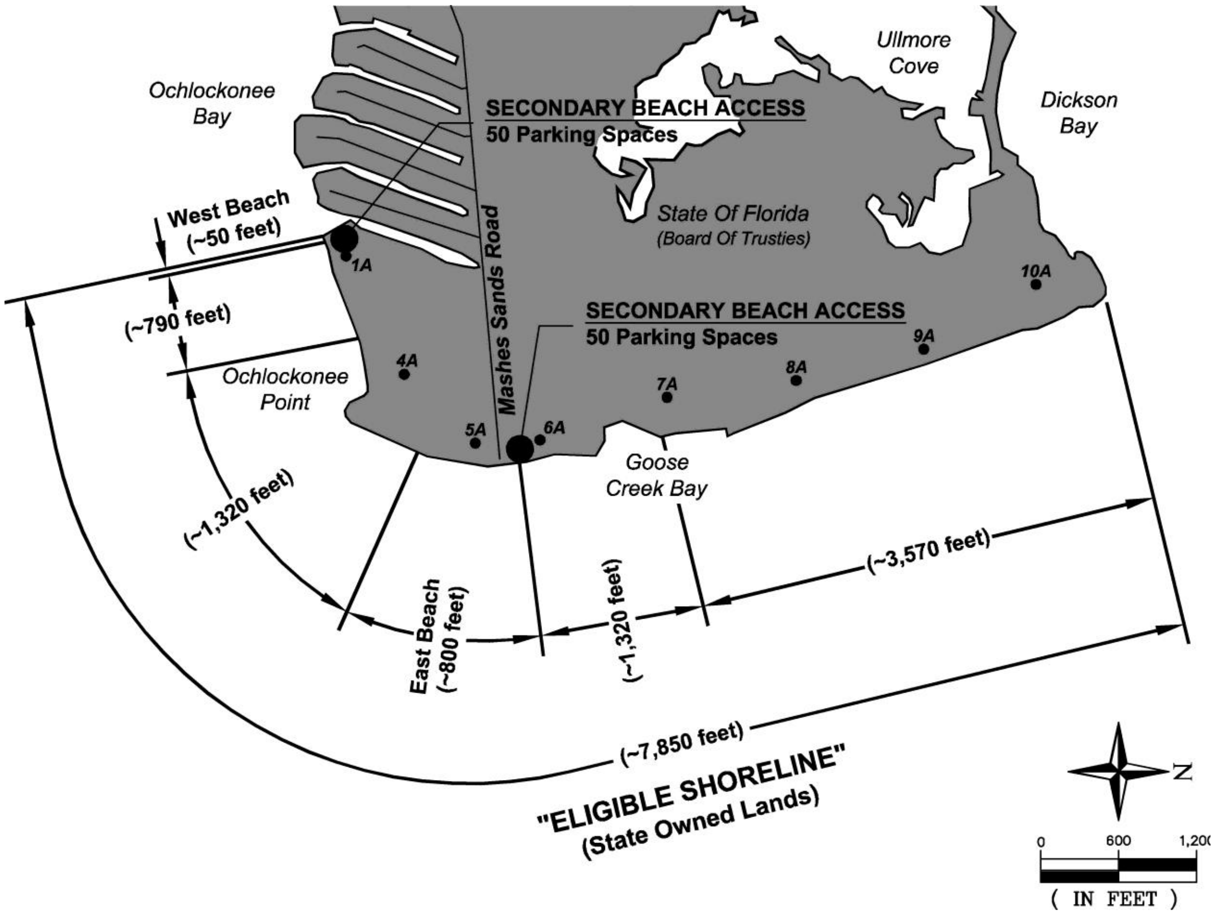


Figure 5-1. Beach access and parking, and eligible shoreline, Mashes Sands, Wakulla County, Florida

6.0. FUNDING OPTIONS

6.1. OVERVIEW OF FUNDING STRATEGY

This section evaluates potential Federal, State and Local funding options for an initial and long-term maintenance of an erosion control project. For each funding option, this section will:

- Briefly describe the option; and,
- Assess the advantages and disadvantages of the funding source.

The recommended short- and long-term funding strategy are found in Section 7.0. - Recommendations. The recommendation was developed based on the evaluation contained in this section, guidance provided by Wakulla County and the community's objectives for the identified problems. There are number of potential funding sources, however, the following options are considered as the most appropriate to fund a "locally" preferred project.

6.2. FEDERAL FUNDING OPTIONS

The U.S. Army Corps of Engineers (USACE) is the primary Federal entity responsible for the restoration and maintenance of erosion control projects in the United States. The USACE's authority to assist local communities with erosion control projects is provided by the Water Resources Development Act (WRDA), a Federal statute re-enacted about every two years - although these timeframes do vary. Through this law, Congress can grant the USACE the legal and budgetary authority to assist States and Local communities combating coastal erosion. Federal funds to support projects authorized under WRDA are appropriated annually through the Energy and Water Development Appropriations Act.

Under WRDA, Congressional authorization for an erosion control project can take two forms:

1) First, Congress can specifically direct the USACE to study, design, or construct a particular project by name and establish a dedicated funding stream for the project. These are often referred to as an "Individual Project Authorizations." This type of funding option may not be appropriate for this project and thus a further description is not provided in this investigation.

2) Second, Congress has granted the USACE general authority to investigate and construct certain kinds of small, one-time projects that fall within specific categories and budget limits. This general authorization program is called the USACE's Continuing Authorities Program (CAP). There are nine separate and distinct CAP authorizations that empower the USACE to assist communities with a variety of water resource related problems. However, only three of the nine CAP authorities are most appropriate for this project and are described and evaluated below.

Within limits established by Congress, the USACE is authorized to plan, design, and construct certain types of water resource improvement projects (including beach nourishment and shoreline protection projects) without first obtaining an individual project authorization. Known as the "Continuing Authorities Program" or CAP, this small projects program allows the USACE, in partnership with local communities, to move quickly to address flooding, erosion, or navigation problems. In general, CAP projects are small scale, one-time projects that constitute a complete solution to the problem.

Each CAP has its own eligibility requirements and funding limits. For all categories of CAP projects, the local project partner (typically a local governmental entity) must share in the cost of the project to some extent. The local share ranges from 20% to 35% of the total project costs, depending on the type of project. However, it should be noted that State funds (described in Section 6.3) may be, in part, used to cost share along with the local government to provide a portion of the required local "non-Federal" match. For example, if a project was authorized and funded by Congress at a Federal share of 65%, the remaining 35% "non-Federal" share could be split between the State of Florida and the local sponsor. If it was determined the State share would be 50% and the Local share would be 50% under the Beach Management Funding Assistance Program described in Section 6.3.1, then the State of Florida and the local government would each pay 17.5% of the "non-Federal" share of the Federal project.

The following are the Continuing Authorities Programs that are most appropriate for this project:

Section 205, Small Flood Control Projects. (Flood Control Act of 1948, as amended). Under this section, small flood control projects may be constructed if the USACE Chief of Engineers determines that the work is advisable and the project cost does not exceed $5 million. Local flood control projects may include the construction or improvement of levees, channels, or dams. Non-structural alternatives may also be considered and include installation of flood warning systems, raising and/or flood-proofing structures, and relocating flood-prone structures.

Section 14, Emergency Stream-bank and Shoreline Protection Projects (Flood Control Act of 1946, as amended). Under this section, the USACE may spend up to $1 million in one locality during any fiscal year for the construction, repair, restoration and modification of emergency stream-bank and shoreline protection works. Typically, work under this section is intended to prevent erosion damage to highways, bridge approaches, public works, as well as churches, hospitals, schools, and other non-profit services endangered by erosion.

Section 103, Small Beach Erosion Control Projects (River and Harbor Act of 1962, as amended). Under this authority, the USACE can spend up to $3 million for projects to protect or restore a public shoreline or beach. Typical projects include construction of revetments, groins, and jetties, or periodic sand replenishment. Large-scale beach restoration projects requiring frequent re-nourishment are not eligible under this section.

The advantages, disadvantages, and potential revenues from the Continuing Authorization Program are summarized in Table 6.1.

6.3. STATE OF FLORIDA FUNDING OPTIONS

The State of Florida has been a national leader in the restoration and maintenance of sandy beaches for more than three decades. Through the Beach Management Funding Assistance Program (described below) the state has established an effective program to assist local communities in the design, construction, and maintenance of beach and dune restoration projects and coastal structures. The Florida Beach Management Funding Assistance Program, administered by DEP, is likely to be the primary funding source for the restoration and maintenance of a shore protection project. This section will also examine the potential of requesting funds through a legislative appropriation request.

6.3.1. State of Florida Beach Management Funding Assistance Program

As presented in Section 5.0., in August 1984 the Mashes Sands property was purchased by the State of Florida and the Board of Trustees from McMillan Realty. The subject property was purchased through the "Save Our Coast Program" and in 1985, the property was subleased to Wakulla County for the "*development, operation and maintenance ... for public recreational uses*". As the upland landowner, the State of Florida may pay for up to 100% of design, permitting and construction of an erosion control project. The State may not pay for the maintenance dredging of the Mashes Sands Boat Ramp canal, but may pay for the transport and placement of the dredge spoil along the beach.

Annual requests for financial assistance under the Beach Management Funding Assistance Program is required to be submitted to DEP, Bureau of Beaches and Coastal Systems in August in order to be considered in *"DEP's Fixed Capital Outlay Legislative Budget Request".* DEP is the "parent" State agency and the Governor and Cabinet acting as the "Board" sits as the head of DEP and is authorized to make payments from the Beach Management Funding Assistance Program. Projects which typically qualify include:

(a) Beach restoration/nourishment;
(b) Jetties, groins, breakwaters, revetments;
(c) Dune construction and vegetation;
(d) Sand source studies;
(e) Design, permitting, bidding and construction observation services; and,
(f) Biological and physical monitoring studies.

DEP compiles the applications and submits a prioritized list of recommended projects to the Board. Once the Board has reviewed and approves the prioritized list of grant applications, DEP forwards the list to the Legislature as a request for funding appropriations. If the Legislature funds a project, funds can become available by the July following the legislation appropriation.

The advantages, disadvantages, and potential revenues from the Florida Beach Management Funding Assistance Program are summarized in Table 6.2.

6.3.2. State of Florida - Legislative Appropriation

A local government may request State funds through the annual legislative appropriations process. A Legislator sponsors a bill, which is referred to one or more committees related to the subject of the bill. If the request passes through all the appropriate Committee hearings, the bill presented to the full house where it passes or fails. The appropriation request must be passed by both the House and Senate before it is placed in the proposed budget to be considered by the Governor. The appropriation may be included in the final budget and funded, or eliminated from the budget through the Governor's "Line Item Veto" authority.

The advantages, disadvantages, and potential revenues from a State of Florida Legislative Appropriation are summarized in Table 6.2.

6.4. LOCAL FUNDING OPTIONS

Federal financial assistance programs for erosion control projects require Local communities to share in the cost of the project. Because the upland property is owned by the State of Florida and managed by Wakulla County, 100% of the "non-Federal" share may be borne by the State of Florida. However, if a local match is required for an erosion control project, the following three (3) options may be the most appropriate for Mashes Sands:

6.4.1. Tourist Development Tax

The Florida Statutes (F.S. 125.0104) authorizes a County to collect a tourist development tax commonly referred to as a "bed tax" and is collected as a percent of rental fees paid for a hotel/motel room or similar rental property typically used by tourists. The tax is remitted to the County. Under Florida Statutes 125.0104, such tax money may be employed "*to finance beach improvement, maintenance, re-nourishment, restoration, and erosion control including shoreline protection.*" In 1994, the Wakulla County Board of Commissioners adopted Ordinance 94-46 to establish the "*Tourist Development Tax*". The Wakulla County Tourist Development Council administers the program and collects 4% of each dollar of the total consideration charged for the rent or lease of short term "transient lodging sales" for a term of six (6) months or less. According to the Wakulla County Budget Department, in FY06/07 $33,677 was collected with expenditures of $20,282, and in FY07/08 $57,863 was collected with expenditures of $99,652.

The advantages, disadvantages, and potential revenues from a Tourist Development Tax are summarized in Table 6.3.

6.4.2. General Funds - Property (ad valorem) Taxes

The local government has the option to use General Funds generated from ad valorem property taxes to provide the local cost share. Approval to generate and allocate General Funds for these projects goes through the County's annual budget process. Property taxes (ad valorem tax) relies upon the fair market value of the property being taxed, The property tax rate is often the amount of tax per thousand currency units of property value, which is also known as a millage rate or mill levy. A mill is also one-thousandth of a dollar. This method of generating revenue is well founded by State law and allows for property owners and public entities to pay for a variety of project costs.

The advantages, disadvantages, and potential revenues from General Funds are summarized in Table 6.3.

6.4.3. Special Assessment – Municipal Services Benefit Unit

Property owners in the project area have the ability to petition the County Commission to create a Municipal Service Benefit Unit (MSBU) to meet special local needs and create a long-term revenue stream. Under this program, the property owners are assessed the costs of the desired services. MSBU have historically been established to fund the construction of more conventional improvements such as street lighting and roadways but also may fund the construction of erosion control projects. The bonds or debt would then be retired over time using the generated revenue.

Pursuant to Florida Statute Chapter 125.01(1)(q), a County is authorized to:

> *Establish, and subsequently merge or abolish those created hereunder, municipal service taxing or benefit units for any part or all of the unincorporated area of the county, within which may be provided fire protection; law enforcement; <u>beach erosion control</u>; recreation service and facilities … and other essential facilities and municipal services from funds derived from service charges, special assessments, or taxes within such unit only. [Emphasis added].*

Subsection (r) of the statute provides, in part, that a County may:

> *"Levy and collect taxes, both for county purposes and for the providing of municipal services within any municipal service taxing unit, and <u>special assessments</u> . . . which power shall be exercised in such manner, and subject to such limitations, as may be provided by general law."*

There are four general characteristics important to an MSBU:

1) An MSBU is created and managed by the Board of County Commissioners. A public referendum can be used to create an MSBU, but such an approach is not required;

2) The boundaries of a municipal service benefit unit may include all or part of the boundaries of a county or municipality;

3) The special assessment made within the MSBU boundary need not be uniform but must be reasonably and fairly related to the benefit that accrues to the property from the project constructed or the service provided; and,

4) The County has broad discretion in identifying the special benefits of a project and in developing a methodology to apportion the benefits (and thus the costs) among the properties in the MSBU.

Over the years, the Florida Attorney General(s) has issued a number of Advisory Legal Opinions on the creation and administration of MSBUs. The Attorney General has explained that a special assessment is an enforceable contribution from the property owner imposed on the property assessed derives a special or peculiar benefit.

The advantages, disadvantages, and potential revenues from a Municipal Services Benefit Unit are summarized in Table 6.3.

Table 6.1. Summary of advantages, disadvantages and potential revenues of Federal funding options.

Funding Option Description	**Advantages**	**Disadvantages**	**Potential Revenues**
Individual Project Authorization Under WRDA	1) Reduce Local and State cost share contribution. 2) Provide long-term financial stability for the project - 50 year life. 3) Provide Federal funds to rebuild or repair the project to the original design following a storm event. 4) Increase the potential for State funding.	1) Can take as long as 5-10 years and requires careful attention to the Federal Legislative process. 2) The Federal project planning process is cumbersome and can be complex. The Local Sponsor would need to commit the resources necessary to move through the project authorization process. 3) If authorized through Congress, the Local Sponsor could lose some autonomy and control over the project – particularly in the project schedule and timing.	The Local Sponsor and State splitting the non-federal share equally, pre-construction cost share at 50% Federal, 25% State, 25% Local, then construction costs would be divided as follows: up to - 65% Federal 17.5% State 17.5% Local Then 50% Federal for periodic re-nourishment over the 50-year economic life of the project. However, these numbers may vary based on the cost-sharing agreement enacted for the project.
General Project Authorizations - Continuing Authorities Program (CAP)	1) Faster than addressing water resource problems through an individual project authorization from Congress. 2) Increase the potential for State funding.	1) Funding under the CAP program is limited. 2) Requires 12-24 months before a project is accepted for funding. 3) The project must be complete and not commit the USACE to further construction and/or maintenance. 4) An Environmental Assessment - coordination with Federal, State and Local agencies, and the public. 5) For controversial projects, a full Environmental Impact Statement may be required. 6) The Local Sponsor for the project must be financially able to assist with the project. 7) Most projects, once constructed, must be operated and maintained by the local sponsor.	1) Section 205, Small Flood Control Projects - project cost does not exceed $5 million. 2) Section 14, Emergency Stream-bank and Shore Protection Projects - total Federal contribution of $1 million in one locality per fiscal year. 3) Section 103, Small Beach Erosion Control Projects - total budget must not exceed $4.6 million of which $3 million is Federal and $1.6 million (35%) is the State/Local share.

Table 6.2. Summary of advantages, disadvantages and potential revenues of State of Florida funding options.

Funding Option Description	Advantages	Disadvantages	Potential Revenues
State of Florida – Beach Management Funding Assistance Program	1) May provide the Local Government with up to 50% of any non-Federal costs for the project or 100% of the project costs if the uplands are owned by the State of Florida. 2) Would cover 50% of the project costs within the "critically eroding" shoreline segment. 3) Provide a potential long-term funding source to maintain the project.	1) The Local Government would need to provide adequate public beach access and parking to meet DEP's standards. 2) Specific project timelines geared to the state budget process. 3) Development of and local commitment to a ten-year budget plan and implementation strategy for the initial construction and future maintenance. 4) Only cost shares for a project within a DEP designated "critically eroding" shoreline.	Provided that adequate public beach access requirements are met, the Local Government and the State (DEP) may equally share in the project costs as follows: 50.0% State 50.0% Local over the 50-year economic life of the project or 100% of the project costs if the uplands are owned by the State of Florida. If the project was authorized and funded by Congress, the State/Local share would apply to the "Non-Federal" share.
State of Florida - Legislative Appropriations	1) Greater flexibility in the percentage of contribution between the State and Local government. 2) If the entire or portion of the locally preferred project does not qualify for Beach Erosion Control Program Funds, a Legislative appropriation would provide a mechanism for State contribution to the project. 3) Obtaining approval of State funding may be faster than through the Beach Erosion Control Program.	1) The State legislative process is cumbersome and can be difficult. 2) The Local Government would need to commit the resources necessary to move the bill through the Legislative process. 3) Numerous "readings" and Committee Hearings and maybe "killed" at any level of the process. 4) Even if passed by the House and Senate, the project may be vetoed by the Governor.	May provide up to 100% of the total cost of the project.

Table 6.3. Summary of advantages, disadvantages and potential revenues of Local funding options.

Funding Option Description	**Advantages**	**Disadvantages**	**Potential Revenues**
Tourist Development Tax	1) The "Tourist Development Tax" is in-place and collecting revenue. 2) All or a portion of the project may be contributed by non-residents. 3) A bed tax can be imposed on hotel/motel, campgrounds, and short-term rentals.	The revenues of approximately $60,000 per year appear to be allocated at the maximum rate.	According to the Wakulla County Budget Department, approximately $60,000 at 4% was generated by the Tourist Development Tax.
General Funds (ad valorem)	1) Provide a potential long-term funding source to construct and maintain the project. 2) A uniform ad valorem tax not to exceed 1 million per year to defray organizational and administrative costs of the district. 3) A district may levy a tax upon each taxable property in proportion to benefits received as determined by an economic benefit analysis.	1) Must proceed through the annual budget process to fund the design, permitting, construction and monitoring phases. 2) Ad valorem taxes are generated across the County. Many property owners may not use the beaches. 3) Public hearings by the Board of County Commissioners are required. 4) May go through intense public scrutiny.	Provide up to 100% of the <u>local</u> total cost for the project over the 50-year economic life of the project.
Municipal Services Benefit Unit - (MSBU)	1) The use of an MSBU is a lawful means to raise local funds and has been successfully employed in other Florida coastal communities. 2) This option alone has the potential to generate sufficient revenue needed for a project. 3) An MSBU is a flexible option that provides the Local Government with wide discretion to tailor this funding mechanism to meet the specific facts and circumstances along the project shoreline.	1) This option may be complex and time consuming to implement. 2) The County will be required to establish an MSBU boundary, assess the project benefits, fairly and equitably apportion costs among the beneficiaries, and adopt an ordinance establishing the MSBU. 3) The County may chose to require a petition or referendum to be conducted before the MSBU is established. This process could require more than a year to complete.	Provide up to 100% of the <u>local</u> total cost for the project over the 50-year economic life of the project.

7.0. RECOMMENDATIONS

As described in Section 1.1, the objective of this study is to develop a feasibility study and beach management plan for this section of shoreline identified in the "*Strategic Beach Management Plan*" as the Mashes Sands County Park. This study includes the formulation of alternative designs and implementation strategies. The information included in this document is intended to provide the Wakulla County Board of County Commissioners (BCC) guidance to implement a beach management program that considers public input, is cost-effective, and is based on best engineering practice.

7.1. VIABLE ALTERNATIVES

Four (4) design alternatives were identified and evaluated. Those alternatives are ranked in order of viability to meet the goals of the investigation:

1) Alternative 3 – Beach Restoration with Terminal Groin;
2) Alternative 1 – No New Action;
3) Alternative 2 – Beach and Dune Restoration, and;
4) Alternative 4 – Beach Restoration with T-Groins.

7.2. RECOMMENDATIONS

Based on the findings of this investigation, input and discussions with DEP staff and the presentation made before the Wakulla County BCC, it is recommended the Wakulla BCC advance Alternative 3 – Beach Restoration with Terminal Groin. The County should apply to the Bureau of Beaches and Coastal Systems for Erosion Control Program funding on an annual basis which is due by August of every year.

This alternative increases the beach's storm capacity as well as mitigating for historic erosion trends. The existing beach would be widened by 100 feet along the 1,800 foot shoreline to enhance the recreational appeal of the Mashes Sands County Park. The northern terminal groin may be included in the initial project, or constructed in the future after the beach restoration project is constructed and monitored. It is also recommended that all the beach quality sand generated from the dredging of the Mashes Sands boat ramp and Sunrise canals be used as all or a portion of the required beach fill volume for this project.

7.3. FUNDING STRATEGY

For each Funding Strategy option, a general assessment of the funding potential, a general description of the process, and the advantages and disadvantages of each option was provided. Based on this information, the Wakulla County BCC should select those options most appropriate for the project and initiate the actions necessary to develop and implement the options selected. The major partner in implementing the beach management program will be the Department of Environmental Protection, Bureau of Beaches and Coastal Systems through the Beach Management Funding Assistance Program. Because the subject property is State owned, the total cost of the project may be paid for by the State.

8.0. REFERENCES

Balsillie James., and Clark R.R., 1992. *The Gulf Coast of Florida: Overview of Physiography, Geology, and Historical Shoreline Change*. A report of the Florida Department of Natural Resources, Division of Beaches and Shores.19p.

Biological Research Associates, 2007. *Mashes Sands Aquatic Habitat Assessment, Gulf County*.

Clark, R.R., and LaGrone, James. 2006. *A Comparative Analysis of Hurricane Dennis and Other Recent Hurricanes on the Coastal Communities or Northwest Florida*.

Clark, R.R.. 1991. *Discussion and Recommendations to Solve Beach Erosion Conditions at Mashes Sands, Wakulla County, Florida*, Florida Department of Natural Resources, Division of Bbeach and Shores.

Clark, R.R. 1986. *Hurricane Kate*, November 15-23, 1985 Florida Department of Natural Resources, Division of Beaches and Shores, Post-storm Report 86-1,114p.

Dean, R.G. and Chui, T.Y., 1983. *Combined total storm tide frequency analysis for Franklin County, Florida.* Submitted to Office of Beaches and Coastal Systems, Florida Department of Environmental Protection, (formally Division of Beaches and Shores, Florida Department of Natural Resources). Submitted by Beaches and Shores Resource Center, Florida State University, Tallahassee, Florida, 71p.

Dean, R.G., Chui, T.Y. and Wang S.Y., 1988. *Evaluation of Storm Tide in Wakulla County, Florida.* Submitted to Office of Beaches and Coastal Systems, Florida Department of Environmental Protection, (formally Division of Beaches and Shores, Florida Department of Natural Resources). Submitted by Beaches and Shores Resource Center, Florida State University, Tallahassee, Florida.

Dean, R.G., and Dalrymple, R.A.,(undated draft). *Coastal processes with emphasis on engineering applications*. Chapters 8-13.

Dean, R.G. and Grant J., 1989. *Development of methodology for thirty year shoreline projections in the vicinity of beach nourishment projects. UFL/COEL-89/026.* Coastal and Oceanographic Engineering Department, University of Florida, Gainesville, Florida, 153p.

FEMA Flood map, 1992. Community Panel Number 120315-0480.

Florida Department of Environmental Protection (DEP), *Beach Erosion Control Assistance Program*, 161.101 et. Seq., Florida Statutes.

Florida Department of Environmental Protection (DEP), *Beach Erosion Control Assistance Program*, Chapter 62-B-36, Florida Administrative Code.

Florida Department of Environmental Protection (DEP), 2008a. *Critically Eroded Beaches in Florida*, Bureau of Beaches and Coastal Systems.

Florida Department of Environmental Protection (DEP), 2008b. *Strategic Beach Management Plan*, Bureau of Beaches and Coastal Systems.

Florida Department of Environmental Protection, 2006. *Hurricane Dennis and Hurricane Katrina Final Report on 2005 Hurricane Season Impacts to Northwest Florida.* Bureau of Beaches and Coastal Systems, 166p.

Florida Department of Environmental Protection (DEP), 2004. *2004 Hurricane Recovery Plan for Florida's Beach and Dune System*. Division of Water Resource Management, Bureau of Beaches and Coastal Systems.

Florida Department of Environmental Protection (DEP), Guidelines - *Florida Beach Erosion Control Program*, February 24, 2000. Office of Beaches and Coastal Systems, Department of Environmental Protection, Tallahassee, Florida.

Florida Department of Natural Resources (DNR), 1987. *Predicted Open Coast Tidal Datums For The Florida Panhandle Gulf Coast*. *Beaches and Shores Special Report No. 87-3*. Division of Environmental Protection, Tallahassee, Florida.

Hallermeier, R.J. 1978. *Uses For A Calculated Limit Depth To Beach Erosion*. Proceedings, 16th Coastal Engineering Conference, American Society of Civil Engineers, 1493-1512.

Hallermeier, R.J.1981. *A Profile Zonation for Seasonal Sand Beaches from Wave Climate*. Coastal Engineering 4, 253-277.

Humiston and Moore, 2002. Letter to Michael Corrigan, DEP Office of Beaches **and** Coastal Systems. Additional Information in Support of Erosion Control Design, Keewaydin Island, DEP File No. 0185549-001-JC.

Kraus, Dr. Nicholas, Larson, Dr. Magnus and Wise, Randall A., 1998. *Coastal, Engineering Technical Note, Depth of Closure in Beach-Fill Design*. U.S. Army Engineer Waterways Experiment Station. Coastal and Hydraulics Laboratory, 13p

Leadon, M.E. et al. 2004. *Hurricane Ivan: Beach and Dune Erosion and Structural Assessment and Post-storm Recovery Plan for the Panhandle Coast of Florida*, Florida Department of Environmental Protection, Bureau of beaches and Coastal Systems, 64p.

Moore, B.D., 1999. *T-groin design and performance as an erosion control alternative at two Florida Gulf Coast Inlets*. Proceedings of the 12th Annual National Conference on Beach Preservation Technology. Florida Shore and Beach Preservation Association, Tallahassee, Florida. pp. 187-203.

MRD Associates, Inc. (MRD) and Preble-Rish, Inc., 2005. *Alligator Point Erosion Control Project, T-Groin Design Document*.

MRD Associates, Inc. and Preble-Rish, Inc., 2006. *Alligator Point Erosion Control Project, Feasibility and Preliminary Design Document.*

National Research Council (NRC), 1995. *Beach Nourishment and Protection*. National Academy Press, Washington, D.C.

National Oceanographic and Atmospheric Administration (NOAA) Nautical Chart 11405 *Apalachee Bay*.

National Ocean and Atmospheric Administration (NOAA), 2008. *Center for Operational Oceanographic Products and Services*. Http://www.co-ops.nos.noaa.gov.

National Ocean Service (NOS), 1998. *GEOphysical Data Systems for Hydrographic Survey Data (GEODAS), Volume 1, Version 4.0.* National Oceanic and Atmospheric Administration, National Geophysical Data Center, Boulder, Colorado.

Preble-Rish, Inc. and Coastal Tech, 2001. *Hurricane evacuation route and beach management, Alligator Point/Bald Point Feasibility and Design Study*.

Silvester, R., 1970. *Development of crenulate shaped bays to equilibrium*. Journal Waterways and Harbors Division, American Society of Civil Engineers. V96(WW2), pp. 275-287.
Silvester, R., and Hsu, J.R.C., 1993. *Coastal Stabilization - Innovative Concepts*. PTR Prentice Hall, Inc.

Smith, J.M., Sherlock, A.R., and D.T. Resio. 2001. *STWAVE: Steady-State Spectral Wave Model User's Manual for STWAVE, Version 3.0. ERDC/CHL SR-01-1*. U.S. Army Corps of Engineers, Engineer Research and Development Center, Coastal and Hydraulics Laboratory.

Tanner, W.F., 1960. *Florida Coastal Classification*, Transactions of the Gulf Coast Association of Geological Societies, Volume 10.

U.S. Army Corps of Engineers (USACE), 2003. *Joint Application for Joint Coastal Permit Authorization to Use Sovereign Submerged Lands*. Alligator Point, Florida - A Shoreline Restoration Project., Mobile, AL.

U.S. Army Corps of Engineers (USACE), April 2002. *Coastal Engineering Manual. EM 1110-2-1100* (Part III). pp. III-2-54.

U.S. Army Corps of Engineers (USACE). 1996. *Coast of Florida Erosion and Storm Effects Study, Region III, Feasibility Report with Final Environmental Impact Statement*.

U.S. Army Corps of Engineers (USACE), *Wave Information Study*, http://frf.usace.army.mil/cgi-bin/wis/atl/atl_main.html, Waterways Experiment Station, Vicksburg, MS.

U.S. Army Corps of Engineers (USACE), 1995. *Engineering and design of beach fills, EM 1110-2-3301*. Department of the Army, Washington, D.C.

U.S. Army Corps of Engineers (USACE), 1989. *SBEACH: Numerical Model for Simulating Storm-Induced Beach Change*, *Report 1*. Washington, D.C., July 1989. 256p., plus appendices.

U.S. Army Corps of Engineers (USACE), 1984. *Shore Protection Manual. Volumes I and II*. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi.

U.S. Army Corps of Engineers (USACE), 1965. *Appraisal Report on Beach Conditions in Florida*.

Wang, R., and Manausa, M., 2005. *Hurricane Ivan Characteristics and Storm Tide Evaluation*, Beaches and Shores Resource center, Florida State University, 11p.

Yon, W. J., Jr., 1966. *Geology of Jefferson County, Florida*, Florida Geological Survey. Bulletin 48.