SANTA ROSA COUNTY, FLORIDA

NAVARRE BEACH
BEACH BERM and DUNE RENOURISHMENT PROJECT
First Scheduled Maintenance

Preliminary
Design Document

June 30, 2011

COASTAL TECH
COASTAL TECHNOLOGY CORPORATION

Sarasota, Vero Beach, Melbourne • Florida
Austin, Galveston • Texas

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1.0 Introduction

1.1 Purpose

The purpose of this document is to summarize results of the preliminary design for the Navarre Beach – Beach and Dune Restoration Project first scheduled maintenance (Project). The maintenance re-nourishment is presently anticipated to occur in the fall and winter of 2013/2014, but the exact timing will depend on desires of the County and stakeholders. Specifically this document describes the preliminary design including:

- fill template alternatives,
- probable cost for each template alternative, and
- geotechnical information for the proposed offshore borrow area.

1.2 Background and History

Navarre Beach is located on Santa Rosa Island, between Federally-owned property that is part of the Gulf Islands National Seashore to the west and [formerly] Navarre Beach State Park and other Federally-owned land that is part of Eglin AFB to the east. The private and commercial development that comprises Navarre Beach has a total Gulf frontage of approximately 18,000 feet (~3.4 miles). The eastern portion of the main Project area also includes the County Park that incorporates the Navarre Pier. The property that was formerly Navarre Beach State Park has now been transferred to the County and is operated as a County park.

Due to significant historical storm events along Navarre Beach, the dune system was compromised, ultimately overtopped, and largely eroded away by 2006. Numerous upland structures were damaged as a result of storms such as Hurricane Ivan (2004) and Hurricane Denis (2005); these storms also damaged public infrastructure including Gulf Boulevard, public beach accesses, parking and utilities. On July 26, 2005, a Joint Coastal Permit was issued by the Florida Department of Environmental Protection (FDEP) to restore Navarre Beach. Subsequently, construction of the Navarre Beach Berm and Beach Restoration Project went from March 2006 to November 2006 where approximately 2,950,000 cubic yards of sand dredged from an offshore borrow area was placed along a total shoreline length of approximately 22,000 feet from FDEP survey reference monument R192+460 to monument R214.

2.0 Originally Constructed Template Performance - Contour Evolution

The originally constructed Project design – as selected by the County and Coastal Tech in 2003 - led to the specification of a dune crest height of elevation +14.5 feet NGVD and a two-tiered beach berm seaward of the dune toe. An upper "storm berm" was designed to be 30 feet wide at elevation +9 feet NGVD. This berm sloped seaward at 10H:1V to a second berm which varied in width along the Project area from 90 to 150 feet wide at elevation +5 feet NGVD. The advanced maintenance volume was incorporated into the +5 berm which was intended to provide a recreational area, a storm buffer to protect the dune, and a means to offset expected future erosion.

The "Core Area" of the Project extends from R204 to R209.5. As noted in the 2002 "Interim Report Navarre Beach Restoration Project" prepared by Coastal Tech: "Since the majority of the alongshore losses are predicted in the Core Area, the fill template reflects placement of the majority of advance nourishment in the Core Area. Advance nourishment in the residential area was decreased, but the average advance maintenance over the entire project length corresponds to the average fill lost as predicted by GENESIS." However, physical monitoring of the previously constructed Project indicates rapid erosion – into the dune feature – occurred in the western portion (R192+460 to R194+250) of the fill area where a truck-haul dune restoration project was constructed in April 2010. Based on this prior performance, the "additional Advanced Fill" Alternative is proposed with advanced fill from R199 to R206.

One method used to assess the performance of the previously constructed Project is to compare the location of key elevation contours as reflected by the pre- and post-construction survey data (2005 and 2006, respectively) and the 3 subsequent annual monitoring surveys (2008, 2009, and 2010). For this analysis, contour change is determined with respect to the post-construction 2006 shoreline position (MHWL) in order to compare the shoreline/contour trends against a common baseline. Based upon plan view plots of the contours, the contour changes (in feet) can be determined – as illustrated in:

- Figure 1 – for the +5ft and +9 ft NGVD contour changes,
- Figure 2 - for the +5ft and MHWL contour changes, and
- Figure 3 - for the +9ft and MHWL contour changes.

In general, these figures compare the *relative* movement of the lower part of the profile to the upper part of the profile. The degree of separation between the contour lines within each plot indicates the characteristic of the profile adjustment – steepening, flattening, or simply translating. The following describes general observations from the contour changes:

- Figure 1 indicates, from 2006 to 2008, the +5ft and +9ft contours realized similar changes resulting in a similar relative position of these contours, which indicates that they are translating in a generally uniform manner between years 2006 and 2008. Over the monitoring period from 2006 to 2009, the relative distance between the +9ft and +5ft contour increases (degree of separation) whereas the profile is steepening as the +5ft contour moved more landward than the +9ft contour). This trend continues as represented from 2006 to 2010, where the separation is similar in magnitude but varied in alongshore pattern/location.
- Figure 2 indicates the +5ft and MHWL contours appear to be retreating at a nearly identical rate – indicating that the shoreline is not steepening but rather equilibrating landward as the original design intended, whereas the degree of separation between the +5ft contour and the MHWL contour lines in Figure 2 is minimal in magnitude. However, the overall *alongshore* evolution of the beach can be seen. For example, at R202 between years 2006 and 2008, there was minimal to no shoreline change at this location. The following year (2009), however, at R202, the shoreline retreated approximately 40 feet with uniform landward recession of the two contours – hence no separation between them on the figure, which also indicates the performance/adjustment of the two Project ends (east & west) is clearly different from the main fill between the ends.

- Figure 3 indicates the +9ft and MHWL contour changes. In general, for the period between 2006 and 2008, all of the profiles within the Project area (R192 to R214) appear to be translating uniformly with minimal degrees of separation with the exception of the outliers west of the Navarre Pier (at R209.5) between R-210 and R-214, as well as at R-198 and R-204. From 2006 to 2009, the degrees of separation increase significantly with greater landward recession of the MHWL - indicating a profile steepening between the +9ft contour and the MHWL contour. This trend continues for the period between 2006 and 2010, in which the magnitude of the separation does not change, however, the evolution alongshore changed, particularly between survey monuments R-202 to R-205.
- Figures 1, 2, and 3 indicate that the presence of the Navarre Pier (at R209.5) has significant influence over the shoreline response east and west of the pier. With net longshore transport generally held to be from east to west, general theory would suggest that sediment is migrating west through the Project area and being trapped at the Navarre Pier, creating a sediment deficit in the area west of the Pier. However, this effect may reverse with transport reversals.
- In summary, for the original design, the lower berm (at +5ft) was intended to absorb winter storm energy and "background" erosion losses, thereby preserving the upper berm (+9ft berm) and restored dune (+14.5ft) to buffer more severe tropical storms, it appears that the originally constructed Project has performed as expected. The lower berm has buffered erosion of the upper berm and the restored dune along the majority of the Project length except for the east and west ends of the Project area and the shoreline region immediately east of the Pier.

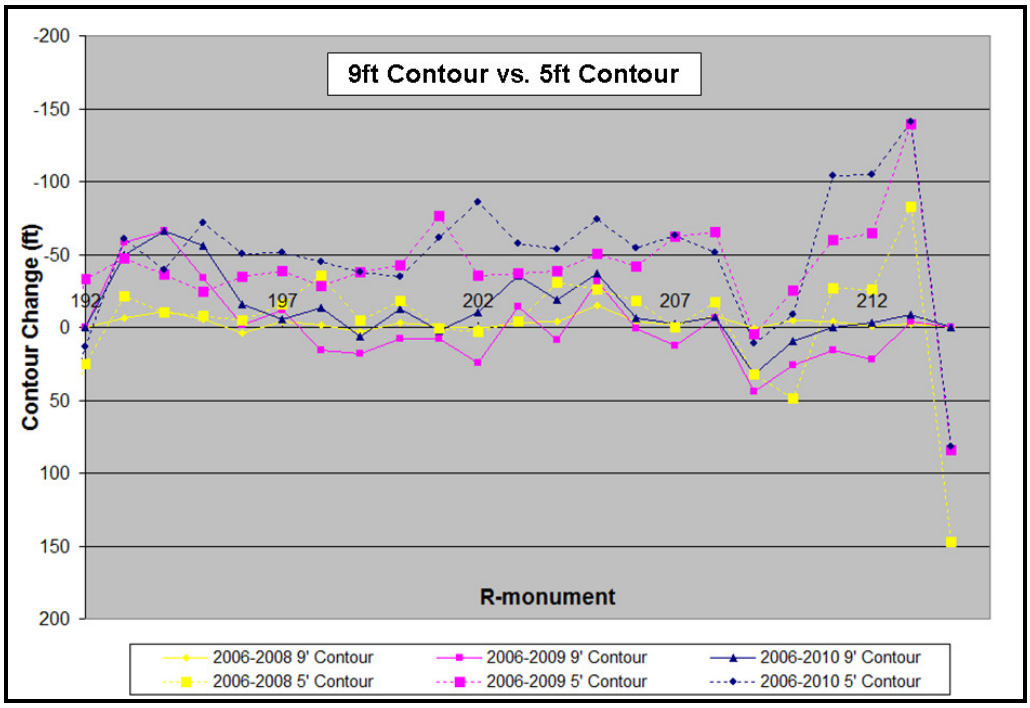

Figure 1 - Comparison of the 5ft contour and the 9ft contour changes.

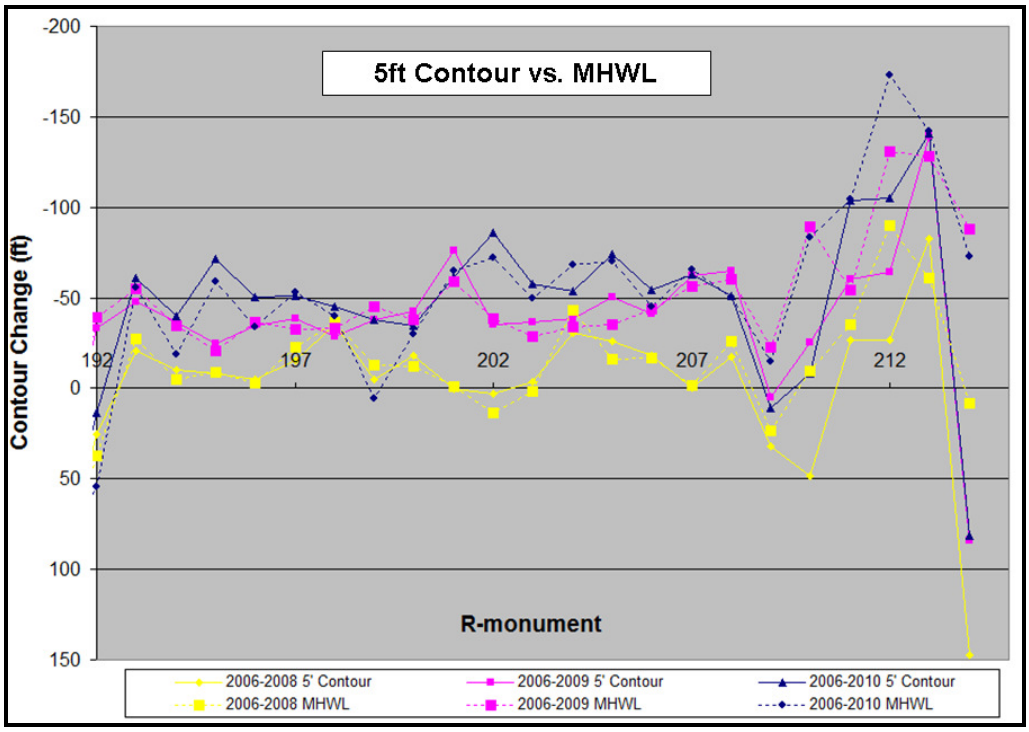

Figure 2 - Comparison of the 5ft contour and the MHWL.

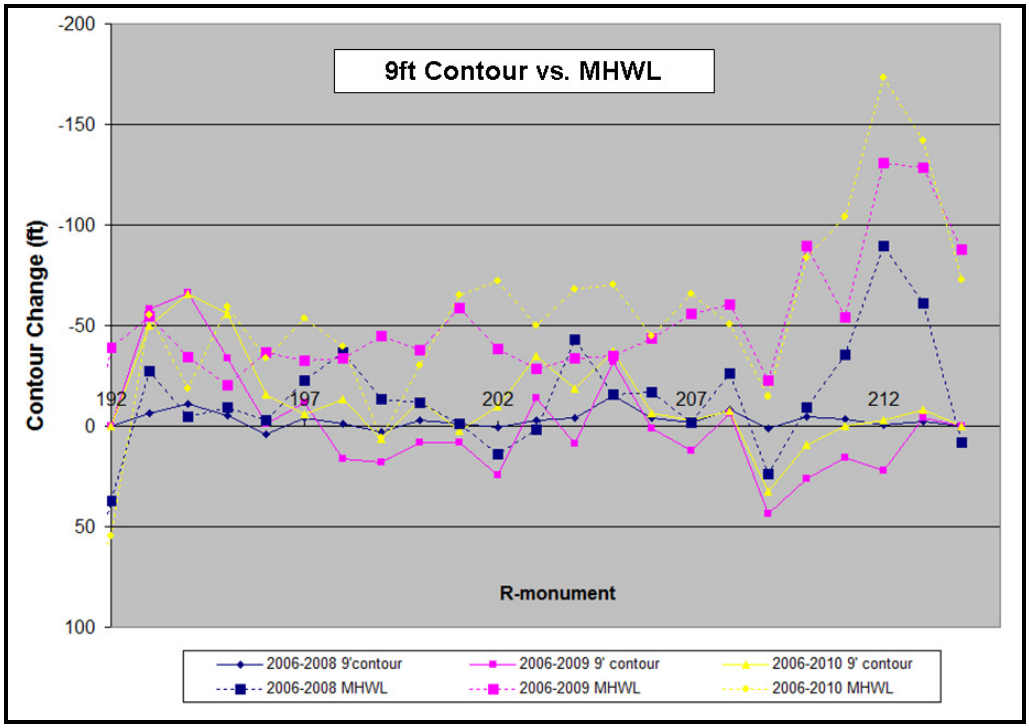

Figure 3 - Comparison of the 9ft contour and MHWL.

3.0 Design Alternatives

The County's design criteria are consistent with the objective identified in the 2000 Feasibility Study by Coastal Tech where it was stated: "*The primary objective of the design analysis was to identify feasible alternatives which mitigate for erosion occurring along Navarre Beach, provide an increased measure of storm protection, enhance recreation, and preserve natural resources*."

Note that the original design of the Navarre Project, the National Geodetic Vertical Datum 1929 (NGVD) was used, thus the original design dune and berm elevations were referenced to this vertical datum. For this report, the descriptions of design alternatives and elevations (i.e. +9 ft berm) are referenced to NGVD. However, due to subsequent requirements from FDEP, each design alternative is herein now referenced to the North American Vertical Datum 1988 (NAVD) which results in a slightly different elevation number shown on the figures; the designs themselves have not changed.

Four design fill template alternatives were evaluated – as summarized in this document and as based upon the criteria as set forth by Santa Rosa County. The four design fill template alternatives are:

(a) the "originally-constructed beach template" with the two-tiered berm (i.e., beach berms at elevations +9 feet NGVD and +5 feet NGVD),
(b) a construction template with a single berm at elevation +9 with a 1 vertical to 12 horizontal slope ("9ft berm alternative"),
(c) a construction template with a straight sloping beach (i.e., not tiered) with a 1 vertical to 20 horizontal slope ("straight-sloping beach alternative"), and
(d) the originally constructed beach template, but with "additional advanced fill" placed between R199 and R206.

Figure 4 below shows each of the design fill template alternatives at R203. Appendix A contains the cross-sections of design alternatives at each monument throughout the Project area.

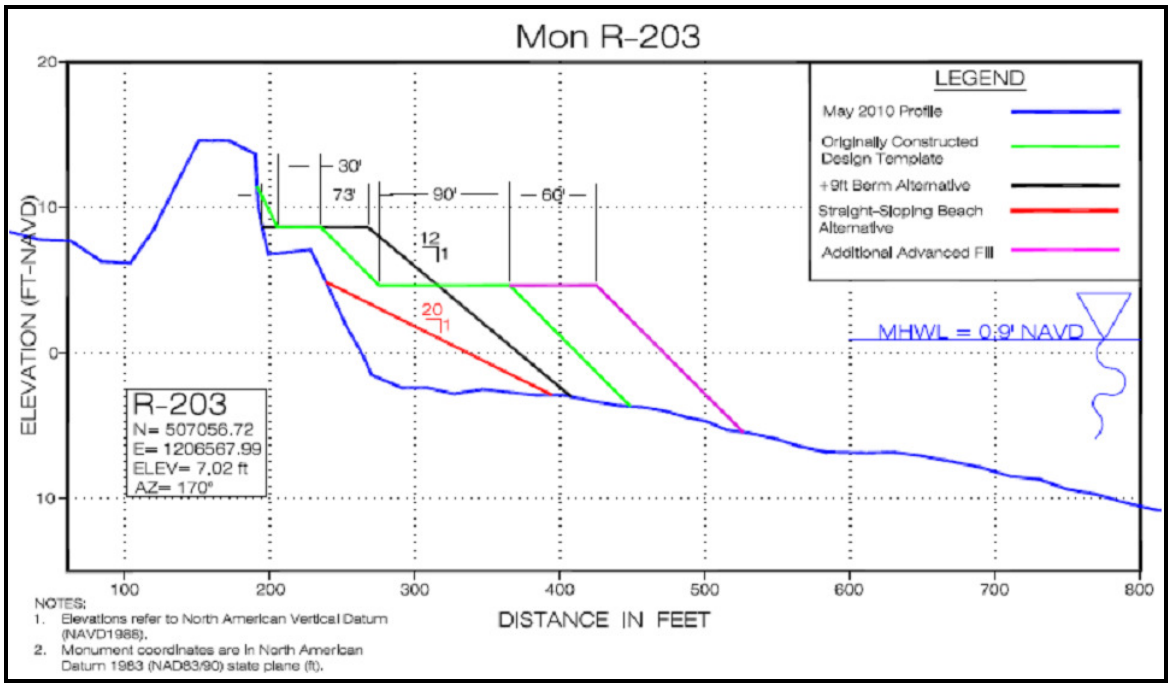

Figure 4 - Design Fill Template Alternatives at R203.

The total volume associated with each of the design fill template alternatives is identified in Table 1 below.

Table 1 - Alternatives - Sand Volume.

Design Fill Template Alternative	Volume (cy)
Originally Constructed Template	938,062
+9ft Berm	633,088
Straight Sloping Beach	576,302
Originally Constructed Template with Additional Advanced Fill	1,019,643

4.0 Numerical Model (LITPROF) Analysis

In order to evaluate the performance of each proposed design alternative, an assessment of the physical ability of each alternative to resist storms was determined using a cross-shore transport model, LITPROF, for representative profiles (R195, R205, and R211) for 10-year and 25-year return interval storm events. The hydrographic storm data used for this assessment was obtained primarily from the National Oceanic and Atmospheric Administration (NOAA) and the National Hurricane Center (NHC).

LITPROF is two-dimensional model developed to simulate cross-shore sediment transport primarily due to breaking waves and changing water levels. A fundamental assumption of the LITPROF model is that profile change is produced solely by cross-shore processes, resulting in a redistribution of sediment across the profile with no net gain or loss of material.

Primary input data for the LITPROF analysis includes:

- the existing profile and the alternative design fill templates,
- geotechnical data describing the beach sand fill,
- storm wave heights and storm surge (water surface elevation) hydrograph.

Since completion of the construction of the original beach template in 2006, the Project has experienced several significant storm events – including Hurricane Ike which was determined to be the equivalent to a 10-year storm event at Navarre – as the measured storm surge for Hurricanne Ike is comparable to the predicted 10-year storm surge as published by FDEP. Real time storm hydrograph data was obtained from an offshore NOAA NDBC buoy (station 42039) which is approximately 120 miles southeast of the Project Area in the Gulf of Mexico (See Figure 5). The wave data from Station 42039 for Hurricane Ike is plotted in Figure 6. The reported peak water level elevation adjacent to the Project Area during Hurricane Ike according to the NHC report was 4.2 feet (1.28 meters) above MLLW. Therefore, a peak storm surge elevation of +4.1 feet (1.25 meters) MSL was used in the LITPROF analysis. Due to the lack of necessary data for a measured 25-year storm return interval, the 10-year storm event surge and wave height was increased by a "multiplier" for the LITPROF model. The storm surge plot for each storm event can be found in Figure 7.

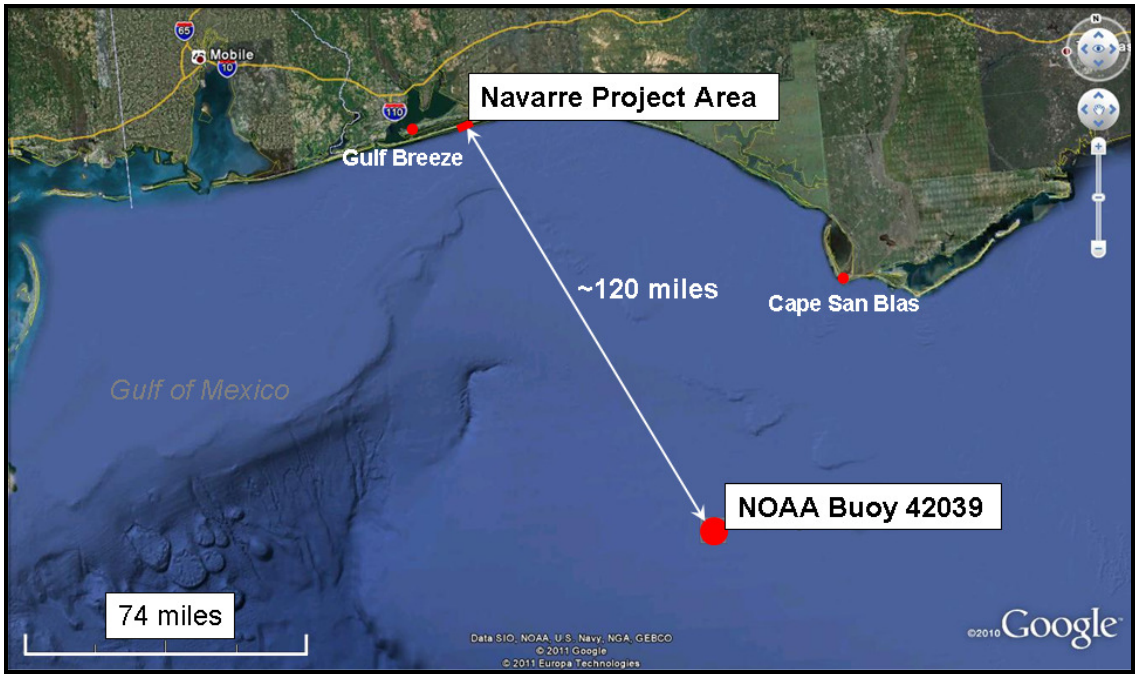

Figure 4 - NOAA Buoy 42039 location relative to the Navarre Project Area.

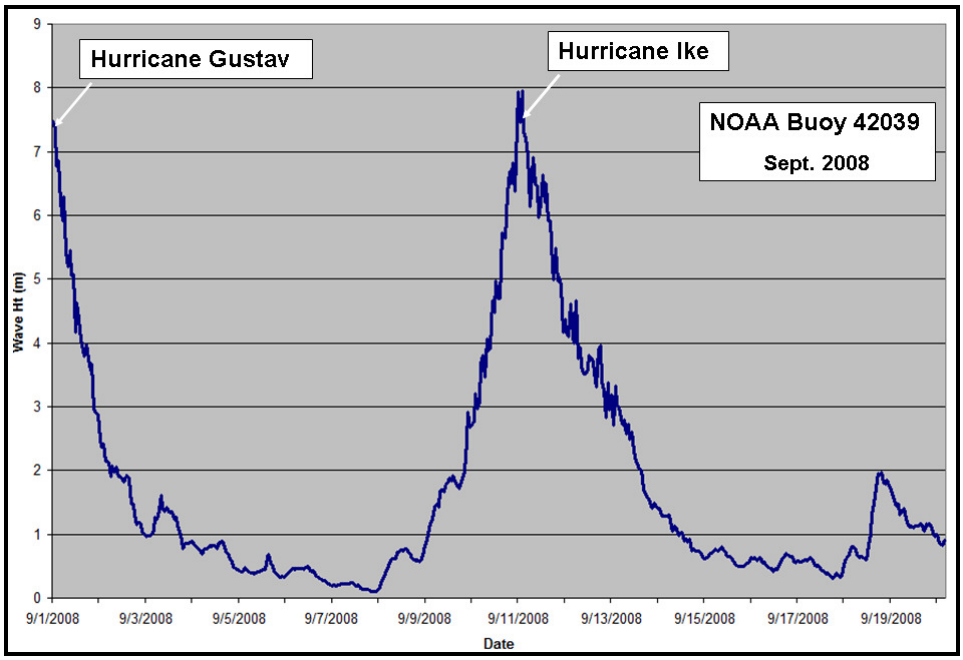

Figure 5 - September 2008 wave heights in meters recorded at NOAA Buoy 42039.

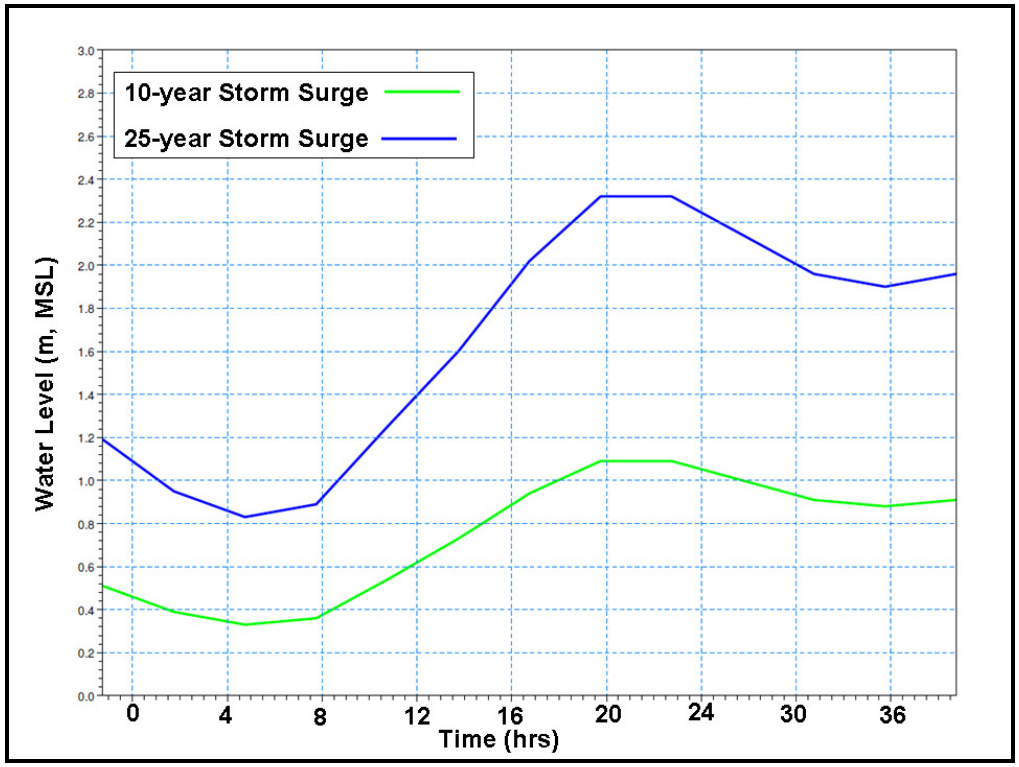

Figure 6 - 10-year and 25-year storm surge.

The profiles evaluated under the LITPROF analysis were selected as the west (R195), middle (R205), and east (R211) portions of the Project Area. For each profile, the following conditions and alternatives were run in the LITPROF model:

- the surveyed May 2010 profile – with no added fill – for comparison purposes,
- originally constructed beach template,
- 9ft berm alternative,
- straight-sloping beach alternative, and
- the Design Beach – with no Advanced Fill – as reflected in Appendix C.

The following summarizes the LITPROF analysis results:

Originally-Constructed Beach Template: For restoration of the fill template constructed in 2006, the LITPROF analysis results indicate immediately after construction:

- The dune feature would:
  - not be vulnerable to erosion during a 10-year storm event, but
  - would be expected to erode about 10 feet (3 meters) to 20 feet (6 meters) during a 25-year storm event.
- The +5 ft berm would:
  - would erode and absorb the majority of wave energy for both storm events,
  - remain at or seaward of the May 2010 +5ft contour for both storm events.

9 ft Berm Alternative: The LITPROF analysis results indicate that immediately after construction:

- The dune feature would:
  - not be vulnerable to erosion at R205 and R211, but would realize minimal erosion at R195 - during a 10-year storm event,
  - would be expected to be inundated at R195, but only realize slightly more erosion at R205 and R211 than compared to the originally constructed beach template - during a 25-year storm event.
- The +5 ft berm would erode and absorb most wave energy for both storm events.

Straight-Sloping Beach Alternative: The LITPROF analysis results indicate the dune would, experience erosion at each profile for both the 10-year and 25-year storm – greater than the erosion recognized for the other alternatives evaluated.

Design Beach: The LITPROF analysis results indicate:

- The dune feature would:
  - experience no erosion under the 10-year storm, and
  - erode approximately 20 feet (6 meters) at each monument – during the 25-year storm – slightly more than originally constructed design.
- The +5 ft berm would:
  - erode and absorb the majority of wave energy for both storm events, and
  - erode comparable to the originally constructed beach template at R195, but would realize slightly more erosion than the originally constructed beach template at R205 and R211 – due to the significant Advanced Fill placed there with the original project.

Based on the results of the LITPROF analysis, the originally constructed design appears to provide to most erosion protection from the 10-year and 25-year storm events. The Design Beach, which has a "narrower" +5ft berm, performed very similar to the originally constructed template however it allowed slightly more erosion at each of the profiles which is to be expected. Figure 8 below shows the LITPROF results for the design beach at R205. The 9ft berm alternative and the straight-sloping beach alternative did not appear to provide any significantly greater erosion protection as compared to the existing profile (May 2010). At R195, the 9ft berm alternative and the straight-sloping beach alternative appear to exacerbate wave run-up and produce overtopping of the dune for the 25-year storm event. Appendix B contains plots of the LITPROF results for all profiles and alternatives evaluated.

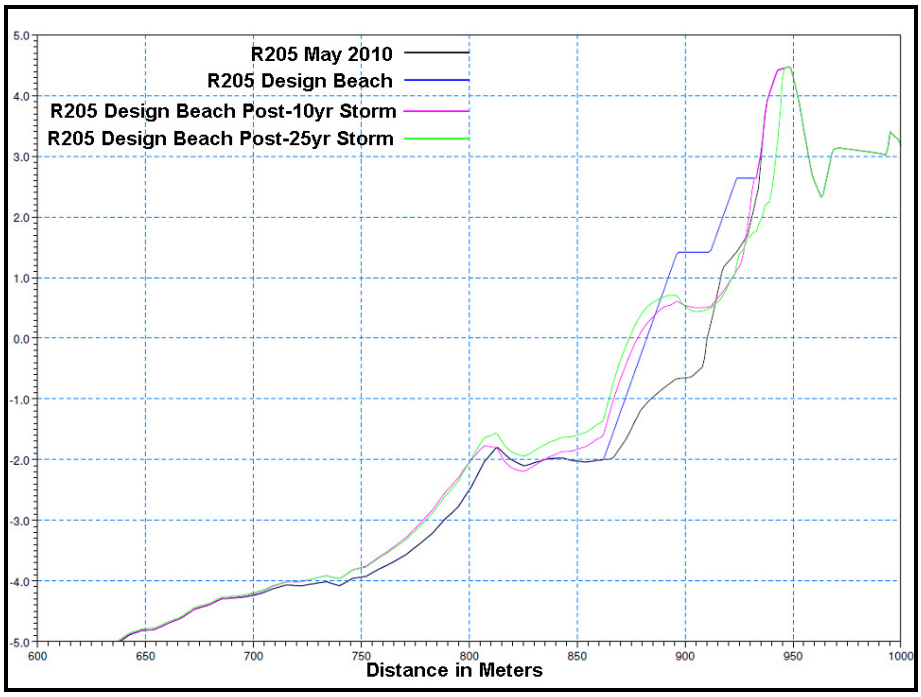

Figure 7 - R205 design beach LITPROF results.

5.0 Environmental Impacts

Environmental impacts associated with the proposed Project are expected to be similar to those which were recognized for the previously constructed 2006 Navarre Beach restoration project. The following sections summarize the potential impacts to environmental resources associated with the currently proposed Project as described in the 2005 Environmental Assessment (EA) prepared by Coastal Tech prior to the 2006 construction of the Navarre restoration project.

The beach and dune system community is comprised of primarily bare sand, sea oats, dune panic grass, railroad vine, and dune sunflower. Most vegetation present on the beach and dune system was planted during the 2005-2006 restoration project. The currently proposed Project would generally not impact the vegetation within the dune communities but instead would act as a

buffer against erosion for existing vegetation. The proposed Project calls for the planting of approximately 40,000 plants from R192+460 to R196.

The marine life most affected by a Project would be the benthic invertebrates potentially located within the offshore borrow area and beach fill limits. However, re-establishment of these types of organisms has been documented within 6 to 18 months following project construction. Fishes would avoid the area during dredging operations by temporarily moving to other areas and likely return in similar numbers and diversity following construction.

Loggerhead turtles occur throughout the Gulf of Mexico and frequently nest along the north Gulf coast beaches including Santa Rosa Island. Green and Leatherback nesting occur less frequently in this area. Continued erosion of Navarre Beach and the associated reduction of the beach berm would decrease suitable nesting areas and increase the number of nests that may need relocation due to potential inundation during storm events.

Potential short-term impacts to nesting sea turtles can be minimized by constructing the proposed Project between November 1 and April 30. However, if construction is conducted during the sea turtle nesting season (May 1 through October 31), reasonable and prudent measures may be incorporated as conditions of the USACE permit to minimize take of sea turtles in the proposed Project area. In general, the placement of compatible fill material, leveling of escarpments, and beach tilling will reduce the potential adverse effects on nesting sea turtles and the long-term impact should be a positive increase in habitat.

Minimal and temporary impacts to beach mice populations may be recognized for the proposed Project. Beach Mouse habitat is expected to increase now that the restored dunes have stabilized and vegetation is better established.

The state threatened Snowy Plover nests in small numbers along the existing Beach Dune community. Snowy Plover nests have been found within the proposed Project area primarily in the less disturbed areas. Since much of the Project area is developed residential area, there is little critical undisturbed nesting habitat for this species. The proposed Project may have minimal temporary impacts on feeding and nesting of this species.

Piping Plover have been documented using the proposed Project area as wintering feeding areas. There is no critical habitat for the Piping Plovers within the proposed Project area and the use of this area by this species is not significant. Critical Habitat for this species is found on the bay side of Navarre and will not be impacted by the proposed Project. The species maybe temporarily displaced when the actual work begins but once the placed sand has stabilized and tidal community invertebrates re-establish, there will be no significant adverse impacts to this species.

In light of the above, no significant adverse impacts are expected as a result of the proposed Project. As a result, no mitigation is expected to be required and is not proposed.

6.0 Opinion of Probable Costs

A preliminary opinion of probable cost (OPC) was prepared for each of the design fill template alternatives. Table 1 summarizes the estimated volume of required sand fill. Table 2 summarizes probable costs for each alternative; Appendix C provides a detailed breakdown of probable costs, which are herein presented for planning purposes only and are subject to revision as part of the final design.

In concert with estimation of probable costs, the following assumptions are made:

- Costs for Mobilization/Demobilization (Mob/Demob) are assumed based on costs for other recent dredging projects – including the 2006 Navarre Beach project.
- The cost estimate for all other items (2 thru 5) were based on the average of all bids received and noted in the bid tabulation from the original project constructed in 2006 - brought to the present cost through application of an 11.23% cumulative inflation rate.
- The acreage of required beach tilling is assumed to be the same as the previously constructed project.
- Costs do not include engineering, administration or other Project related costs.

The total expected Project construction cost for each of the design alternatives is identified in the Table 2 below. Table 3 contains the itemized OPC for the recommended alternative.

Table 2 - Alternative - Probable Costs.

Design Alternative	Volume (cyds)	Total Cost
Originally-Constructed Beach Template	938,062	$7,956,487
+9 Foot Berm Alternative	633,088	$6,031,102
Straight Sloping Beach Alternative	576,302	$5,678,147
Additional Advanced Fill (Recommended Alternative)	1,019,643	$8,463,557

Table 3 - Additional Advanced Fill - Probable Costs

Item No.	Description	Quantity	Unit	Installed Unit Cost	Cost
1	Mobilization/Demobilization	1	LS	$2,000,000	$2,000,000
2	Furnish and Install Sand	1,019,643	CY.	$5.65	$5,761,476
	10% Contingency	1	LS	$576,148	$576,148
3	Permit Compliance Including Turbidity Monitoring	1	LS	$42,267	$42,267
4	Beach Tilling of Placed Material	132	Acre	$408	$53,856
5	Furnish and Install Native Plants	40,000	Each	$0.75	$29,810
				Total Cost =	**$8,463,557**

7.0 Offshore Borrow Area Geotechnical Data

As noted in the April 2007 "Navarre Post-Construction Certification Report" prepared by Coastal Tech:

> "…a single offshore borrow site just over 4 miles directly offshore from the Project beach was identified and permitted for use on the Project. Water depths in the area range from a little over 60 feet to about 70 feet. Based on core analyses summarized in the original Coastal Tech geotechnical study, the larger site was divided into two sub-areas by proposed cut depths. The sub-area designated 'T2-1B' comprised approximately 378 acres of surface area and was selected for the initial beach restoration project. With a cut proposed and permitted to *elevation* -78 feet (NGVD) (i.e., an *average cut thickness* of 10 feet) a total of approximately 3,400,000 cubic yards of beach compatible sand was estimated to be available in this sub-area."

Figures 9 through 11 illustrate (a) the location of the proposed offshore borrow area relative to the Project fill area, (b) the detailed plan view of the proposed borrow area, and (c) cross-sections of the proposed offshore borrow area, respectively.

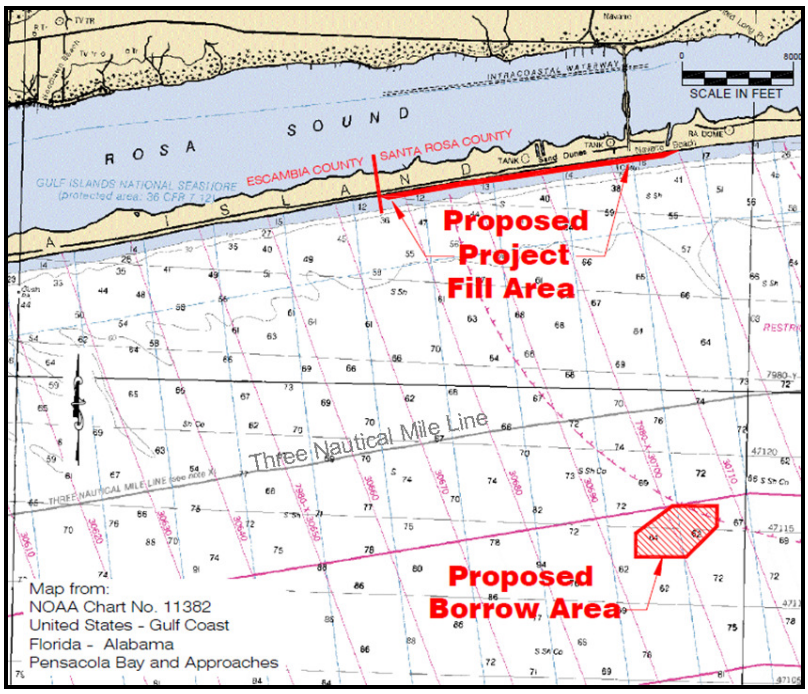

Figure 8 - Borrow Area and Fill Area - Location.

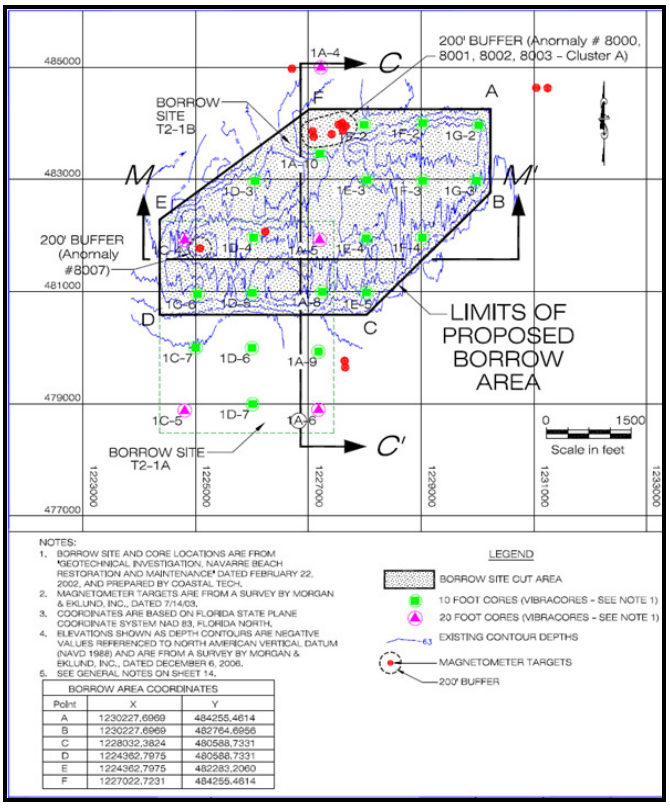

Figure 9 - Borrow Area - Detailed Plan View

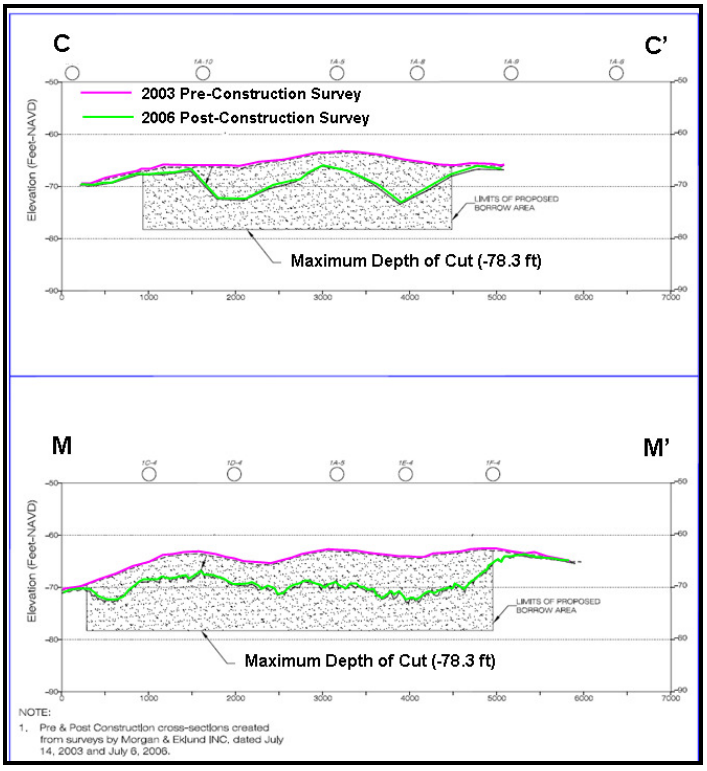

Figure 10 - Borrow Area - Cross-sections.

6.1 T2-1B – Previously Permitted Borrow Area

Borrow Area T2-1B was utilized for the previously constructed Project. The permitted maximum depth of cut was -78 feet NGVD (-78.3 ft NAVD) as reflected in the permit drawings. This borrow area:

- was delineated through the extraction of fifteen 10ft vibracores and two 20ft vibracores,
- has two magnetometer contacts that each require a 200 foot buffer, which was applied during the previous dredging event.

All samples above the maximum depth of cut of -78 feet NGVD and below the 2006 post-construction borrow area survey "sediment-water" interface were weighted within each vibracore to develop a core composite, and each vibracore was weighted within the borrow area based on a "volumetric" area of influence. The resulting borrow area composite indicates that the previously permitted borrow area T2-1B is fine grained (0.35 mm), moderately sorted quartz sand with less than 0.2% fines and less than 0.5% gravel sized material. These results are somewhat similar to those developed in the 2002 Geotechnical Investigation report (CTC, 2002), which states that the borrow area is fine grained (0.40 mm), moderately sorted quartz sand with 0.1% fines and less than 1% gravel.

The volume of sediment that remains above the maximum depth of cut following the last dredging event was determined by using the 2006 post-construction survey and a maximum depth of cut of -78 feet NGVD, resulting in a volume estimate of 5.21 million cubic yards of material remaining. This volume would then be adjusted to 4.95 million cubic yards of available sediment taking into account and exclude the volume within the magnetometer buffer zone. The volume of sediment above -78 feet NGVD was also determined using the pre-construction survey and was found to be 9,381,850. This indicates that approximately 4.17 million cubic yards of material was removed during the 2006 dredging event; this volume exceeds the accepted "pay volume" of 2.95 million cubic yards.

6.2 T2-1A – Alternate Borrow Area

Potential borrow area T2-1A is adjacent to the southern end of T2-1B. Six vibracores have been extracted from this borrow area. Two of these cores are in the corners of the south end of the borrow area and are twenty feet in length. The other four vibracores are ten feet in length. The two cores in the center of the borrow area, cores 1D-6 and 1D-7, are the shallowest, extending to -69 feet NGVD. This depth was used as the maximum depth of cut for purposes of calculating the volume and developing the sedimentologic composite for the borrow area as a whole.

All samples above the maximum depth of cut of -69 feet NGVD were weighted within each vibracore to develop a core composite, and each vibracore was weighted within the borrow area based on a "volumetric" area of influence. The resulting borrow area composite indicates that potential borrow area T2-1A is fine grained (0.41 mm), moderately sorted quartz sand with less than 0.1% fines and less than 1% gravel sized material. These results are similar to those developed in the 2002 Geotechnical Investigation report (CTC, 2002), which states that the borrow area is fine grained (0.38 mm), moderately sorted quartz sand with 0.1% fines and less than 1% gravel.

Using the -69 foot NGVD cut depth, the volume is estimated to be 1.32 million cubic yards. It should be noted that this cut depth leaves a two foot buffer above the bottom of the shallowest core. It is possible that a deeper cut depth may be used based on the two twenty foot vibracores in the south corners. Using a two foot buffer above the end of the shallower of the two twenty foot cores, 1C-5, which extends to -78.8 feet NGVD, a cut depth of -76.8 feet NGVD could be used. This would add an additional 1.88 million cubic yards, for a total of 3.2 million cubic yards of sand. It would be advisable to have seismic data to correlate the sediment layers between the twenty foot cores to ensure that the layers continue at the same depth through the center of the borrow area, and in the north end where there are no twenty foot cores.

6.3 Compatibility Analysis

Sediment compatibility of the native beach and offshore borrow areas T2-1B (remaining material in the previously permitted borrow area) and T2-1A was determined via the use of the Overfill Factor. The Overfill Factor is a common design element in coastal engineering practice used for simple comparison of potential borrow source material to native beach material. The Overfill Factor seeks to estimate, based on grain-size distributions, what volume of borrow source fill is necessary to functionally replace a 'unit' of native beach sand. The Overfill Factor was estimated via methods prescribed by the U.S. Army Corps of Engineers (USACE) *Coastal Engineering Manual*. Overall, for T2-1B, a volume-weighted average composite mean grain-size and sorting coefficient (see Table 4) compared to the composited data of the native beach (as described in 2002 Geotechnical Investigation Report by Coastal Tech) is determined to yield the Overfill Factor at 1.10; T2-1A has an estimated Overfill Factor of 1.15. Composite curves of the native beach, T2-1B, and T2-1A are shown in Figure 12. The composite curves show that sediment in remaining T2-1B and T2-1A is compatible with the native beach material along Navarre Beach.

Based on the volume of material available and the results of the compatibility analysis, it is recommended that the previously permitted borrow area T2-1B be utilized for the renourishment of the proposed Project. Borrow Area T2-1A may be utilized for a future nourishment event.

Table 4 - Overfill Factor - Native Beach and Offshore Sand Sources.

Sand Sample	Descriptive Statistics			James Method (1975)		
	Mean (mm)	*Mean (phi)*	*Std. Dev. (phi)*	$(M_b-M_n)/s_n$	s_b/s_n	**Overfill Factor**
Native Beach Composite	0.37	1.43	0.63	--	--	**--**
T2-1A Composite	0.41	1.30	0.84	-0.21	1.33	1.10
T2-1B Composite	0.35	1.51	0.76	0.12	1.21	1.15

Note:
1. M_n and S_n is the Mean grain size (phi) and Standard deviation (phi) of Native Beach Composite
2. M_b and S_b is the Mean grain size (phi) and Standard deviation (phi) of upland sand sources.

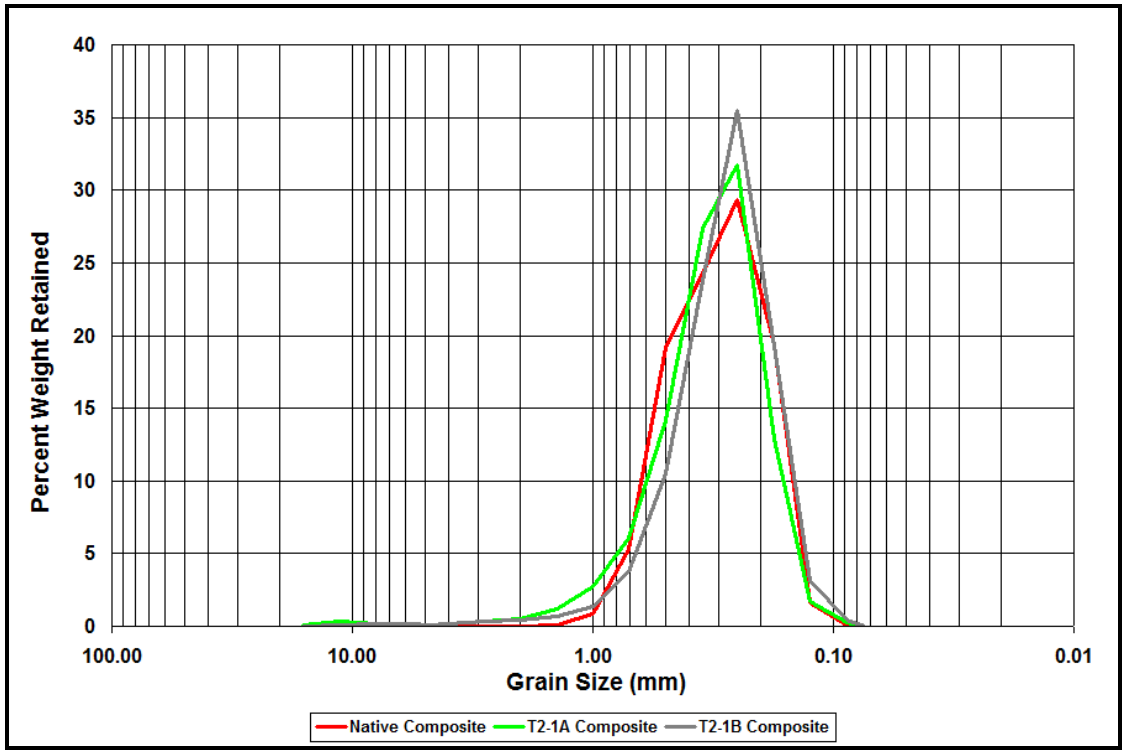

Figure 11 - Native Beach and Borrow Area Composite Curves.

8.0 Conclusions

Relative to the contour evolution assessment of the previously constructed project, the presence of the Navarre Pier has significant influence over the shoreline orientation surrounding the pier. For the previously constructed beach fill project, the lower berm has buffered the upper berm and the restored dune along the majority of the Project length except for the east and west ends of the Project area and the shoreline region immediately east of the Pier. The contour evolution analysis also suggests that additional advanced fill may be warranted from R199 to R206.

Based on the results of the LITPROF analysis, the originally constructed design provides the most protection against a 10-year and 25-year return interval storm.

Based on the volume of material available and the results of the compatibility analysis, it is recommended that the previously permitted borrow area T2-1B be utilized for the renourishment of the proposed Project. Borrow Area T2-1A may be utilized for a future nourishment event.

Based on the results of criteria set forth by the County, the contour evolution analysis, and the results of the LITPROF analysis, it is recommended that Santa Rosa County adopt the originally constructed design, but with additional advanced fill as the recommended alternative.

9.0 References

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