ENVIRONMENTAL ASSESSMENT

FOR THE

GRAND STRAND
STORM DAMAGE REDUCTION PROJECT

NORTH MYRTLE BEACH, MYRTLE BEACH & SURFSIDE BEACH, SOUTH CAROLINA

HORRY & GEORGETOWN COUNTIES

US Army Corps of Engineers ®
Charleston District

JUNE 2007

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Environmental Assessment

1. Purpose and Need for this Document

This Environmental Assessment (EA) represents a supplement to the position of the U.S. Army Corps of Engineers (USACE), Charleston District and the Minerals Management Service (MMS) regarding the environmental effects associated with the 2007/2008 re-nourishment of the Myrtle Beach, South Carolina and vicinity beaches. The proposed action calls for the removal and placement of up to 702,600 yd^3, 1,442,500 yd^3, and 778,600 yd^3 of Federal OCS sand from Little River, Cane South, and Surfside borrow areas respectively to renourish 25.4 miles of shoreline along the Grand Strand.

The Corps of Engineers has previously described the affected environment and evaluated environmental effects with the Myrtle Beach Storm Damage Reduction Project in its Feasibility Report on Storm Damage Reduction (USACE, 1987a), Environmental Assessment Beach Erosion Control Study (USACE, 1987b), Environmental Impact Statement (USACE, 1993a) and General Design Memorandum (USACE, 1993b). Only the 1993 EIS is incorporated in this document by reference and can be found in its entirety in Appendix 1. In 1996, the MMS also prepared an EA covering the initial nourishment of Surfside Beach using Federal OCS sand from the Surfside borrow area (MMS, 1996).

This document is intended to communicate new environmental information and update the coordination between a number of Federal and State regulatory agencies. All other findings from the aforementioned documents are still valid, however are not reiterated in this EA.

2. Description and Need for the Proposed Action

The Grand Strand is a major recreational and economic resource for South Carolina. The 2005 hurricane season was unusually intense and destructive along the highly developed coastline. Hurricane Ophelia caused significant erosion along the length of the federal project qualifying it for restoration under the authority of Public Law 84-99. P.L. 84-99 allows the Corps of Engineers to perform repairs to Federally-authorized shore protection works that have been damaged by coastal storms. Due to the cycle of nourishment originally calculated during authorization of this project, there is a potential that the volume of sand placed will be greater than what is authorized strictly under P.L. 84-99. It is expected that this work will be performed around November 2007.

Four offshore borrow areas were identified in the USACE March 1993 General Design Memorandum for the project (Figure 1). The four borrow areas with intended nourishment reaches in parenthesis and available sand quantities are identified in Table 1. Design drawings for all three reaches can be found in Appendix 3, along with the geo-technical report that describes the sand resources at the designated borrow areas. Only Little River, Cane South, and Surfside Borrow Areas are proposed for use in this re-nourishment effort.

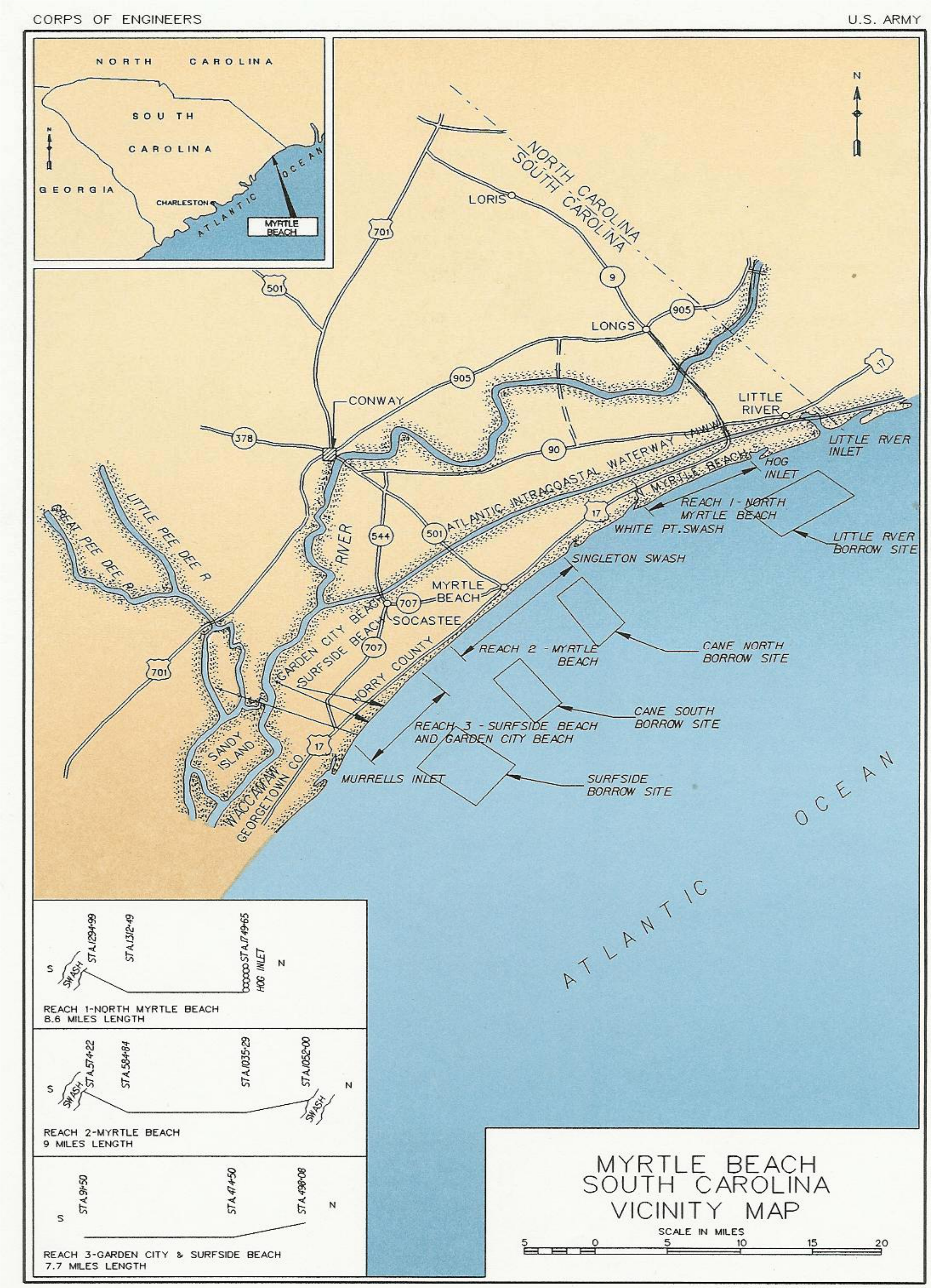

Figure 1: Offshore Borrow Areas

Table 1: Borrow Area Capacity

Borrow Area	Capacity
Little River (Reach 1)	18.1 million cy
Cane North (Reach 2)	6.7 million cy
Cane South (Reach 2)	12.3 million cy
Surfside (Reach 3)	34.4 million cy

The project is anticipated to be constructed using a hopper dredge, booster pump, and land based heavy equipment (i.e. bulldozers and front-end loaders). The dredge will remove the sand to a depth not to exceed ten feet within the borrow areas. Each borrow area will be subdivided into separate smaller zones. The contract specifications will require the contractor remove material completely from one borrow zone prior to moving to another borrow zone. In addition to borrow area requirements, the contract specifications will require that the contractor control beach placement techniques. The beach renourishment, including mobilization, is anticipated to continue 24 hours per day, 7 days per week for a period of approximately 15 months. Noise pollution and construction activities will be monitored to ensure minimum disturbance to the surrounding community.

Initial construction of North Myrtle Beach (Reach 1) was completed in May 1997. Initial placement consisted of 57.7 cubic yards per linear foot along 8.6 miles of beach. This quantity includes material for the protective berm, advanced nourishment and overfill ratio, for a total placement of 2,622,900 cubic yards. Future renourishment of 490,000 cubic yards was planned for every ten years. Based on current conditions, Reach 1 is in need of 702,600 cubic yards to restore the project to the full design template. Initial construction of Myrtle Beach (Reach 2) was completed in December 1997. Initial placement consisted of 47.1 cubic yards per linear foot along 9.0 miles of beach. This quantity includes material for the protective berm, advanced nourishment and overfill ratio, for a total placement of 2,250,000 cubic yards. Future renourishment of 440,000 cubic yards was planned for every eight years with the final nourishment being 550,000 cubic yards for the last ten years of the project life. Based on current conditions, Reach 2 is in need of 1,442,500 cubic yards to restore the project to the full design template. Initial construction of Surfside/Garden City Beach (Reach 3) was completed in November 1998. Approximately 1,517,494 cubic yards of sand was placed along 7.7 miles of beach in Horry and Georgetown Counties extending from 1.2 miles south of the Horry/Georgetown County line to Myrtle Beach State Park in Horry County. Based on current conditions, Reach 3 is in need of 773,000 cubic yards to restore the project to the full design template.

There is a tentative plan to install sand fencing along the entirety of all three reaches of the project in the back-beach area of the projective berm. The purpose of this additional element is to promote the formation of dune structures and will be facilitated with plantings of natural vegetation. Fencing was installed in this manner for the initial nourishment and was highly successful. Design drawings for the fencing effort can be viewed in Appendix 10. However, execution of this portion of the plan is dependent on funding. An additional permit from the South Carolina Department of Health and Environmental Control – Office of Coastal Resource Management will be necessary prior to construction, but the Corps has chosen to wait to apply for this permit until funding is secured.

3. Endangered/Threatened Species

Coordination was conducted in compliance with the Endangered Species Act (ESA) with the submission of a Biological Assessment (BA) to the Fish and Wildlife Service (FWS) in September, 2006. The FWS Biological Opinion (BO) was received in January 2007. Both documents are present in their entirety in Appendix 2. This BA and BO consider the effect of the proposed project on threatened and endangered species either known to be present or suspected to be present in the vicinity of the project.

New coordination with the National Marine Fisheries Service with regard to marine species protected under the ESA was not conducted due to the existence of a Regional Biological Opinion (RBO) for the South Atlantic Region. The RBO addresses dredging operations and provides guidance and requirements on a state by state basis. The RBO can be viewed via the internet at: http://el.erdc.usace.army.mil/tessp/pdfs/1997SADBO.pdf

The Army Corps of Engineers determination is that the proposed project will either have "no affect" or "is not likely to adversely affect" all listed species except for the loggerhead sea turtle. Because the beach nourishment work may impact nesting sea turtles or emerging hatchlings, we determined that the proposed project "may adversely affect" the loggerhead sea turtle; however, we do not believe the proposed project will jeopardize the species.

4. Coastal Consistency

The existing Grand Strand Storm Damage Reduction Project satisfied the restrictions and guidelines of the South Carolina Coastal Management Program pursuant to the Coastal Zone Management Act (CZMA). Since it has been more than ten years since the last coordination with the agency (SC Department of Environmental Control - Office of Coastal Resource Management) that enforces the provisions of CZMA in South Carolina, a letter of intent was sent by the Corps of Engineers. The consistency concurrence can be found in Appendix 4.

5. Essential Fish Habitat

Adjacent to the project area, there is a designated Essential Fish Habitat - Habitat Area of Particular Concern (HAPC) – Hurl Rocks. Hurl Rocks was designated as an HAPC after the initial construction of the Grand Strand Project. Due to the proximity of the project, an Essential Fish Habitat (EFH) Assessment was conducted as required by the Magnuson-Stevens Fishery Conservation and Management Act of 1976, as amended through 1996 (Magnuson-Stevens Act). The objectives of this EFH Assessment were to describe how the actions of the U.S. Army Corps of Engineers (USACE), their non-Federal sponsors, and the Minerals Management Service (Department of Interior) potentially influence the quality of habitat designated by the National Marine Fisheries Service and the South Atlantic Fisheries Management Council. The EFH Assessment describes fish, coral, and benthic species common to the sandy borrow and nearshore areas and hard-bottom habitats and discusses the potential impacts of the proposed action on those species. The EFH Assessment and the

Conservation Recommendations from the National Marine Fisheries Service are contained in Appendix 5.

6. Archeological and Cultural Resources

Initial coordination for the protection of archeological and cultural resources was done with the understanding that, if cultural resources were located, the State Historic Preservation Office (SHPO) would be notified. For this nourishment cycle, a new geophysical survey of the borrow areas was conducted using side scan sonar and magnetometer devices to locate potential archeological and cultural resources. Results of the geophysical survey were used to define areas of avoidance. The survey and coordination results are included in Appendix 6.

7. Water Quality Certification

A new water quality certification was not a necessary element of this coordination effort. However, the South Carolina Department of Environmental Control was consulted for recommendations and affirmation of the existing permit. Correspondence can be found in Appendix 7.

8. Borrow Area Impact Analysis

An impact analysis was conducted to address the potential changes that may occur in the project area resulting from modifications to the sea floor within the borrow area caused by dredging. The primary focus was to evaluate the potential change in wave impact to the adjacent shoreline using a numerical wave transformation model. The Army Corps of Engineers performed the analysis using STWAVE and documented minimal changes to the incident wave field. The impact analysis also describes the physical environment of the borrow area and nearshore zone, including a discussion of potential impacts to hard-bottom areas. The complete analysis is presented in Appendix 8.

9. Environmental Monitoring

Coordination with the National Marine Fisheries Service and the South Carolina Department of Natural Resources resulted in an agreement to monitor biological recovery and hard-bottom habitat impacts for two years post-construction. The purpose of this sampling and analysis is threefold:

- Document changes in beach profile and determine the ecological impacts on and recovery rates of sediment characteristics and burrowing ghost crabs on nourished beaches.
- Determine the impacts on nearshore hard-bottom habitats and biological recruitment to those habitats.
- Document the impacts on and recovery of native bathymetry, sediment characteristics, and benthic infaunal communities in sand borrow areas

A scope of work for all of the elements of the monitoring plan can be found in Appendix 9.

10. Cumulative Impacts

The Council on Environmental Quality (CEQ) defines cumulative impact as:

The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7). This analysis follows the 11-step process outlined by the CEQ in their 1997 publication Considering Cumulative Effects Under the National Environmental Policy Act.

A. Cumulative Effects Issues

This assessment of cumulative impacts will focus on impacts of dredging from the proposed ocean borrow sites and impacts of placement of sand material on the beach (whether for beach nourishment) on significant coastal shoreline resources. In discussing the potential cumulative impacts of offshore borrow area dredging and beach nourishment, we consider time crowded perturbations and space crowded perturbations, as defined below, to be pertinent to this action.

***Time crowded perturbations** – repeated occurrence of one type of impact in the same area.*
***Space crowded perturbations** – a concentration of a number of different impacts in the same area.*

B. Geographic Scope

This analysis will focus on cumulative impacts within the project area since portions of affected beaches under the current proposal have received fill in the past. Additionally, this analysis will study the cumulative impacts, within the project area, of increased offshore borrow area use. The proposed project represents an additional impact to the offshore benthic resources in the Grand Strand area. Cumulative impacts of beach nourishment and offshore borrow area use on a statewide scale will also be assessed herein.

C. Time Frame

This analysis considers known, past, present and reasonably foreseeable future sand placement and offshore borrow activities on a statewide scale and within the project vicinity. Projections were extended to the end of the current project life, as that date represents a reasonably foreseeable future, and the majority of remaining ocean beach that could reasonably be expected to have federal projects implemented is currently under study and included in this analysis. This assessment assumes continued periodic beach disposal of maintenance material along the Grand Strand and construction of the proposed project.

D. Actions Affecting Resources of Concern

Cumulative effects of the proposed action will focus on the impacts of dredging from the proposed ocean borrow sites and placement of sand material on the beach.

D.1. Actions Affecting Benthic Resources

Dredging: As a result of dredging areas for beach nourishment sand, there is concern for potential cumulative impacts due to repeated dredging in a borrow area within short periods of time such that the benthic community may not have time to recover. Dredging in subsequent areas close to one another may result in impacts to potential adult organism recruitment to the dredged areas, further lengthening the time for recovery in an area. Monitoring of borrow sites used in previous nourishment projects in South Carolina have suggested that the depth of the dredge pit and the proximity of the borrow area to tidal inlets have significant consequences for the recovery of benthic ecosystems (Jutte and Van Dolah, 2000).

Other factors affecting Benthic Resources: Many factors unrelated to dredging of sand from borrow areas may affect benthic resources including, beach resources and ocean fish stocks. The factors can be a result of natural events such as population cycles or as a result of favorable or negative weather conditions including La Niña, El Niño, and major storms or hurricanes as examples. These global events have far greater impacts on these resources at the population level than relatively local activities such as removal of sand from a given area of ocean bottom. Primary human-induced factors affecting fish stocks are over fishing and degradation of water quality due to pollution. When examining the cumulative effect of space crowded perturbations, these other factors far outweigh the potential incremental effects of borrow dredging of sand on benthic or fish populations.

D.2. Actions Affecting Beach Resources

The major anthropogenic sources of beach impacts are local beach maintenance activities (which include local beach nourishment), disposal of dredged material from maintenance of navigation channels, and beach nourishment (berm and dune construction with long-term periodic maintenance). Of particular concern are macroinvertebrate, fisheries, shorebird, and sea turtle species that utilize or occur on or adjacent to ocean beaches. These resources are also impacted by natural events and anthropomorphic activities that are unrelated to disposal of sand on the beach as discussed below.

Dredging: The physical effects of offshore sand mining on the incident wave field and associated sediment transport regime may alter local shoreline change.

Local Maintenance Activity: Under the existing condition the project area is subjected to repeated and frequent maintenance disturbance by individual homeowners and local communities following major storm events. These efforts are primarily made to protect adjacent shoreline property. Such repairs consist of dune rebuilding using sand from beach scraping. Limited fill and sandbags are generally used to the extent allowable by OCRM permit. Such frequent maintenance efforts could keep the natural resources of the barrier island ecosystems from reestablishing a natural equilibrium with the dynamic forcings of the area.

Permitted Beach Nourishment: Local efforts can also include beach nourishment. While locally funded beach nourishment activities are not wide spread, they also occur along other developed South Carolina beaches. These infrequent maintenance efforts could keep the natural resources of the barrier island ecosystems from reestablishing a natural equilibrium with the dynamic forcings of the area.

COE Beach Disposal: Beach quality sand is a valuable resource that is highly sought by beach communities to provide wide beaches for recreation and tourism, as well as to provide hurricane and wave protection for public and private property in these communities. When beach quality sand is dredged from navigation projects, it has become common practice of the Corps of Engineers to make this resource available to beach communities, to the maximum extent practicable. Placement of this sand on beaches merely represents return of material, which eroded from these beaches, and is, therefore, replenishment with native material. The design of beach placement sites is very simple; generally it extends the elevation of the natural berm seaward. Widths of beach placement zones generally reflect the wishes of the local government relative to the choice between a long, narrow beach, or a shorter, wider beach.

COE Beach Nourishment: Beach nourishment activities typically include the construction and long-term (50-year) maintenance of a berm and dune. The degree of cumulative impact would increase proportionally with the total length of beach nourishment project constructed.

Other factors affecting Beach Resources: Many factors unrelated to placement of sand on the beach may affect beach resources including, benthic resources, shorebird populations and ocean fish stocks. The factors can be a result of natural events such as natural population cycles or as a result of favorable or negative weather conditions including droughts, floods, La Niña, El Niño, and major storms or hurricanes to name a few. In terms of scale, the primary disturbance to beach ecosystems is the natural erosion and deposition of material via wave and wind action. A primary anthropogenic factor affecting shorebird populations is beach development resulting in a loss or disturbance of nesting habitat and invasion of domestic predators. Primary man-induced factors affecting fish stocks are over fishing and degradation of water quality due to pollution. Sediment sources have also been disrupted by dams, estuarine dredging and hard structures such as jetties and groins.

E. Significant Resources

Based on scoping comments from resource agencies and others, the primary concerns with the proposed beach disposal are direct and indirect impacts to macroinvertebrates, fish, shorebirds, and sea turtles. Federally listed threatened or endangered species which may be present along the South Carolina coast are the blue whale, finback whale, humpback whale, right whale, sei whale, sperm whale, West Indian manatee, green sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, loggerhead sea turtle, shortnose sturgeon, seabeach amaranth, and piping plover. The potential benefits of periodic renourishment may include enhancement of nesting habitat for sea turtles and provision of additional habitat for sea beach amaranth. In relation to dredging of offshore sites for material, the primary concerns are the potential impacts to benthos, fish species and hardbottom habitat areas.

<u>Beach and Dune</u>: Terrestrial habitat types within these areas include sandy or sparsely vegetated beaches and vegetated dune communities. Mammals occurring within this environment are opossums, cottontails, gray foxes, raccoons, feral house cats, shrews, moles, voles, and house mice. Common vegetation of the upper beach includes beach spurge, sea rocket and pennywort. The dunes are more heavily vegetated, and common species include American beach grass, panic grass, sea oats, broom straw, seashore elder, and salt meadow hay. Seabeach amaranth, a federally listed threatened species, may be present in some of the project area, but has not been documented as such. Ghost crabs are important invertebrates of the beach/dune community. The beach and dune also provide important nesting habitat for loggerhead and green sea turtles as well as habitat for a number of shorebirds and many other birds, including resident and migratory songbirds. Placement of material along the ocean beach enhances and improves important habitat for a variety of plants and animals, and restores lost habitat in the areas of most severe erosion. This is especially important for nesting loggerhead sea turtles (although lighting issues often inhibit nesting activities) and seabeach amaranth. Furthermore, new populations of seabeach amaranth have been observed to follow sand placement on beaches where sand has been disposed by the Corps of Engineers (ex. Wrightsville Beach and Bogue Banks, North Carolina) (USFWS, 1996b; CSE, 2004). Individually and cumulatively, in addition to providing important habitat, beach nourishment projects protect public infrastructure, public and private property, and human lives.

<u>Marine Waters</u>: Along the coast of South Carolina, marine waters provide habitat for a variety of pelagic fish and are important commercial and recreational fishing grounds. Kingfish, spot, bluefish, weakfish, spotted seatrout, flounder, red drum, king mackerel, and Spanish mackerel are actively fished from boats, the beach, and local piers. Offshore marine waters serve as habitat for the spawning of many estuarine dependent species. Oceanic large nekton located offshore of South Carolina are composed of a wide variety of bony fishes, sharks, and rays, as well as fewer numbers of marine mammals and reptiles. Marine mammals and reptiles that may be present in the offshore borrow sites are addressed in the Biological Assessment in Appendix 2.

Dredging and placement of beach fill may create impacts in the marine water column in the immediate vicinity of the activity, potentially affecting the surf zone and coastal ocean. These impacts may include minor and short-term suspended sediment plumes and related turbidity, as well as the release of soluble trace constituents from the sediment. Overall water quality impacts for any given project are expected to be short-term and minor. Cumulative effects of multiple simultaneous beach nourishment operations could be potentially harmful to fishes of the surf zone. However, the high quality of the sediment selected for beach fill and the small amount of beach affected at any point in time would not suggest that this activity poses a significant threat.

Inter-tidal and Surf Zones**:** The inter-tidal zone within the proposed beach nourishment areas serves as habitat for invertebrates including mole crabs, coquina clams, amphipods, isopods, and polychaetes, which are adapted to the high energy, sandy beach environment. These species are not commercially important; however, they provide an important food source for surf-feeding fish and shore birds. The surf zone is suggested to be an important migratory area for larval/juvenile fish moving in and out of inlets and estuarine nurseries (Hackney *et al*., 1996). Disposal operations along the beach can result in increased turbidity and mortality of intertidal macrofauna, which serves as food sources for various fish and bird species. Therefore, feeding activities of these species may be interrupted in the immediate area of beach sand placement. These mobile species are expected to temporarily relocate to other areas as the project proceeds along the beach. Though a short-term reduction in prey availability may occur in the immediate disposal area, only a small area is impacted at any given time, and once complete, organisms can recruit into the nourished area. To summarize, the impacts of beach renourishment projects on the intertidal and surf zones are considered temporary, minor and reversible. Cumulative effects of multiple simultaneous beach nourishment operations could be potentially harmful to fishes of the surf zone; however, the high quality of the sediment selected for beach fill and the small amount of beach affected at any point in time would suggest that this activity would not pose a significant threat.

Hardbottoms: Hardbottoms are also called "live-bottoms" because they support a rich diversity of invertebrates such as corals, anemones, and sponges, which are refuges and food sources for fish and other marine life (Sedberry and Van Dolah, 1984). They provide valuable habitat for reef fish such as black sea bass, red porgy, and groupers. Hardbottoms are also attractive to pelagic species such as king mackerel, amberjack, and cobia. While hardbottoms are most abundant in northern portions of South Carolina, they are located along the entire coast. Hardbottoms in the Myrtle Beach area are discussed in detail in Appendix 5. Though the potential for sedimentation exists with any storm damage reduction project, the effects on low lying ephemeral hardbottom communities are not expected to be significant and impacts to high relief hardbottom will be avoided because of mandatory buffers; cumulative effects are expected to be minimal.

Nearshore Zone: Beach nourishment projects introduce fill into nearshore waters out to a specified depth of closure, usually from about –20 to –25 feet. Benthic organisms, phytoplankton, and seaweeds are the major primary producers in this community with species of *Ulva* (sea lettuce), *Fucus*, and *Cladocera* (water fleas) being fairly common where suitable habitat occurs. Many species of fish-eating birds are typically found in this area including gulls, terns, cormorants, loons, and grebes.

Borrow Areas**:** Polychaetes, amphipods, oliogchaetes, pelecycpods, and decapods are major infaunal assemblages inhabiting the borrow areas. The loss of benthic marine invertebrates may occur as organisms pass through the hopper dredge. Sessile benthic organisms may be buried by resuspended and redeposited sandy sediments. Hard-bottom areas in and adjacent to the borrow areas, that support complex communities described above, have been identified by recent survey and will be avoided.

Incident Wave Conditions: The potential impacts of local deepening of the offshore borrow areas have been analyzed and are documented in detail in Appendix 8.

Longshore Sand Transport and Shoreline Change: On a regional basis, renourishment projects add material to the longshore transport system, providing increased sand supply. Although a regional sediment budget analysis has not been completed, it is assumed that the proposed action and the combined effects of all other existing and proposed beach projects will have a minimal effect on shoreline and sand transport.

E.1. Other Resources

Air Quality: The ambient air quality for all of coastal South Carolina has been determined to be in compliance with the National Ambient Air Quality Standards. All coastal counties in South Carolina are designated as attainment areas and do not require conformity determinations. Although ozone is not a significant problem in the coastal counties, ozone is South Carolina's most widespread air quality problem, particularly during the warmer months. High ozone levels generally occur on hot sunny days with little wind, when pollutants such as nitrogen oxides and hydrocarbons react in the air. The proposed project and all other existing similar projects along the South Carolina coast are not anticipated to create any adverse effect on air quality from April through October.

Social and Economic: The coastal areas of South Carolina will continue to grow and expand both with and without beach nourishment projects. Therefore, the economic benefit analysis for the proposed project claims no increase in benefits or hurricane and storm damage due to induced development. Development of vacant lots is limited to lots buildable under the regulations set forth by OCRM, flood plain regulations, State and local ordinances, and applicable requirements of the Federal National Flood Insurance Program. IWR Report 96-PS-1, FINAL REPORT: An Analysis of the U.S. Army Corps of Engineers Shore Protection Program (June 1996) states: "Corps projects have been found to have no measurable effect on development, and it appears that Corps activity has little effect on the relocation and/or construction decisions of developers, homeowners, or housing investors."

F. Resource Capacity to Withstand Stress and Regulatory Thresholds

There are no known thresholds relating to the extent of ocean bottom that can be disturbed without significant population level impacts to fisheries and benthic species. Therefore, a comparison of cumulative impacts to established thresholds is not made. It is clear that the potential impact area is small relative to the area of available similar habitat on a vicinity, statewide, and regional basis. It is expected that there is a low risk that the direct and cumulative impacts of the proposed action and other known similar activities would reach a threshold with potential for population level impacts on important commercial fish stocks. In regard to physical habitat alterations it is expected that alterations in depths and bottom sediment may occur and be persistent. However, site modifications would be within the range of tolerance by these species and, although man-altered, consistent with natural variations in depth and sediment within the geographic range of EFH for local commercial fish species.

During the 1996 Myrtle Beach project, benthic infaunal and sediment samples were collected quarterly from the borrow area and an undredged reference area from November 1995 until February 1998, with supplemental sampling occurring in February 1999 (Jutte et al., 2002). Sediment composition at the borrow area underwent significant changes following dredging activity. Organic matter content at the borrow site was elevated after dredging occurred, with effects persisting throughout the study period. Biological effects at the dredged site, based on temporal and spatial comparisons, included altered diversity indices (H', J', and species richness), shifts in general taxonomic composition, and changes in numerically dominant species. The benthic infaunal assemblage in the borrow area recovered to pre-dredging conditions, showing signs of enhancement, within 27-30 months after dredging. The relatively rapid recovery of the dredged area was attributed to the use of hopper dredges that leave shallow dredged furrows separated by relatively undisturbed areas of sediment and biota

Benthic organisms living in beach habitats are adapted to living in high energy environments; they are able to quickly recover to original levels following beach nourishment events; sometimes in as little as three months (Van Dolah et al., 1994; Levison and Van Dolah, 1996). This is again attributed to the fact that intertidal organisms are living in high energy habitats where disturbances are common. Because of a lower diversity of species compared to other intertidal and shallow subtidal habitats (Hackney et al., 1996), the vast majority of beach habitats are recolonized by the same species that existed before nourishment (Van Dolah et al., 1992; Levison and Van Dolah, 1996; Hackney et al., 1996). While the proposed beach disposal may adversely impact intertidal macrofauna, these organisms are highly resilient and any effects will be localized, short-term, and reversible.

G. Baseline Conditions

Environmental monitoring, described in Appendix 9, will establish the baseline environmental conditions for this project in a specific manner. However, it is assumed that the current condition of the project area is that of a healthy, functioning ecosystem.

H. Cause and Effect Relationships

The following section describes impacts of the proposed action on significant resources. Cause and effect relationships described in the EA are consistent with those that would be expected for other similar projects that are pertinent to this analysis.

Magnitude and Significance of Resource Impacts

I. Offshore Borrow Areas

Site Specific Impacts: The project borrow areas, as defined in the project description, would be the extent of site specific impacts.

II. Beach Areas

Project Level Impacts: The cumulative area of all three reaches of the protective berm will be impacted.

a. Existing Local Maintenance:

Under existing conditions, the entire study area is expected to experience frequent local maintenance, including beach scraping and bulldozing, etc.

b. Existing Disposal Activities:

Portions of the study area receive dredged material on an 8 to 10 year cycle. The placement of nourishment material along the study area is not expected to affect the current disposal schedule.

c. Existing Beach Nourishment:

This re-nourishment is a portion of an existing Federal project.

d. Proposed Beach Nourishment:

The area of Singleton Swash is under study for additional nourishment. This area is located between reaches 1 and 2.

e. Cumulative Impacts:

It is possible that the proposed action will impact beach invertebrates in areas that have not fully recovered from past sand deposition, extending recovery time.

11. Conclusion

A relatively small segment of the South Carolina coastline and nearshore, including the borrow areas, are likely to be affected by the proposed action. The impact area would not increase significantly since portions of the areas proposed for dredging and fill have previously been dredged or had sand deposition. On a statewide scale, the existing and approved placement sites are well distributed in northern, central and southern parts of the state. It is unlikely that cumulative impacts from space crowded perturbation are occurring or will occur due to the construction of this project. The analysis suggests that the potential impact area from the proposed and existing actions is small relative to the area of available similar habitat on a vicinity, statewide, and basin basis. Also, for some species, such as sea turtles and seabeach amaranth, beach projects may provide additional habitat or improve existing habitat by replacing beach material lost to erosion. Invertebrates are expected to recover in and adjacent to the borrow areas.

12. Actions to Reduce Cumulative Impacts

Activities undertaken as a result of coordination with the Fish and Wildlife Service, the National Marine Fisheries Service and the South Carolina Department of Natural Resources will result in the reduction of cumulative impacts.

13. Alternatives to the Proposed Action

The Corps of Engineers 1993 EIS addresses alternatives to using the proposed borrow areas.

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Appendix 1

Myrtle Beach and Vicinity Shore Protection Project
Environmental Impact Statement

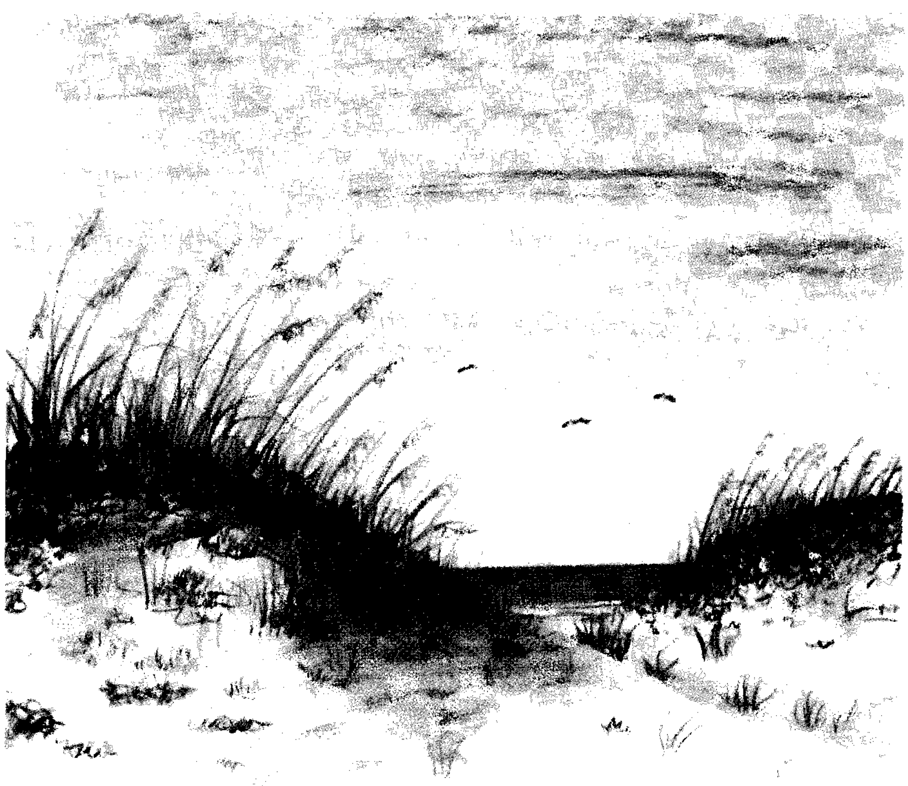
US Army Corps
of Engineers
Charleston District

January 1993

Environmental Impact Statement

Myrtle Beach and Vicinity Shore Protection Project

Horry and Georgetown Counties South Carolina



MYRTLE BEACH AND VICINITY SHORELINE PROTECTION PROJECT
HORRY AND GEORGETOWN COUNTIES, SOUTH CAROLINA

FINAL
ENVIRONMENTAL IMPACT STATEMENT

US ARMY CORPS OF ENGINEERS
CHARLESTON DISTRICT
SOUTH ATLANTIC DIVISION

JANUARY 1993

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FINAL
ENVIRONMENTAL IMPACT STATEMENT

Myrtle Beach and vicinity Shoreline Protection Project, Horry and Georgetown Counties, South Carolina.

RESPONSIBLE AGENCY: The responsible lead agency is the U.S. Army Engineer District, Charleston.

ABSTRACT: Myrtle Beach and vicinity, known as the Grand Strand, is a major recreational and economic resource for the state of South Carolina. The main attraction to the Grand Strand is the coastal beaches. Despite state and local efforts to protect and preserve the beach resources, the problem of protecting existing coastal development from erosion and winter storm tides remains an extreme concern. Many nonstructural and structural alternative plans were evaluated to remedy the problem. The recommended plan involves the construction of 25.4 miles of protective beach on three independent reaches. All nourishment material will come from offshore borrow areas. These borrow areas are from 1.5 to 5 miles offshore from the beaches to be nourished.

The official closing date for the receipt of comments is 30 days from the date on which the Notice of Availability of this Final EIS appears in the Federal Register.

If you would like further information on this statement, please contact:

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MYRTLE BEACH AND VICINITY SHORELINE PROTECTION PROJECT
HORRY AND GEORGETOWN COUNTIES, SOUTH CAROLINA
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1.0 Summary

1.1 General

In response to a resolution by the Committee on Public Works and Transportation of the House of Representatives, United States, adopted 17 November 1981, a feasibility study was conducted to identify problems and needs associated with beach erosion and storm protection along the northeastern coast of South Carolina. The study was completed and a report prepared in October 1987 (revised June 1988). The recommended source of borrow material for initial construction and periodic nourishment was identified in the report as the Canal Industries Waterway and International Paper Waterway sites, with additional investigation of offshore sites. Hurricane Hugo struck the South Carolina coast 21 September 1989 causing extensive beach erosion, damage to beach revetment structures, and damage to homes and commercial buildings. The state of South Carolina responded with an emergency nourishment project which involved transporting sand material from various inland and inlet locations to the Grand Strand beaches. Some of the borrow sites used were those planned for the authorized project. In addition to borrow sites, the emergency nourishment also changed beach profiles. The changes in topography and borrow site location required the original pre-Hugo authorized project to be updated. The update, or General Design Memorandum (GDM), includes project design, economic investigations, real estate and environmental requirements. The original report contained an Environmental Assessment which was completed in 1987. The Environmental Impact Statement, contained herein, addresses the entire recommended project, including the borrow sites located offshore. The project was authorized for construction in the 1990 Water Resources Development Act and is published in House Document 101 - 248, 1990.

1.2 Authorized Project

The authorized project called for construction of a protective beach along the Grand Strand area.

The project recommended for construction herein consists of three reaches. Reach 1 extends for a total distance of 45,466 feet or 8.6 miles. This reach is referred to as Reach 1 or North Myrtle Beach.

Reach 2 extends for a total distance of 49,732 feet or 9.0 miles and is referred to as Reach 2 or Myrtle Beach.

Reach 3 extends for a total distance of 40,658 feet or 7.7 miles and is referred to as Reach 3 or Garden City/Surfside. The total distance of all three reaches is 135,856 feet or 25.4 miles.

This project has three non-Federal sponsors, one for each reach. The non-Federal sponsor for Reach 1 is the City of North Myrtle Beach. The non-Federal sponsor for Reach 2 is the City of Myrtle Beach. Reach 3 lies within the jurisdictional boundaries of Georgetown County, Horry County, and the Town of Surfside Beach. Horry County has agreed to be the non-Federal sponsor for Reach 3; they plan to enter into a separate agreement with Georgetown County and the Town of Surfside Beach for the cost share of their respective portions.

The recommended project calls for the initial placement of 5.1 million cy of material on the beach. This material will come from offshore borrow sites. There are sufficient quantities of material at these sites for initial construction and all periodic nourishment efforts. Periodic nourishment will take place once every eight or ten years as required. This material will also come from the offshore sites. Sand fencing will be installed at Reach 1 to aid in achieving the design berm height. The new berm will be planted with beach grasses to stabilize the dune.

1.3 Alternatives

Several alternatives were considered during this study to prevent beach erosion and storm damage to the beaches. Nonstructural alternatives were considered as were a combination of nonstructural and structural measures. None of these plans, including the "No Action Plan", would result in an effective preventive for beach erosion or storm damage reduction. Several structural plans were studied and eliminated from consideration because of economic constraints and in recognition of desires and preferences voiced by state and local government representatives. Because of the difficulty in locating suitable sources of sand in the study area, a considerable amount of effort was concentrated in locating suitable inland/offshore borrow areas. More than 170 property owners with highest potential reserves were contacted concerning availability of land and permission to explore their property. Of the 170 properties, eight were identified as potential sources for conducting field investigations. Four upland sites were identified but were eliminated from consideration because they became unavailable. Several studies involving vibracore sampling were conducted to locate suitable offshore borrow areas. Suitable offshore borrow areas have been located and have been recommended for use during construction of this project.

1.4 Environmental Impacts

The recommended plan would provide storm protection for valuable beachfront property and help assure the viability of the Grand Strand's tourist oriented economy through use of methods that will have a negligible adverse impact on the area's fish & wildlife resources. The area's aquatic environment would not be significantly altered. An additional intertidal and high-tide beach area would be created and maintained which would benefit a variety of invertebrates, birds, and fish.

The principle adverse effects of constructing the recommended project are related to the dredging of sand from offshore borrow sites and placement as well as movement of the sand once it is on the beach. Hopper dredging would temporarily increase turbidities in the immediate vicinity of the dredge and in the immediate vicinity of the beach where the material is being placed. The effects from turbidity associated with this project would be temporary and minor. Hopper dredges operate like a large vacuum, which cause only insignificant and temporary turbidity plumes. In addition to a minor increase in turbidity which may temporarily depress water quality, the dredging may destroy benthic organisms which are picked up and pumped to the beach. Placement of sand on tidal and subtidal beaches will smother some organisms inhabiting the beach. The loss of organisms from the dredging operation at the borrow sites and from smothering on the beach is considered insignificant as these animals will recolonize affected areas very quickly. A monitoring plan is being designed to monitor the effects to nearshore, and offshore borrow site benthos. The presence of the dredge and other construction equipment will be aesthetically displeasing to some people as will the noise from this equipment.

2.0 Need for and Objectives of Action

2.1 Purpose and Need (of the Proposed Action)

The Grand Strand area of South Carolina has become a major recreational and economic resource of the state. Based on the latest information obtained by the South Carolina Department of Parks, Recreation, and Tourism, this area, comprised of Horry and Georgetown Counties, had in excess of 10.6 million visitors in 1991 who created a record breaking total of nearly $2.2 billion in visitor spending and accounted for approximately 40% of the State's total travel-tourism spending.

A major seasonal attraction to the Grand Strand is the coastal beaches which are the basis for the majority of recreational development. Approximately 90 golf courses attract people to the Grand Strand on a year-round basis. Coastal development has proceeded at a rapid pace and now covers practically the entire beach front area. Density has also increased dramatically as single family residences have been replaced by high rise hotels and resort condominiums. The demand for beach access has resulted in an encroachment of development as close as possible to the remaining dune line and in many cases this development has damaged the natural coastal defense system.

The City of Myrtle Beach has completed the second phase of a two-phase nourishment project designed for typical weather and erosion conditions experienced along Myrtle Beach during a one-to-ten year period. The project also resulted in a 45-55 foot wider high-tide beach along the nourished portion within the city limits.

Phase I, placed during the winter months of 1985 and 1986 consisted of the placement of 316,517 cubic yards of fill between 10th Avenue North and 29th Avenue South. Phase II, placed during the winter of 1986 and 1987, added an additional 537,270 cubic yards between 82nd Avenue North and Sunset Terrace; and between 31st Avenue North and 19th Avenue North for a total pay yardage of 853,787 cubic yards. This project placed an average of 19.75 cubic yards of sand per foot of shoreline at an average cost of $109.61 per foot or $5.55 per cubic yard. Total project cost was approximately $4.5 million.

Beach fill was obtained from inland sources and trucked to the front beach where the material was spread using land based equipment. Each truck carried an average of 14.3 cubic yards and during work periods there were an average of 19.34 truck hauls per hour for a total of 59,539 truck loads.

Despite state and local efforts to protect and preserve the beach resources, the problem of protecting existing coastal development from damages due to normal erosion and to abnormal tides, particularly during winter storms and hurricanes still remains. In 1989 Hurricane Hugo struck the South Carolina coast just north of Charleston. Damages to Horry County including the Grand Strand beaches were estimated at approximately $460 million. The winter storm of 1 and 2 December 1986 resulted in an estimated $2 million in structural damages in the Grand Strand area. This storm was followed by a second storm in January 1987, which, according to figures obtained by the State Office of Emergency Preparedness, damaged 387 homes and 601 businesses along the coast. Damages in the Horry County/ Georgetown County area were estimated to be about $13.3 million.

GRAND STRAND
Hurricane Hugo Damage - 1989

2.2 Planning Objectives

The "Economic and Environmental Principals and Guidelines for Water and Related Land Resources Implementation Studies" (The Principals and Guidelines, or P&G) are the principle guidelines for planning by Federal agencies involved in water resources development (USWRC, 1983). Although each project and project setting presents unique problems and opportunities, the Corps of Engineers applies a consistent set of decision criteria to participation in project planning and construction. There are three basic criteria: 1. that there be an economically justified and environmentally acceptable project, 2. that Federal participation be otherwise warranted, and 3. that the project meets current Administration budget priorities.

The Federal objective, as stated in the P&G, is to contribute to national economic development consistent with protecting the nation's environment, pursuant to national environmental statues, applicable executive orders, and other Federal planning requirements.

Economic justification has been a major consideration in the development of civil works projects since the Flood Control Act of 1936. In this Act, Congress required that the Corps recommend a project only "if the benefits to whomsoever they may accrue are in excess of the estimated costs and if the lives and social security of people are not otherwise adversely affected."

If there is an economically justified project, decision on whether and to what extent there should be Federal participation are guided by a concept of the Federal interest that has evolved from legislation, from precedent in project authorization and construction, and from Administration budget priorities. Federal participation is limited in circumstances where there are special and local benefits which accrue to a number of identifiable beneficiaries. The Federal government does not formulate projects based on benefits which are incidental to basic project purposes. The Administration does not budget for a project unless a significant proportion of the outputs have a high budget priority.

Federal planning concerns other than economic include environmental protection and enhancement, human safety, social well being, and cultural and historic resources. Environmental and safety considerations are of prime importance. In developing project modifications, the Corps:

- Provides for full consideration of measures to protect, enhance and restore ecological, aesthetic, historical and cultural resources;

- Attempts to obtain the best available information on the environmental effects of plans through an exchange of views and information with resource agencies at all levels of government, affected interests and the public;

- Provides equal consideration throughout planning for environmental, economic, social, financial and engineering factors in plan development, evaluation and modification of the authorized project;

- Attempts to minimize adverse environmental effects, including irreversible commitments of resources, and to mitigate unavoidable losses to the extent appropriate, concurrent with project construction.

Participation in shore protection projects is limited to beach restoration and protection, not beach creation or improvement unless such improvement is needed for engineering purposes. In addition, the Federal cost share is reduced proportionately to the extent that a project protects private shores from beach erosion and land loss.

The recommended project is formulated to insure that the project meets the specific needs and concerns of the general public within the project area; responds to expressed public desires and preferences; is flexible in order to accommodate economic, social, and environmental patterns and changing technologies; is integrated with and is complementary to other related programs in the study area; and is implementable with respect to financial and institutional capabilities and public consensus.

2.3 Study Authority and Background

In response to a resolution by the Committee on Public Works and Transportation of the House of Representatives, United States, adopted 17 November 1981, a feasibility study was conducted to identify problems and needs associated with beach erosion and storm protection along the northeastern coast of South Carolina. The study was completed and a report prepared in October 1987 (revised June 1988). The primary source of borrow material for initial construction and periodic nourishment was identified in the report as the Canal Industries

Waterway and International Paper Waterway sites, with additional investigation of offshore sites. Hurricane Hugo struck the South Carolina coast 21 September 1989 causing extensive beach erosion, damage to beach revetment structures, homes, and commercial buildings.

The state of South Carolina responded with an emergency nourishment project which involved transporting sand material from various inland and inlet locations to approximately 15 miles of Grand Strand beaches. Some of the borrow sites were those planned for the authorized project. In addition to borrow sites, the emergency nourishment also changed beach profiles. The new dunes were generally designed with a top elevation of 9.0 feet NGVD and a 15 foot top width. The changes in topography and additional borrow site locations required the pre-Hugo project to be updated. The General Design Memorandum (GDM), which updates the necessary items, includes project design, economic investigations, real estate, and environmental requirements. The Feasibility report contained an Environmental Assessment which was completed in 1987. This Environmental Impact Statement addresses the entire project, including the new borrow sites located offshore. The project was authorized for construction in the 1990 Water Resources Development Act. The authorization was based on the original Feasibility Report and Environmental Assessment.

3.0 Alternatives Considered

3.1 Plans Eliminated From Further Study

As shown in Table 1, all possible alternatives did not meet each established local and Federal planning objectives. The alternatives which best met all objectives were variations of beach fill measures and the stabilization of beaches and dunes by vegetation. However, since the dune system has been destroyed or severely damaged, the stabilization of the dune and beach system by vegetation was not a viable solution. Therefore, only variations of beach fill measures were carried into the intermediate phase of plan formulation.

TABLE 1

PRELIMINARY ALTERNATIVES CONSIDERED

Possible Alternatives	Local Planning Objectives 1/				Other Objectives 2/			
	RB	FP	EC	TBE	NED	EQ	OSE	RD
Nonstructural Alternatives (NS)								
No Action	0 3/	0	0	0	0	0	0	0
Rezoning of beach area	0	P	0	P	P	0	P	P
Modification of building codes	0	P	0	0	P	0	P	P
Construction setback line	0	P	P	P	P	0	P	P
Moratorium on construction	0	P	0	0	0	0	0	0
Flood insurance	0	0	0	P	0	0	P	0
Evacuation planning	0	0	0	0	P	0	P	P
Establish a no-growth program	0	0	0	0	0	P	0	0
Relocation of structures (building...)	0	F	P	0	0	P	0	0
Flood proofing of structures	0	F	0	0	0	0	0	0
Condemnation of land and structures	P	P	P	0	0	F	P	0
Various combinations of above	-	-	-	-	-	-	-	-
Structural Alternatives (S)								
Beach revetment	0	P	P	0	P	0	P	P
Beach fill with periodic nourishment	P	P	P	P	P	P	P	P
Beach fill with periodic nourishment stablized by offshore breakwaters/ perched beach	P	P	P	0	P	P	P	P
Beach fill with periodic nourishment stablized by groins	P	P	P	0	P	0	0	P
Seawalls	0	P	P	0	P	0	0	P
Stabilization of beaches and dunes by vegetation	P	P	P	P	P	P	P	P
Hurricane dune	P	F	P	P	P	P	P	P
Removal or modification of detrimental structures	P	P	P	P	P	P	0	P
Offshore sand sources	F	F	F	P	F	P	P	P
Inland sand sources	F	F	F	P	P	P	P	P
Various combinations of the above	-	-	-	-	-	-	-	-

Notes:

1/ RB - Provision of recreation beach
FP - Protection of flooding and wave damage
EC - Beach erosion control
TBE- Protection of tourist base economy

2/ NED- National Economic Development
EQ - Environmental Quality
OSE - Other Social Effects
RD - Regional Development

3/ F - Fully meets objective
P - Partially meets objective
0 - Does not meet objective

A combination of nonstructural measures was also carried forward into the intermediate stage of evaluation. These alternatives included rezoning, building code modification, establishment of setback lines, flood insurance, evacuation planning and other similar nonstructural measures. Most of these alternatives have been at least partially implemented by local government and only some refinement is needed. Although these alternatives can decrease the overall storm impact, they do not substantially reduce the vulnerability to damage of existing beaches and structures. Therefore, a nonstructural plan does not fully meet the objectives of this study. From the point of view of the economic evaluation, a nonstructural plan at this location has approximately the same value as the no action plan.

Hard structure plans which included measures such as bulkheads, groins, and offshore breakwaters were eliminated from detailed consideration due to economic constraints and in recognition of desires and preferences voiced by state and local government representatives. Construction of a dune to provide hurricane surge protection was also evaluated. This would require construction of a dune with a width and height capable of protecting upland property from run up induced flooding and wave attack from storms of hurricane severity. The construction of a 20-year level protection beach fill would provide protection against a hurricane with a surge of approximately 8.8 feet NGVD. However, a project of this size is not justified, nor acceptable to the general public. Protection against larger storms would also be unjustified due to the low elevation of the existing dune system. A hurricane project for a 100-year storm would of necessity have to be constructed along the entire 37-mile study area and the cost of such a project would greatly exceed the benefits. Therefore, during the evaluation of preliminary plans, it was determined that hurricane protection measures for the study area were not justified at the present time.

3.2 Without Conditions (No Action Alternative)

The "no action" alternative would allow the continuation of the erosion and storm damage currently being experienced along the Grand Strand. This alternative would not provide relief from the problems affecting residents and visitors to the Grand Strand and their property. The no action alternative represents the baseline condition and is retained only for comparison with the considered alternatives.

3.3 Plans Considered in Detail

Beach nourishment with periodic nourishment was determined to be the best solution to the problems being experienced in the study area. Four variations of this alternative providing 2,5,10, and 20-year levels of protection were evaluated for each study reach. The volume of sand and berm height and width, and periodic nourishment cycles are the only differences between the four plans. Major damage areas identified for restoration include an 8.6 mile reach in North Myrtle Beach (Reach 1), an 9.0 mile reach in Myrtle Beach (Reach 2), and a 7.7 mile reach in the Garden City/Surfside Beach area (Reach 3).

3.4 Borrow Areas.

Because of the difficulty of locating suitable sources of sand in the study area, a considerable amount of effort was concentrated in locating suitable inland and offshore borrow areas. More than 170 property owners with high potential for inland sand reserves were contacted concerning availability of land and permission to explore their properties. The 170 properties were narrowed to four sites [the Canal Industries Waterway site, Bell, International Paper Waterway site, and International Paper 501 site (south parcel only)] which were selected for consideration for project construction. The Canal Industries Waterway site contained more than 10 million cubic yards of sandy dredged material suitable for beach nourishment. This material was placed in a 425 acre strip along the waterway during initial construction and O&M of the AIWW. The Bell site consisted of a sandy area between Carolina Bays which contained about 537,000 cubic yards of sand. Reserves in sand ridges in the International Paper 501 site (south of 501 only) were estimated at more than 2 million cubic yards. The International Paper (IP) Waterway site was a 326 acre state permitted sand mining area which was used as a source of sand materials for the city of Myrtle Beach nourishments project in 1986 & 1987. Reserves totaled more than 7 million cubic yards of sandy dredged material placed during initial construction and O&M of the AIWW. Because of concerns expressed by state and Federal agencies, it was determined that the most environmentally acceptable sources of sand was the AIWW disposal areas in the Canal Industries Waterway and IP Waterway sites.

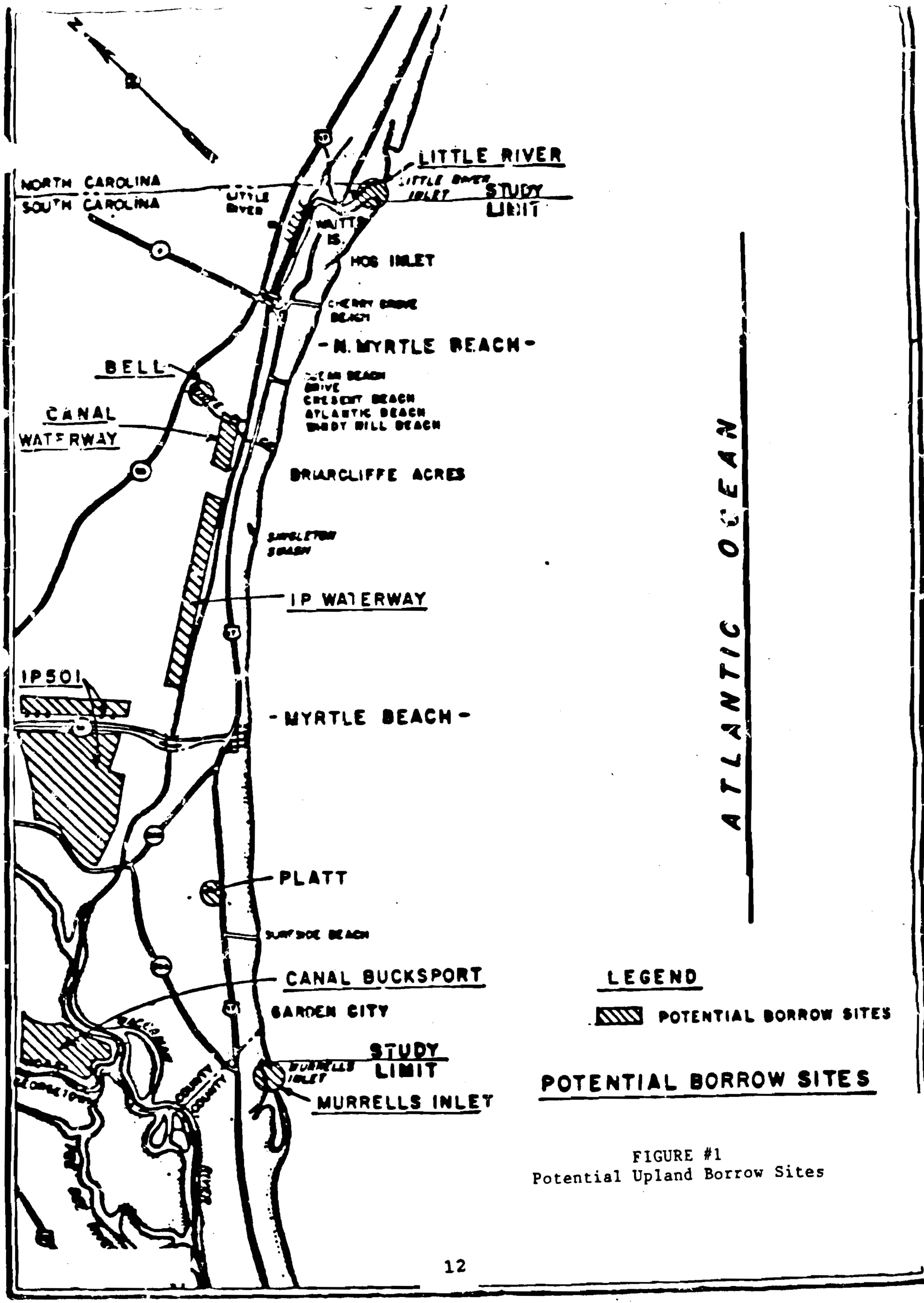

FIGURE #1
Potential Upland Borrow Sites

EMERGENCY BEACH NOURISHMENT
Surfside Beach Following Hugo - 1989

In addition to inland sites, several studies of potential offshore borrow areas were conducted. The first study investigated areas up to 5000 feet offshore. Vibracore sampling revealed much of this area to be hard bottom and live bottom not suitable for beach nourishment. The second offshore study included vibracore sampling from about one to three miles offshore. This study revealed that suitable quantities of sand may be present in: a sand ridge off Garden City; surface cover from Little River Inlet to Cherry Grove Beach; buried channels offshore of Canepatch Creek; and located in the delta offshore of Murrells Inlet (See Figure 2).

A third offshore study involved extensive vibracore sampling (every 2,000 feet apart over the entire area) of the same three areas from approximately 1.5 miles offshore to approximately 5 miles. This sampling identified more than adequate sand supplies for initial construction and periodic nourishment for the 50 year economic life of the project. These same three areas were surveyed for live bottom. During this survey an artificial reef was discovered in the northern most area (surface cover). Because of this reef, the dimensions of this area were shifted south where vibracore sampling indicated an abundance of sand. Live bottom surveys were performed on this new area with no artificial reefs located.

3.5 Recommended Plan

The recommended plan is the most acceptable environmental plan and provides for construction of a protective beach in three separate reaches.

<u>North Myrtle Beach (Reach 1)</u> - Restore about 8.6 miles of beach from Hog Inlet downcoast to White Paint Swash near 48th Avenue South with approximately 2.2 million cy of dredged material obtained from the northern most offshore borrow sites (See Figure 2). Periodic nourishment with about 440,000 cy of material obtained from the same borrow area will be required every 10 years. The initial berm will be constructed to an elevation of 10.0 feet NGVD with a top width of 20 feet. Side slopes will be 1.0 foot vertical and 20.0 feet horizontal.

<u>Myrtle Beach (Reach 2)</u> - Restore 9.0 miles of beach from Bear Creek Swash near 82nd Avenue North downcoast to Midway Swash near 29th Avenue South with approximately 1,830,000 cy of sand obtained from either the Cane North or the Cane South offshore borrow sites (See Figure 2). Periodic nourishment with about 440,000 cy of sand obtained from the same borrow site would be required every eight years, with

one 10 year effort requiring 550,000 cy. The initial berm would be constructed to an elevation of 9.0 feet NGVD with a top width of 15 feet.

Garden City/Surfside Beach (Reach 3) - Restore 7.7 miles of beach from near Myrtle Beach State Park downcoast to approximately 1.2 miles south of the Georgetown/Horry county line with about 1.1 million cy of sand obtained from the Surfside offshore borrow site (See Figure 2). Periodic nourishment with about 360,000 cy of material from the same borrow area would be required every eight years, with one 10 year effort requiring 450,000 cy. The initial berm would be constructed to an elevation of 7.0 feet NGVD with a top width of 10 feet.

4.0 Affected Environment.

This section describes the environmental components of the project area that would affect, or be affected by, any of the final array of alternatives.

4.1 Physical Environment

a. General

The study area encompasses approximately 37 miles of South Carolina's coastline and its environs from Little River Inlet at the North Carolina-South Carolina border to Murrells Inlet. The area extends oceanward to about 18,200 feet from the shoreline and inland approximately 14 miles near the City of Conway. This straight to gently-curving shoreline bordered by the Atlantic Ocean is oriented in a northeast-southwest direction. On the basis of geomorphology, it is classified as an arcuate strand, characterized by wide, flat beaches and breached by few tidal inlets (Hayes et al. n.d.). Referred to as the Grand Strand, the area includes Little River, North Myrtle Beach (Cherry Grove Beach, Ocean Drive Beach, Crescent Beach, and Windy Hill Beach), Atlantic Beach, Myrtle Beach, Surfside Beach, Garden City, and Murrells Inlet. The study area is located in Horry and Georgetown Counties.

b. Climatology

The climate of the area is temperate and is moderated by the nearness of the ocean and the Gulf Stream. Although summers are warm and humid, temperatures of 100 degrees

Fahrenheit or higher occur on the average of less than once a year. The mean annual temperature is about 64 degrees Fahrenheit. The frostfree growing season averages about 231 days. The first freeze generally occurs around the first part of November and the last freeze near the end of March. Precipitation is well distributed throughout the year with an average of about 50 inches. Percentage of precipitation by seasons is as follows: 18% winter; 20% spring; 41% summer; and 21% fall. Low pressure areas moving northeast along the coast bring heavy amounts of rain but rarely snow during the winter months. During the late summer or fall months, hurricanes occasionally reach the South Carolina coast. Available records indicate that over 70 storms and/or hurricanes have struck the coast. Heavy precipitation usually occurs with these storms.

c. Geology, Soil, Minerals

The project lies along the eastern edge of the Atlantic Coastal Plain Physiographic Province. This province is underlain by sediments of cretaceous to recent age which becomes thicker in a southeasterly direction from the fall line. The materials forming the beaches in the project area consist chiefly of silica sand. On most beaches, a thin bed of peaty clay or sand crops out near mean sea level. This layer is commonly covered except immediately after storms and is more resistent to erosion than the beach sands. Soils in the Myrtle Beach and vicinity commonly belong to the Capers and Wando coastal beach association.

Native beach sand characteristics were determined from grab samples taken from 33 profile lines 4000 linear feet apart along the length of the project. These samples were taken near the surface and at locations of the edge of dune (EOD), +2.8 NGVD, 0.0 NGVD, -2.3 NGVD, -6.0 NGVD, -12.0 NGVD, -18.0 NGVD, and -24.0 NGVD for each profile line. Reach 1 and Reach 2 each had a total of 96 samples while Reach 3 had 72 total samples. The District compared the native beach material with that of the potential borrow site material for grain size and composition compatibility. These samples were analyzed using standard sieve sized 1/2, 1/8, 4, 7, 10, 14, 18, 25, 35, 45, 60, 80, 120, 170, and 230.

<u>Native Beach Materials.</u> The native sand sampled on the beach and nearshore of North Myrtle Beach, Myrtle Beach, and Garden City and Surfside Beaches varied from fine sand size classification to medium sand size classification in both the Unified Soil Classification System and the Wentworth Classification System. In North Myrtle Beach the mean grain size for the beach samples varied from 0.16 mm (2.64 phi) to

1.08 mm (-0.11 phi) with a composite mean grain size of 0.263 mm (1.93 phi). The mean grain size for the nearshore sample varies from 0.11 mm (3.18 phi) to 0.59 mm (0.76 phi) with a composite mean of 0.208 mm (2.23 phi). The composite mean for both the beach sand samples and the nearshore sand samples was 0.235 mm (2.09 phi). Of the 48 nearshore sand samples, eight were not used in the composite. These samples did not appear to be representative due to their large shell content. Of the 48 beach samples, more than 62% had less than 1% visual shell content, and the maximum shell content for a single sample was 21%.

Myrtle Beach grain size varied from 0.20 mm (2.32 phi) to 0.89 mm (0.17 phi) for beach sand samples. The composite mean grain size was 0.44 mm (1.18 phi). The mean grain size for the nearshore sample was 0.16 mm (2.64 phi) to 1.78 mm (-0.83 phi) with a composite mean of 0.50 mm (1.00 phi). The composite mean for both the beach sand samples and the nearshore sand samples was 0.47 mm (1.09 phi). Of the 48 nearshore sand samples taken, 12 were not used in the composite. These samples did not appear to be representative because of their excessive shell content. From the 48 beach sand samples, more than 37% of the samples contained less than 1% visual shell content. The maximum amount of shell content for a single sample was 14%.

The mean grain size of beach sand sampled at Garden City and Surfside Beaches varied from 0.18 mm (2.47 phi) to 1.14 mm (-0.19 phi). The composite mean grain size was 0.44 mm (1.21 phi). The mean grain size for the nearshore sample varied from 0.16 mm (2.64 phi) to 1.34 mm (-0.42 phi) with a composite mean of 0.41 mm (1.29 phi). The composite mean for the beach sand samples and the nearshore samples were not used in the composite due to excessive shell content. Of the 33 beach sand samples considered, 30% contained less than 1% visual shell content. The maximum amount of shell observed for any one sample was 21%.

The wide range of sorting values for both the beach and nearshore sand samples indicate that the material placed on the beaches after Hurricane Hugo has yet to become fully sorted. For North Myrtle Beach the composite sorting value for the beach sand samples was 0.52 and the composite sorting value for both the beach and the nearshore sand samples was 0.55. Myrtle Beach had a composite sorting value for the beach sand samples of 0.91 while the combined composite sorting value for the beach sand samples and the nearshore sand samples was 0.88. The composite sorting value for the beach sand samples at Garden City and Surfside Beaches was 0.88 with a combined sorting value for the beach nearshore sand samples of 0.83. The varied range of grain sizes from one section of beach to another could also be explained by this. North Myrtle Beach was nourished by material from Hog Inlet, while the material which nourished Myrtle Beach came from inland borrow sites. Garden City and Surfside Beaches were nourished from the deposition basin adjacent to the up-coast side of the jetty at Murrells Inlet.

d. Littoral Drift

When waves approaching the shoreline at an angle are not completely refracted, the breaking waves create a longshore of littoral current. This current is more apparent in the surf or breaker zone than farther out. It carries the beach sand, which has been stirred into suspension by the turbulence of the breaking waves, along the shore parallel to the beach. The sand, which is moved in this way, is known as littoral drift. The term "net littoral drift" refers to the difference between the volume of sand moving in one direction along a beach and that moving in the opposite direction. At Myrtle Beach and adjacent beaches, this directional movement appears to be balanced. Shoreline changes in the vicinity of Myrtle Beach have averaged approximately one foot lost per year during the last half of this century and is due primarily to storm damage erosion and a rising sea level.

e. Water Resources

There are three geologic formations in the area which serve as ground water aquifers, the Tuscaloosa, Black Creek, and Peedee (Cooke, 1936). Most of the well water along the Grand Strand comes from the Black Creek and Peedee formations. The Black Creek formation consists chiefly of dark-gray laminated clay and sand. Water drawn from this formation is soft, highly mineralized, and contains considerable sodium bicarbonate. Many flowing wells in Georgetown and Horry Counties draw their water from this formation. The Peedee formation consists of gray sandy marl interbedded with thin ledges of marlstone. Waters in this formation are soft and contain considerable sodium bicarbonate. The Tuscaloosa formation contains a great deal of sand through which water can circulate freely and as a result is one of the most productive water bearing formations in the Coastal Plain. Water derived from the Tuscaloosa formation is soft and only moderately mineralized.

f. Tides

At Myrtle Beach, the mean tide range is 5.1 to 5.3 feet and the spring range is 5.3 to 5.9 feet (the spring tide is the tide which rises highest and falls lowest when the earth, sun and moon are aligned). Some of the highest observed storm tides in the area were produced by Hurricane Hazel on 15 October 1954. At Cherry Grove Beach, a maximum highwater mark of nearly 17.0 feet above NGVD was observed.

g. Water Quality

Ocean waters in the study area are generally considered to be of high quality and are used for numerous water oriented activities such as swimming and fishing. Salinity is very close to that of the open ocean due to a general lack of freshwater inflow.

4.2 Biological Resources.

a. Vegetation and Wildlife

As a result of extensive development, the primary terrestrial habitat in the immediate study area consists of urban and built-up lands, such as residential, commercial, industrial, and transportation, communication, and utility corridor areas. Vegetative cover in the area varies from sparse remnants of previous vegetation in areas that have been severely altered to a more natural condition in areas where developers recognized the importance of maintaining areas of undeveloped open space. Many species are displaced when development occurs while other, more gregarious species continue to prosper in suitable habitat in and along the edges of developed areas. Other habitats in the study area include the beach and nearshore ocean, dunes, shrub thickets, and forested areas.

In most areas along the South Carolina coast, beaches are gently sloping transitional areas between open water and upland communities. These communities typically consist of a dry berm zone located beyond the high tide zone, an intertidal zone that is alternately covered and exposed by tidal action, and a subtidal zone that occurs below the low tide line and extends seaward. In the study area, the dry beach berm has generally been severely eroded and the intertidal areas are narrower and steeper due to the extensive development and erosion control activities which have occurred all along the Grand Strand. Patchy areas of near shore and live bottom habitat occur in the subtidal zone (Van Dolah and Knotts 1984) throughout the length of the project area. Hard ground was more prevalent in the area between Garden City and Myrtle Beach than at other areas of the project.

Relatively few species inhabit sandy beaches, but of those that are present many frequently occur in large numbers. Typical inhabitants are beach fleas (*Orchestia agilis*) and ghost crabs (*Ocypode albicans*) in the beach berm; coquina (*Donax variabilis*), mole crabs (*Emerita talpoidea*), amphipods and various burrowing worms in the beach intertidal zone; and blue crabs, horse-shoe crabs, sand dollars, and a variety of clams and gastropod mollusks in the beach subtidal areas. In addition, many species of fish commonly occur in the surf zone and deeper nearshore waters. The Atlantic silverside (*Menidia menidia*), bay anchory (*Anchoa mitchili*), spot (*Leiostomus xanthurus*), bluefish (*Pomatomus saltatrix*), mullet (*Mugil cephalus*), king fish (*Menticirrhus saxatilis*), red drum (*Sciaenops ocellata*), flounder (*Paralichtys sp.*), and seatrout (*Cynoscion nebulosus*) are the most common. Although the beach zone is utilized by many species of wading and shore birds along much of the South Carolina coast, much of the project area provides somewhat less than ideal habitat for these species because of extensive development, heavy public use, and severe erosion problems.

Much of the dune system is totally lacking in many areas along the Grand Strand due to the extensive development. Few plant species can tolerate the harsh dune environment of sediment instability, salt spray, and periodic salt water overwash. As a result, vegetative cover generally consists of perennial grasses such as sea oats (*Uniola paniculata*), and other salt tolerant grasses. Because of a general lack of vegetative cover, wildlife usage is limited to small birds, ghost crabs, reptiles and amphibians, and insects.

Offshore borrow sites.

The offshore ocean borrow sites are subtidal and defined by two distinct bottom characteristics; hard bottom and sand bottom. Animals commonly found on the nearbeach ocean bottom are: sponges, corals, hydroids, bryozoans and ascidians as well as certain anemones, sessile polychaetes, and some arthropods. Most of these animals require hard substratum for attachment. Polychaetes, amphipods, oligochaetes, pelecypods, and decapods represent, among other taxa, the major infaunal assemblages inhabiting sand bottom.

b. Threatened and Endangered Species

In a 24 September, 1991 letter, the Fish and Wildlife Service (FWS) advised that the following threatened and endangered species may be present in the study area:

Listed Species	Scientific Name	Status
Bald eagle	(_Haliaeetus leucocephalus_) -	E
Red-cockaded woodpecker	(_Picoides borealis_) -	E
Wood stork	(_Mycteria americana_) -	E
Piping plover	(_Charadrius melodus_) -	T
Arctic peregrine falcon	(_Falco peregrinus tundrius_) -	T
Loggerhead sea turtle	(_Caretta caretta_) -	T
Shortnose sturgeon	(_Acipenser brevirostrum_) -	E
Canby's dropwort	(_Oxypolis canbyi_) -	E
Pondberry	(_Lindera melissifolia_) -	E
Cooley's meadowrue	(_Thalictrum cooleyi_) -	E
Rough-leaved loosestrife	(_Lysimachia asperulaefolia_) -	E
Sea-beach pigweed	(_Amaranthus pumilus_) -	SR
Carolina grass-of-parnassus	(_Parnassia caroliniana_) -	SR
Awned meadowbeauty	(_Rhexia aristosa_) -	SR
Vahl's fimbry	(_Fimbristylis perpusilla_) -	SR
Godfrey's sandwort	(_Minuartia godfreyi_) -	SR
Carolina grass-of-parnassus	(_Parnassia caroliniana_) -	SR
Chaff-seed	(_Schwalbea americana_) -	SR

LEGEND

E = Endangered
T = Threatened
SR = Status Reviews

In September 1981, the National Marine Fisheries Service (NMFS) provided the following information on threatened and endangered species which may occur in the area.

Listed Species	Scientific Name	Status
finback whale	Balaenoptera physalus	E
humpback whale	Megaptera novaeangliae	E
right whale	Eubaleana glacialis	E
sei whale	Balaenoptera borealis	E
sperm whale	Physeter catodon	E
green sea turtle	Chelonia mydas	Th
hawksbill sea turtle	Eretmochelys imbricata	E
Kemp's (Atlantic) ridley sea turtle	Lepidochelys kempi	E
leatherback sea turtle	Dermochelys coriacea	E
loggerhead sea turtle	Caretta caretta	Th
shortnose sturgeon	Acipenser brevirostrum	E

4.3 Human Resources

The evaluation of existing and future socioeconomic conditions in the Myrtle Beach Project area is based on land use plans, demographic conditions, economic base conditions, tourism and recreation, and infrastructure. The project includes areas within Horry and Georgetown Counties.

a. Land Use

In 1987, there were 1,177 farms in Horry County. Farm land made up 24.0 percent of the total land area in Horry County. In 1987, there were 224 farms in Georgetown County. Farm land made up 7.2 percent of the total land area in Georgetown County. Forest land made up 62.0 percent of the total land area in Horry County and 73.2 percent of the total land area in Georgetown County. Horry County contains 15,249 acres of state and Federal owned land, 2.1 percent of the total land area. Georgetown County contains 38,435 acres of state and Federal owned land, 7.3 percent of the total land area.

b. Demographics

The total population of Horry County in 1990 was 144,053 inhabitants. This represents a 42 percent increase since 1980. Horry County ranked first in annual average population growth of all counties in South Carolina from 1980 through 1990. The total population of Georgetown County in 1990 was 46,302 inhabitants. This represents a 9 percent increase since 1980.

Table 2
Population of Incorporated Places
within the Study Area

Place	1990 Population
Myrtle Beach City	24,848
North Myrtle Beach City	8,636
Atlantic Beach Town	446
Briarcliffe Acres Town	552
Surfside Beach Town	3,845

c. Economic Base and Income

Income. In 1989 the per capita income in Horry County was $13,122. In Georgetown County the per capita income was $11,191. In 1991 the median family income in Horry County was $29,100. In Georgetown County the median family income was $31,600.

Table 3
Per Capita Income and Median Family Income
of Incorporated Places within the Study Area.

Place	1989 Per Capita Income	1979 Median Family Income
Myrtle Beach City	$11,067	$16,904
North Myrtle Beach City	12,290	18,496
Atlantic Beach Town	5,314	9,063
Briarcliffe Acres Town	22,347	28,182
Surfside Beach Town	11,555	19,542

d. Housing

The number of housing units in Horry County increased from 29,109 units in 1970 to 89,960 units in 1990, an increase of 209 percent. The number of housing units in Georgetown County increased from 10,813 units in 1970 to 21,134 units in 1990, an increase of 95.4 percent. The median value of homes in Horry County increased form $42,900 in 1980 to $75,600 in 1990, an increase of 76.2 percent. In Georgetown County the median value of homes rose from $36,000 in 1980 to $63,800 in 1990, an increase of 77.2 percent. In 1990 there were 17,566 renter occupied units in Horry County. The median rent was $350 per month. In 1990 there were 3,354 renter occupied units in Georgetown County. The median rent was $232 per month.

e. Employment

In 1990 the civilian labor force in Horry County was 73,880, an increase of 1.8 percent from 1989. In 1990 the civilian labor force in Georgetown County was 22,880, an increase of 5.8 percent from 1989.

Table 4
1989 Employment by Sector for
Horry and Georgetown Counties

Sector	Horry County	Georgetown County
Agriculture	259	238
Mining	B	A
Construction	3,758	655
Manufacturing	6,670	5,263
Transportation and Other Public Utilities	1,517	445
Wholesale	1,840	305
Retail Trade	17,592	3,755
Finance, Insurance, and Real Estate	4,077	607
Services	15,712	2,367
Unclassified Establishments	E	C

A: 0 - 19 employees.
B: 20 - 99 employees.
C: 100 - 249 employees.
D: 250 - 499 employees.
E: 500 - 999 employees.

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f. Tourism

Tourism is the main industry in the Grand Strand area. In 1991, tourism generated $2.1 billion throughout the Grand Strand. Area attractions include the beach, golf courses, amusement parks, shopping malls, fishing piers, charter boats, restaurants, and festivals, such as the Sun Fun Festival and Canadian - American Days.

The 90 golf courses in the area alone generated $350 million. Surveys showed the average party of four visiting the area for the Sun Fun Festival spent $260 per day.

The total tourism-generated expenditures can be broken down as follows:

Food Expenditures	31.1%
Transportation Expenditures	29.4%
Lodging Expenditures	21.2%
Retail Expenditures	10.9%
Entertainment Expenditures	7.4%

The accommodations tax money collected in Horry County in 1991 was $6,415,997, an increase of 16.1 percent from 1990. Georgetown County collected $356,910 in 1991, a decrease of 2.8 percent from 1990. In Horry County the net revenue received from accommodations tax in 1991 was $5,527,686, an increase of 17.4 percent. In Georgetown County the net revenue received from accommodations tax in 1991 was $380,037, a decrease of 2.1 percent from 1990.

Table 5
Economic Impact of Travel on Horry and Georgetown Counties, 1988.

	Horry County	Georgetown County
Total Travel Expenditures (in thous.)	$1,587,257	$73,056
Travel-Generated Payroll (in thous.)	$308,245	$13,696
Travel-Generated Employment (jobs)	36,389	1,647
State Tax Receipts (in thous.)	$91,523	$4,243
Local Tax Receipts (in thous.)	$18,724	$621

The Myrtle Beach State Park is located in Horry County. In 1990 there were 1,100,218 total visits to the state park. This ranks above all other state parks in South Carolina.

g. Infrastructure.

Horry County contains 342.80 miles of state primary system highways and 974.12 miles of state secondary system highways. Georgetown County contains 146.83 miles of state primary system highways and 499.78 miles of state secondary system highways.

Within Horry County there are three airports. There is a basic transport airport in the town of North Myrtle Beach, an air carrier airport in the Myrtle Beach area, and a military airport. The military airport has been selected for closure in 1993 in response to the Base realignment and closure act. This base will be available after closure for alternate uses by either Horry County or the City of Myrtle Beach.

4.4 Cultural Resources

A survey using underwater video and side scan sonar of the affected ocean bottom sites has been completed.* The survey was completed by simultaneously towing a side scan sonar system and a television camera mounted on a sled. The tows were spaced 200 meters apart over the entire areas of each offshore borrow site. All five borrow areas surveyed contain a few hard targets which may be non-natural.

5.0 Environmental and Socioeconomic Consequences

5.1 Physical Environment

a. Air Quality

Air pollution derived from the dredge and other construction equipment should be negligible during both initial construction and periodic nourishment of the project. It is

* Stender, Bruce W.; Van Dolah, Robert F.; Maier, Phillip; 1991. Identification and Location of Live Bottom Habitats in Five Potential Borrow Sites of Myrtle Beach, SC. Marine Resources Division; South Carolina Wildlife and Marine Resources Department, Charleston, SC.

reasonable to assume that any impacts would be localized and of relatively short duration. Coastal winds prevent the buildup of automobile, boat, industrial and construction produced air pollutants.

b. Noise

Operating dredges are generally quiet and contribute less to ambient noise levels than normal motor and speed boat traffic. Offshore pumps are not expected to impact the ambient noise level as they will be far enough removed from the beach to be heard. Bulldozers will be working on the beach around the clock and may impact adversely the ambient noise level. The bulldozers will be muffled and impacts will be restricted to the immediate construction reach.

c. Water Quality

There will be short-term adverse water quality impacts during the construction period of this project. Dredging the proposed borrow areas will generate turbidity and sedimentation impacts within the immediate vicinity of the operation[1], but the generally large grain size of the material will keep the area of impact small and will ensure that there are no impacts beyond the period of construction.[2] The period of construction will be approximately 12 months each for the three nourishment reaches. Similar short-term water quality impacts will occur at the deposition sites along the 26-mile project shore. Fill operations will deliver a slurry of sand to the receiving shore, increasing turbidity in the immediate area. This effect, however, will not be significant since turbidity levels in the high-energy surf area are naturally high. Depths below the existing grade at the borrow sites will average less than two feet. Because of this, there is not expected to be any long term decrease in water quality at these sites. Periodic beach nourishment, which is expected to be required every 8 or 10 years, will have water quality impacts similar to those for initial construction. A 401 Water Quality Certification has been received from the South Carolina Department of Health and Environmental Control.

5.2. Biological Resources

a. Fish and Wildlife

The effects of the beach nourishment project on population levels of the coquina clam, mole crabs, and other invertebrate species inhabiting the beach intertidal zone will result in temporary adverse impacts to these organisms.[3]

These animals are important members of the food chain because they are preyed upon by a variety of commercially and recreationally important fish species and shore birds.

During preparation of the feasibility report for storm damage reduction at Myrtle Beach and vicinity (1987), the U.S. Fish & Wildlife Service provided an accompanying Coordination Act Report (CAR). This CAR dealt primarily with effects to fish and wildlife inhabiting proposed upland borrow sites. Since upland borrow sites are no longer being considered for beach nourishment, most of the service concerns are no longer applicable. However, a concern which did not involve upland borrow sites was the incorporation of a biological monitoring program into the recommended plan to determine the long-term impacts of beach nourishment on benthic populations and the significance of both short-term and long-term reductions in benthic productivity on fish and wildlife populations in the project area. It was the District's position in 1987 and continues to be, that inclusion of a costly long-term program to monitor impacts to benthos inhabiting the intertidal beach area proposed for nourishment would not be a sound investment of local and Federal funds. Since animals of high energy beaches are continually subjected to the effects of erosion and accretion and major physical changes resulting from storms and hurricanes, which in many cases are much more severe and widespread than the effects of the proposed nourishment project, beach nourishment and periodic nourishment would not unduly stress beach and intertidal fauna beyond their adaptive capabilities. Published accounts[4] of the effects of beach nourishment with sandy materials support the conclusion that adverse affects are generally short-term in nature, and the Corps believes the results of the monitoring program being conducted for the Myrtle Beach project support this conclusion. In addition, it must be recognized that beaches in much of the study area have been eroded to the point that they provide less than ideal habitat for many of the species of concern. This condition will likely persist or become much worse before project construction is initiated. As a result, we feel that the long-term benefits to be derived from providing a more stable beach environment far outweigh short-term adverse impacts which may result from placement of nourishment materials.

This does not mean however, that the District would not support a monitoring plan for nearshore and offshore borrow sites. A plan is currently being developed for consideration.

The proposed sandfill operation on the project beaches will cover an area of the shore and nearshore. The fill will extend to a maximum of approximately 3 feet below NGVD with a deposit of sand for the entire 25.4-mile project length.

Approximately one-third of this area of beach fill, will be raised from tidal or subtidal elevations to above the level of mean high water. The tidal zone will be displaced offshore from its present location and will experience no net loss in total area. In some areas of Myrtle Beach where there is little or no existing beach at high tide, the project will provide an increase in high tide beach area as the tidal zone is pushed offshore from the face of sea walls to a more gradual sandy beach slope. Much of the increase in beach and beach slope will result in a net loss of shallow nearshore (Littoral) zone.

The loss of (Littoral) zone area will mean a direct reduction in habitat for benthic marine invertebrates. This loss is negligible in view of the vast amount of existing nearshore area available. The loss of benthic marine invertebrates which currently inhabit the nearshore will be a short-term impact, since the new sand bottom will begin to be recolonized shortly after construction ceases and recolonization should be complete within three-to-six months following beach nourishment[5]. Tidal zone species will have an area of habitat equivalent to that at present. Nourishment materials will be clean sand having a grain size similar to that of the existing beach and should be rapidly recolonized following completion of initial nourishment and periodic nourishment. Since animals associated with high energy beaches are continually subjected to effects of erosion and accretion and major physical changes resulting from storms and hurricanes, initial construction and periodic nourishment will not unduly stress beach and intertidal animals beyond their adaptive capabilities.

There is no anticipated adverse effect on shore birds which loaf and feed on the beach. In fact the beach, after initial construction, may be enhanced for shore bird use. Loss of benthos and epibenthos associated with sandy ocean bottom will be the most direct impact in the borrow areas for this project. Some mortality will occur as organisms pass through the hopper dredge and pumping plants or as a result of being placed in the beach environment. Undoubtedly some benthic organisms, especially sessile species, will be buried by resuspended and redeposited sandy sediments. This effect is expected to be minimal because hopper dredges, which operate like a large vacuum, do not suspend material into the water column in significant amounts. Due to the rich diversity and abundance of invertebrates and fishes associated with live bottom, considerable effort has been made to identify the nature and extent of these areas. Television and side scan sonar equipment were used in surveys conducted in 1991 - 92 to document characteristics and identify the location and extent of bottom communities within the borrow sites.* Sufficient sand deposits are available in the offshore sites to completely avoid hard bottom communities and still construct and maintain the project beaches. Avoidance of these areas is part of the construction plan. In addition to avoidance of the hard bottom areas, a monitoring plan to collect quantitative data on both the benthic and epibenthic biomass within the offshore borrow areas will record their recovery following dredging. Since the water quality conditions and bottom substrate in the borrow sites will not be significantly altered from those at present, there should be no serious impediment to the recovery of the bottom fauna.[6] The depth of furrows left in the bottom by the hopper dredge drag head will be determined by dredge speed, bottom conditions, etc. but is not expected to exceed two feet.

The project will have no serious direct impact on marine fisheries. Some bottom fishes may be entrained in the intake stream of the hopper dredge, but most fishes are active swimmers and can avoid areas of disturbance. There will be little impact to fish eggs and larvae because the dredge areas are not sites where these life stages are concentrated. The impact to fisheries will be due to the reduced forage base within the borrow area immediately following construction as a result of the destruction of benthos and epibenthos. Because benthic and epibenthic recovery is expected to be rapid following project completion, this impact to fisheries is anticipated to be short-term. There is some evidence to show that the creation of borrow furrows may actually enhance fisheries by attracting fish to these areas of changed bottom contours, a situation that may be related to the "edge" effect, or ecotones.[7] Sampling for benthic and epibenthic recovery and water quality parameters will help monitor project impacts and may assist with predicting impacts to shrimp, crabs, etc. which may be attracted to the areas of damaged bottom contours.

* Stender, Bruce W., et. al., 1991. <u>Identification and Location of Live Bottom Habitats in Five Potential Borrow Sites Off Myrtle Beach, SC: Report to U S Fish and Wildlife Service</u>, Marine Resources Department Charleston, SC.

b. Threatened and Endangered Species

Coordination with the National Marine Fisheries Service and the Fish and Wildlife Service revealed that their primary concern relates to the effects of the proposed project on loggerhead sea turtle nesting habitat. A Biological Opinion Prepared by the U.S. Fish and Wildlife Service in accordance with Section 7 of the Endangered Species Act states that construction during the nesting season can cause harassment and disturbance to nesting turtles. It further states that nesting activity in the project vicinity is low and that nest surveys, which would be required if construction occurs during the nesting season, would reduce the likelihood of nest destruction. The project plan is to implement nest surveys and relocation plans. The nest survey and relocation activities will begin 65 days prior to beach construction activities. Construction occurs during the nesting season. Nest surveys and relocations will be conducted by personnel trained in nest survey and relocation procedures, and with a valid South Carolina Wildlife and Marine Resources Department (SCWMRD) permit. Nests also will be relocated between sunrise and 10 AM each day, and the relocation will be to a nearby self-release beach hatchery or other safe beach location where artificial lighting will not conflict with hatchling orientation. Also, the project construction plans and specification will provide for plowing of the beach after construction (if compacted), to a depth of 36 inches and to level sand escarpment etc. to facilitate nesting. The service recommended that "night time lighting on the dredge should be minimized". This and other construction recommendations will be written into the contracting specifications. It is the opinion of the service that if these provisions are provided, then the project would not likely jeopardize the continued existence of the loggerhead sea turtle.

c. Other Environmental Factors

There are no wildlife preserves, important agricultural lands, wild and scenic rivers, natural land marks, recognized scenic areas, or any other environments of special interest with the exception of Hurl Rock located where it could be impacted by the proposed project. Hurl Rock, a limestone outcropping at the same elevation as the beach, will be covered over with sand. This project will not involve any hazardous or toxic waste. This project is consistent, to the maximum extent practicable, with the South Carolina Coastal Zone Management Program and the South Carolina Coastal Council has concurred that the proposed activities are consistent.

5.3 Effects of the Project on Human Resources

The beach nourishment project will impact Horry and Georgetown Counties in a positive manner. Without the project, tourism could be expected to decrease or remain the same due to the lack of an adequate beach front. Therefore, travel-generated expenditures and employment could be expected to be stagnant. However, the project will allow Horry and Georgetown Counties to continue growth in these areas at the current rates. In short, the project will allow Horry and Georgetown Counties to progress at the status quo rates.

a. Recreation

The proposed project will significantly improve opportunities for recreational beach use. Where beaches now are narrow or nonexistent, a usable recreational beach 50 - 100 feet wide will stretch 25.4 miles along the project shore. This will draw additional visitors to the South Carolina shore. Recreational fishing, sunbathing and swimming will be temporarily affected by the project since the public, including fishermen, will not be allowed to enter active work areas. However, since the project will be constructed in sections and only those sections actually under construction will be closed to the public, impacts to these activities will be localized and relatively short-lived.

b. Aesthetics

Visual and aesthetic features include the Atlantic Ocean and a narrow beach along much of the project length. There is very little evidence of a dune system along the project length. Man made bulkhead and riprap form the landward side of the nourishment zone for much of the project length especially at Myrtle Beach. A slight increase in the berm height will not reduce the ocean view. Conversely, the nourishment project will provide an attractive and usable all-tide beach. Temporary degradation of aesthetics will occur on the beach during sand placement and movement.

5.4 Cultural

Reference Section 4.4; Hard targets identified during remote surveys of Bottom characteristics within the offshore borrow sites will be avoided during initial construction and periodic nourishment operations. The South Carolina Department of Archives and History has concurred with the opinion that avoidance of these hard target areas is an effective way to avoid any effects to properties that might meet National Register criteria. There are no Historical or Archaeological features within the beach nourishment zone which would be affected by the placement and movement of sand.

6.0 Any Probable Adverse Effects Which Cannot Be Avoided

The principle adverse effects of constructing the recommended project are related to the dredging of sand from offshore borrow sites and placement as well as movement of the sand once it is on the beach. The hopper dredging would temporarily increase turbidity in the immediate vicinity of the dredge and in the immediate vicinity of the beach where the material is being pumped. The effects from turbidity associated with this project would be minor because hopper dredging, which operates like a large vacuum, does not cause significant turbidity plumes. In addition to a minor increase in turbidity, which could temporarily affect the water quality, the dredging may destroy benthic organisms picked up and pumped to the beach. Placement of sand on tidal and subtidal beach would smother some beach inhabitants. The presence of the dredge and other construction equipment will be aesthetically displeasing to some people as will the noise from this equipment.

7.0 The Relationship Between Local Short-term Uses of Man's Environment and the Maintenance and Enhancement of Long-term Productivity.

The recommended project would serve both the short-term and long-term interests of the local economy by providing immediate and continuing relief from continual damage to the beaches and by enhancing the economic growth of the area by attracting additional tourism and beach related commerce to the area.

8.0 Any Irreversible and Irretrievable Commitment of Resources Which Would Be Involved in the Proposed Action Should It Be Implemented.

The project would not cause any known significant curtailment of the diversity and range of beneficial uses of the local environment. The labor, fuel, and material associated with construction would be irreversible and irretrievably committed.

9.0 Comments and Responses

COUNTY

Georgetown County

COMMENT (1): Several times the report lists Hurricane Hugo as striking in 1987. The correct date is 1989.

RESPONSE: The indicated corrections have been made in the final EIS.

COMMENT (2): Page 15 4.1 a - General - The last sentence indicates the study area is in Horry County. About one half of Garden City is in Georgetown County.

RESPONSE: Noted. Georgetown County is included in text.

State

South Carolina Wildlife and Marine Resources (SCWMRD)

COMMENT (1): The DEIS recognizes existing live bottom communities in the vicinity of offshore borrow sites, and states that these areas can be completely avoided during borrow activities. The current document lacks specifics on methods to be used in avoiding live bottom habitats. Given the sensitivity of live bottom habitats and the level of accuracy associated with dredging operations, we feel it necessary to maintain buffer areas around live bottom communities. Buffers of at least 200 meters should be maintained between dredging operations and identified live bottoms. Where feasible, a 500 meter buffer would be preferable.

RESPONSE: Areas of live bottom habitat were identified in a side scan and video survey conducted by SCWMRD during 1992. The identified live bottom areas will be shown on the contract dredging drawings. The dredging industry has sophisticated electronic positioning equipment to accurately locate and avoid these areas with an established 200 meter buffer zone.

COMMENT (2): We also feel that the environmental review for this project should consider changes in live bottom communities, including monitoring prior to future renourishment projects to revalidate the presence or absence of these communities.

RESPONSE: Future periodic nourishment will consider location of live bottoms, depth of suitable material, grain size of material, and location of borrow sites to nourishment area(s). Additionally, a monitoring plan is being developed with SCWMRD to assess the changes and impacts to the sandy borrow sites.

COMMENT (3): Live bottom communities have also been identified in the nearshore zone off Myrtle Beach. There is no evidence that impacts to the nearshore hard bottom habitats will be short-term. In fact, our department would expect just the opposite, at least during the 50 year project period. Potential impacts to these resources as a result of beach nourishment and subsequent sand migration are not addressed in the DEIS. We recommend that nearshore live bottom habitats be mapped and a program developed to monitor the movement of discharged materials and its impact on these communities. This information will be essential in the environmental review of future renourishment projects in this area.

RESPONSE: In general, patchy areas of Nearshore hard and live bottom habitat in the project area was identified by Van Dolah and Knott in 1984 in a report entitled A Biological Assessment of Beach and Nearshore Areas Along the South Carolina Grand Strand. The bulk of the hard bottom habitat is located in the Myrtle Beach reach. The scattered areas of hard bottom areas located in water 5.5 NGVD or less is subject to direct fill by sand. A monitoring plan is being developed with the S.C. Wildlife and Marine Resources Department (SCWMRD) to assess the secondary impacts of sand movement on nearshore hard bottom areas in water depths greater than 5.5 NGVD.

COMMENT (4): The recovery rate of benthic communities needs to be fully documented, especially since several previous studies have documented relatively, long-term impacts at these sites on other areas of the region. The DEIS indicates that benthic recovery rates will be monitored, but the document should not suggest that impacts will probably be minimal. In fact, impacts on the benthic resources will probably be significant since these communities are largely restricted to the upper 15-20 cm of bottom sediments. Although it is likely that the proposed dredging method will only result in short-term impacts, the effects should be monitored to ensure that this is the case.

RESPONSE: An extensive review of the literature of other beach renourishment projects have shown that benthic communities recover quickly.[8,9] However, a plan is being developed to monitor the recovery rate of benthic communities by SCWMRD staff for at least the initial renourishment effort at Myrtle Beach.

COMMENT (5): The review of impacts to threatened and endangered species in the current document is limited to nesting sea turtles. Sea turtles are present in offshore waters proposed for dredging and the potential exists for mortality or turtles as a result of entrainment during hopper dredge operations. For this reason, we feel attention to this issue is warranted. Dredging operations should be monitored to avoid negative impacts to turtles and to ensure no loss of these animals. We recommend that an observer be on board dredging vessels during the warmer months (April 1 - November 30) and all monitoring results coordinated with our department.

RESPONSE: Trained turtle observers will monitor all dredging activities during the period April 1 - November 30.

South Carolina Department of Parks, Recreation, and Tourism

COMMENT (1): Page 21-4.2.6 Entitled Threatened and Endangered Species - It is not clear if the Fish and Wildlife species list is the National list or the South Carolina list. As you know, some species listed in the National list as threatened are listed as endangered on the South Carolina list. Also a legend as to the "status" column's abbreviations would help clarify the lists of the Fish and Wildlife Service and the National Marine Fisheries Service.

RESPONSE: The suggested changes have been made in the final EIS.

COMMENT (2): Page 1, 8, 10, 14 and 15 make reference to the National Geodetic Vertical Datum, NGVD, assumed to be 1929 datum while pages 16 and 30 reference Mean Low Water Datum and while page 19 references Mean Sea Level. Referencing three different datums can be confusing; and with only the study's information, it is impossible to accurately convert between the datums. Since there is a small numerical difference between NGVD and Mean Sea Level and an even bigger difference between NGVD, Mean Sea Level, and Mean Low Water, I would recommend the study be on a single datum. You might even find it to be more advantageous to convert to the North America Datum (NAD) 1988 depending on your past data and future accuracy requirements.

RESPONSE: Concur that only one horizontal datum (NAD 83) and one vertical datum (NGVD 29) should be used. Corrected in text.

South Carolina Department of Highways and Public Transportation

COMMENT (1): If upland borrow sites are used (pp 11-12), they could impact future projects Conway Bypass and/or Carolina Bays Parking.

RESPONSE: This project will not use upland borrow sites.

South Carolina Department of Health & Environmental Control

COMMENT (1): SCDHEC must issue water quality certification pursuant to Section 401 of the Federal Clean Water Act. Certification will be issued if the work will not violate State water quality standards.

RESPONSE: This work is in compliance with section 401 of the Federal Clean Water Act (FCWA) and will not violate state water quality standards. NOTE: A section 401, FCWA certification was issued on November 19,1992.

Federal

United States Environmental Protection Agency

COMMENT (1): EPA remains equivocal regarding the issue of pumping sand onto an eroding shoreface. Generally, we have not had significant opposition to beach nourishment when it provides a disposal site for a proximate, already authorized navigation project. However, the key factor in our concurrence was whether or not biologically sensitive resources would be adversely affected through the use of this disposal method. In this particular case the value of the threatened structures, declining width of the recreational beach, and the perceived need to provide continued economic potential to shorefront property owners serve as the rationale for beach nourishment.

RESPONSE: No response required.

COMMENT (2): The purpose and needs statement notes that these societal factors subsume the minor environmental losses resulting from the proposed beach fill. The basis for the characterization of minor losses is the observation that the surf zone is inherently unstable. We acknowledge that the surf zone places pronounced stresses on the biota which reside there, however, these organisms are evolutionarily attuned to these perturbations and their natural seasonal rhythms. The magnitude of the activities associated with renourishment transcends all but the most catastrophic natural processes. Moreover, the necessity of subsequent renourishment due to continuing erosion means that the periods of natural equilibrium can be short.

RESPONSE: No response required.

COMMENT (3): We have some concerns about this proposal from a cumulative standpoint. We would like to know how many other coastal areas of the Charleston District are experiencing similar erosion and/or other marine processes which will require nourishment activities to protect development immediately adjacent to the ocean? The cost potential, environmental and otherwise, of providing similar protection to these areas needs to be factored into federal agency planning as a total package rather than as increments.

RESPONSE: Other South Carolina coastal areas which are experiencing erosion include (but are not limited to) Folly Beach, Edisto Beach, Hilton Head, and Hunting Island. Folly Beach is currently under initial construction. Cost potential, environmental and otherwise, for the Folly Beach Project was included in that Project's General Design Memorandum (GDM) dated May 1991 (REVISED). At your request, copies of this GDM will be furnished to your office. As of this date, Edisto Beach, Hilton Head, and Hunting Island either do not qualify for Federal assistance or have declined to be non-Federal sponsors for nourishment projects. Although planning as a total package rather than as increments may be the preferred alternative, each project has to be studied and justified individually. Several beaches along the South Carolina coast such as Hilton Head, Hunting Island, Seabrook Island, Pawleys Island, Litchfield Beach, Garden City, Myrtle Beach, and North Myrtle Beach have been privately nourished in the past with minimal environmental effects.

COMMENT (4): An unstated problem at Myrtle Beach is the election of home owners, businessmen, etc., in conformance with the current zoning regulations to intensify development in this attractive, but high risk area. Given the amenities associated with living on the shoreline, this may be understandable. Nonetheless, Corps of Engineers' publications have well documented that these coastal areas are dynamic features experiencing almost daily fluctuations due to marine processes.

RESPONSE: Acknowledged. No response required.

COMMENT (5): An examination of the papers - "Saving the American Beach" (results of the Skidaway Institute of Oceanography Conference of America's Eroding Shoreline, March 25-27, 1981), "Greenhouse Effect and Sea Level Rise - A Challenge for This Generation," edited by Michael Barth and James Titus, or "The Beaches are Moving" by Wallace Kaufman and Orrin Pilkey, have been helpful in our understanding of the long-term overall public interest in these kinds of projects. Quite simply, given the comprehensive nature of the problem and the magnitude of the forces involved, we are uncertain that maintenance of an increasing number of these nourishment projects is feasible.

RESPONSE: Periodic nourishment and maintenance have been factored into the economic analysis of this project and has shown a benefit/cost ratio of better than 1:1. We believe that we can physically and economically maintain beach projects as have been demonstrated with past beach nourishment projects.

COMMENT (6): All of the above notwithstanding we are sensitive to the economic and societal benefits accruing from individual beach nourishment projects. However, the local sponsors should be made aware of the possibility that ultimate economic losses could actually be greater due to continued intensification of land use predicated in large measure on the assumption that a beach will always be present in front of the property. These observations may not prove especially compelling to the local sponsors right now, but we would be remiss not to indicate that the technical insight/understanding on the long-term effectiveness of beach nourishment has been called into doubt by some coastal geologists.

RESPONSE: The local sponsors are well aware of short-term and long-term economic responsibilities.

COMMENT (7): In this regard, an important point to emphasize is that "short-term" protection is all that is being offered. At the end of the project life it is conjectural whether the present erosion situation will be any different. The EIS did not indicate whether the exact cause of the beach losses is known. At some point a study to determine the causal reason for this erosion should be considered in an attempt to see if a more lasting solution is available. While not seriously considered, the nonstructural alternative of building relocation may provide the only long-term solution to the situation. The nourishment proposal may merely postpone the inevitable. In the light of recent decisions to restructure federal funding as well as changes in the cost sharing mechanisms, subsequent evaluations should factor in the possibility that the local sponsor may have to increase its financial commitment over the projected life of the project.

RESPONSE: Beaches along the South Atlantic coast have historically eroded and accreted along varying reaches. No attempt to determine the causal reason for erosion along the Grand Strand was attempted due in part to the magnitude of the project and the general assumption that the gradual sea level rise will cause continued beach erosion. The local sponsors are aware of the financial responsibilities for maintaining a usable beach and have weighed these responsibilities against benefits.

COMMENT (8): The ultimate use of the selected borrow sites (Surfside and Cane North and South) should be examined in the following contexts: long-term effect on the sand budget of the adjacent shoreline, compatibility of the borrow with native beach material, and their percentage of fines. The shoreline of these beach sites is currently degrading. If the material from the borrow site is moved directly onto the shoreface, how will this affect future onshore sediment movement via natural incremental processes? We are concerned that the present instability may be exacerbated and/or the maintenance frequency may have to be shortened. The possibilities associated with what is effectively a mining action should be determined now rather than after the fact.

RESPONSE: The borrow sites are designated to be approximately 1.5 to 5 miles offshore beyond the depth of closure. Therefore, future onshore sediment movement via natural incremental processes will not be affected.

COMMENT (9): We assume that the computer model, DUNE or an analog, was used to evaluate this project. We are interested in the results of this modelling since one of its basic components in determining storm reduction benefits predicates that the amount of material eroded must equal the amount deposited. If the offshore area has been mined of material, then it would appear that the model results would be influenced. The extent of the "influence" should be determined during this planning phase.

RESPONSE: The DUNE computer model was used to develop cross-shore movement during storm events. The movement of material was within the nearshore area (less than 1500 feet from the shoreline). Since the borrow sites are 3 to 5 miles offshore, these borrow sites had no influence on the model results.

COMMENT (10): A large number of vibracore samples were taken throughout the borrow area. A comparison of the textural classes of this borrow sand has already been made with the current material on the subject beaches. However, since the native beach has been modified by the addition of sand from various other sources, compatibility may be more problematic than the text implies. It may be necessary to shorten the frequency of renourishment due to increased erosion in this regard. The consequences, environmental and otherwise, of this possibility should be examined in the final EIS.

RESPONSE: The vibracore borings were analyzed and the results of this analysis are provided in the Myrtle Beach Storm Reduction Project GDM. At your request, this GDM will be provided to your office.

COMMENT (11): Additionally, these cores should be examined to determine the percentage of fines in the proposed fill. It has been our experience that even a small percentage of silt and clay fractions in beach fill can lead to long-term turbidity problems at a renourished beach. The percentage of fines and dissimilar fill material determine the degree to which the beach will be "overbulked" to factor in losses due to wave action.

RESPONSE: The District office concurs that compatibility may be very difficult to predict because the native beach has been modified by the addition of sand from various other sources. However, overfill factors were determined using the Adjusted Shore Protection Manual Technique. James' curves (from James, 1975), showing isolines of adjusted overfill factors for values of phi mean difference and phi sorting rations were utilized. By using James' curves, a graphical determination of associated overfill factors was made. Also, the District excluded areas within the borrow sites which had fines exceeding 25 percent of the core sample. Fines were defined as material which would not be retained on a standard sieve size of 200. At the time of final design, additional core samples will be collected and used to determine the exact area which will be used during initial construction. One of the borrow site selection factors will be material compatibility. The analysis of the borrow sites and native beach at Myrtle Beach and vicinity comprise a major portion of that project's GDM. At your request, copies of this finalized GDM will be provided to your office.

COMMENT (12): The storm damage model together with its component elements used for this project should be discussed. we are particularly interested in the assumptions used in the development of an estimate of annual storm damages compared to different scenarios of sea level rise. We would like to be able to determine how the potential for an increase in the present rate of sea level rise would influence this project. If an accelerated rise does prove to be the case, the details of the impact(s) should be assessed.

RESPONSE: The impact on sea level rise was not included in the economic analysis. A figure for sea level rise was computed for the GDM on an annual basis and is included in the General Engineering Design and Cost Estimates (Appendix 1 of the GDM). The sea level rise projected would amount to less than half a foot over the life of the project and was not considered to have a significant impact on the amount of future periodic nourishment that would be required to maintain the designed project.

> COMMENT (13): Since this is a reformulation, the benefits generated by project construction were not stated. It has been our experience that they are usually a significant subset of the total value of threatened beach front property. The final EIS would be improved if the components of the latter figure were presented. More precisely, how much of this total value figure is a function of the housing value, per se, and how much has to do with its location immediately adjacent to the shoreline? This information is very important since the second element is immediately affected by the degree of shoreline stability. In this particular case the shoreline is degrading; therefore, just how this property should be valued is important. In the absence of a federal interest to continue with this nourishment project and/or the ability/willingness of the homeowners to protect this property, its long-term value would be lessened. This would greatly affect the economics of the project and more importantly its purpose and need. This potential should also be examined in the final EIS.

RESPONSE: A detailed analysis of the economics associated with the proposed project is included in the General Design Memorandum (GDM) (Appendix 2). The value of land was not included in the analysis. The benefits were derived using the value of the structures and associated improvements. The value associated with the location was not included. Copies of the GDM will be provided to your office.

> COMMENT (14): Moreover, for the without project condition is it reasonable to assume that this property would be maintained for more than a few years let alone the 50-year life of the project? This, in fact, is the underlying premise of the without project comparison. Rather, it seems much more likely that the annual loss value would just accumulate as no repairs were accomplished. The figure would rapidly approach the total value of the beach front dwellings and then as rapidly decline after they were no longer habitable. Of course, the value of the adjoining,

landward property would probably increase as it became "beach front". We would be interested to learn if there are any data which would support the premise that in the absence and/or anticipation of a federally subsidized nourishment project that homeowners will sustain the losses assumed by the Corps of the Engineer's models. The most interesting factor associated with this overall benefits comparison is the probability that the costs of the nourishment project over its 50-year life span subsume the real value of threatened property.

RESPONSE: Again the value of the land was not included in the analysis. Field investigations after Hurricane Hugo along Myrtle Beach and other barrier islands along the coast show that not only do the land owners maintain their structures, but where they are completely removed the structures are replaced with higher valued structures. In the analysis a conservative assumption was made that the analysis would only consider the replacement and maintenance of the existing structures and would not consider any future development. The analysis also included that replacement property would be constructed in accordance with Federal Flood Insurance Regulations.

COMMENT (15): This is a reformulation of an existing authorized project, therefore, we assume that public access to each of the three segments meets Corps' requirements. Nonetheless, we would like to be reassured in the final EIS that assess and adequate parking is available to more than just the owners of the shoreline property.

RESPONSE: The issue of public access is addressed in the GDM, and the non-Federal sponsor will be required to maintain access in accordance with Corps regulations.

United States Department of the Interior

COMMENT (1): The coast of South Carolina is noted for its exceptional deposits of heavy sands that comprise the greatest resource of that material in the United States. Material found in the sands include the minerals ilmenite, rutile, zircon, and monazite from which can be obtained the elements titanium, zirconium, thorium, cesium, lanthium, and rare earth elements. The heavy sands are not being mined in South Carolina now because material can be imported cheaper than it can be mined in the United States. Still, in a time of national emergency, the deposits in South Carolina could become critical. The richest deposits are toward the southern end of the state. Exploration has shown the heavy sands in the area of this project are of low grade compared with the deposits further south and likely would not be mined. Because of the national importance of these deposits, however, the document should include a discussion of the heavy sand resources and explain why this particular project would have no significant impact upon them.

RESPONSE: Construction of this project would not diminish the quantity nor quality of heavy sand resources obtainable along portions of the South Carolina coast. During a time of National Emergency any sand used in the construction of this project, which proved to be unique or unattainable from other sources, would be conveniently available on the beach at the Grand Strand.

United States Department of Commerce (NOAA)

COMMENT (1): The description of hard and live bottom habitat found in the project area is confusing. Sufficient detail is not presented to assess project impacts on the nearshore environment in connection with placement of sediment for beach nourishment. The DEIS also does not adequately describe impacts that may occur in the vicinity of the offshore borrow sites.

RESPONSE: A description of nearshore hard and live bottom habitat occurrence has been clarified in the EIS. In general, patchy areas of Nearshore hard and live bottom habitat in the project area was identified by Van Dolah and Knott in 1984 in a report entitled A Biological Assessment of Beach and Nearshore Areas Along the South Carolina Grand Strand. The bulk of the hard bottom habitat is located in the Myrtle Beach reach. The scattered areas of hard bottom areas located in water 5.5 NGVD or less is subject to direct fill by sand. A monitoring plan is being developed with the S.C. Wildlife and Marine Resources Department (SCWMRD) to assess the secondary impacts of sand movement on nearshore hard bottom areas in water depths greater than 5.5 NGVD.

In regard to offshore borrow site impacts, a considerable amount of effort was concentrated in locating sand offshore sites which are free from hard and live bottom areas. Sidescan sonar and video camera transects were employed via contract with SCWMRD in assessing potential borrow sites. Areas of hard and live bottom habitat were identified, plotted on contract maps, and will be avoided during borrow activities. Numerous studies from neighboring states of offshore borrow site impacts have shown only short-term impacts to macro infaunal communities. A similar monitoring study will be conducted on offshore borrow site impacts for the Myrtle Beach project.

COMMENT (2): The DEIS also fails to adequately address the cumulative impact of this type of activity on living marine resources. We are concerned that habitat alteration associated with this and numerous similar projects along the South Carolina coast will result in a reduction of forage species such as macro invertebrates and, subsequently, harvestable fish that rely on these organisms. In the absence of this information, we find no basis for the determination that the proposed action will have "no serious impact on fisheries".

RESPONSE: Numerous studies of beach nourishment projects and offshore borrow sites along the South Atlantic coast have shown impacts to be short-term, with rapid recovery of macro invertebrate forage species. Based on the demonstrated rapid recovery of macro invertebrates and the fact that the Myrtle Beach project will be renourished in three segments over a multi-year period, the project will have no significant impact on fisheries. The District is cooperating with SCWMRD in developing a biological monitoring plan to assess recovery of macro invertebrates in at least one of the three nourishment reaches.

COMMENT (3): Page 3, paragraph 2. The total project length should be clarified. The project length given on Page 1 is 22.6 miles. Page 11, paragraph 1, specifies 25.7 miles and page 30, paragraph 4, specifies 23.9 miles.

RESPONSE: The project length on page 1 refers to the authorized project in the 1990 Water Resources Development Act. The total project length described on page 30 refers to an alternative beach nourishment consideration. The project length on page 30 was considered accurate at the time the Draft EIS was printed. However recent calculations indicate the project will be approximately 25.4 miles total. The corrected calculation has been included in the final EIS.

COMMENT (4): Page 3, paragraph 1. We disagree with the statement that beach nourishment would "benefit a variety of invertebrates, birds, and fish." The likely "best case" scenario is one in which the adverse impacts would be of short duration and existing animal populations quickly return to predisposal levels. Consequently, documentation of any anticipated benefits to living marine resources, as referenced in the DEIS, is needed.

RESPONSE: This project will create approximately 600 acres of high tide and intertidal beach where none now exists. It is reasonable to assume that a variety of species would benefit from this additional beach area over the life of the project. Birds enjoy a primary benefit from the renourishment operation as can be witnessed by any one visiting a nourishment operation. The intertidal beach would provide additional habitat for invertebrate species and subsequently fish forage.

COMMENT (5): Page 3, paragraph 2. We disagree with the determination that the loss of organisms at the offshore borrow sites and on the intertidal beach are "insignificant." The ecological roles of these habitats and their associated fauna are not described, but may be significant with regard to the survival and abundance of resident and migratory species such as spot, summer flounder, bluefish, whiting, Florida pompano, and others. Although the magnitude of impact associated with dredging and dredged material disposal in these habitats varies seasonally, the significance of this relationship is not discussed. The importance and need for seasonal work restrictions should be addressed, particularly with regard to benthic and epibenthic population recovery.

RESPONSE: We agree that the ecological roles of the intertidal beach and offshore borrow sites are ecologically important. However, numerous scientific monitoring studies of similar beach nourishment projects throughout the South Atlantic region has demonstrated that the recovery of macro invertebrate forage species from both intertidal and offshore borrow sites is rapid. Seasonal variation of faunal diversity is well documented in the literature. The magnitude of the Myrtle Beach project requires construction throughout all seasons of the year, therefore seasonal dredging restrictions were not optional for this project.

COMMENT (6): The DEIS states that a monitoring plan is being developed to assess project related impacts on the intertidal disposal and offshore borrow site benthos; however, monitoring of project impacts on finfish is not included. Information on the impacts of beach nourishment on finfish is needed, especially with regard to the effects of periodic elimination of nearshore forage species such as mole crab (*Emerita talpoida*) and donax (*Donax* spp). Therefore, we recommend that fish monitoring, including effects on feeding and forage species abundance, be performed and that the NMFS be consulted in connection with development of the monitoring plan. Additionally, other project related effects such as increased turbidity levels and changes in substrate composition should be addressed with respect to possible impacts on fishery resources.

RESPONSE: As stated earlier, a monitoring plan is being developed in cooperation with SCWMRD to assess project related impacts on benthos in the intertidal, subtidal and offshore borrow sites. Monitoring of lower life benthos is considered a more accurate indicator of project impacts in lieu of monitoring the more mobile finfish. Van Dolah, et al. 1992, suggested from the diet analysis of finfish studied in the offshore borrow sites for the Hilton Head Nourishment project that most finfish would not be directly affected by the loss of benthic fauna in the borrow areas. A copy of the monitoring plan will be forwarded to NMFS for review and comment.

COMMENT (7): Page 14, paragraph 1, line 4. Much of the area within 5,000 feet of the shore is "hard bottom." However, it is unclear how this term is used and whether it is synonymous with the biological description of "live bottom." If extensive live bottom habitat is located within 5,000 feet of shore, any significant offshore migration of sand could adversely impact this important habitat. Accordingly, the DEIS should address the impact of beach nourishment and possible movement of sand onto live bottom areas.

RESPONSE: The EIS has been reviewed to clarify the term. Refer to Response No. 1 for discussion of hard and live bottom resources and a proposed monitoring plan.

COMMENT (8): Page 21, paragraph 1. No information is provided in this section regarding the size, frequency, and distribution of "hard bottom" habitat in the project area. Although a bottom survey of the project area was performed, we are concerned that the small size of some live bottom areas may have resulted in an underestimation of the occurrence of hard and live bottom habitats in the project area. More detail needs to be provided regarding the techniques used to assess the occurrence of hard and live bottom habitat in the project area.

RESPONSE: The hard and live bottom survey report for the offshore borrow sites are too bulky to be added as an appendix. However, these reports are available upon request addressed to the Charleston District.

COMMENT (9): Page 31, paragraph 2, line 8. The basis for the determination that recovery would occur in three-to-six months should be provided. This section also does not address the cumulative impact on fisheries of depositing sand on about 24 miles of beach. Assuming that a 200-foot-wide fill zone is created (no cross sectional drawings were provided), approximately 581.8 acres of intertidal/nearshore habitat would be altered. In this regard, the effects of periodic maintenance work, occurring at eight year intervals, should also be described.

RESPONSE: The three-to-six months determination is based on Reference 5 page 38, of the DEIS and on personal communication with Dr. Robert Van Dolah (SCWMRD). This project will be constructed in three phases. Recovery of resources in one phase is expected to be complete before construction of another begins. Any one of these phases is not expected to have a significant cumulative impact on fisheries especially in view of the overall quantity of similar habitat along the South Carolina coast. A detailed plan with cross section drawings, etc. are available in the project General Design Memorandum (GDM). This GDM is available upon request addressed to the Charleston District. The effects of maintenance work will be essentially the same as the initial construction.

COMMENT (10): Page 32, paragraph 1, line 2. See our previous comments on the need for additional information on live bottom survey techniques. To our knowledge, the study referenced in this section has not been provided for our review. In view of the importance of this information, we request that the report be included as an appendix to the DEIS.

RESPONSE: The live bottom surveys are bulky and cannot be conveniently attached as an appendix and mailed. However these survey reports are available upon request addressed to the Charleston District.

COMMENT (11): Page 32, paragraph 2. We disagree with the determination that "This project will have no serious impact on marine fisheries." Studies of beach nourishment in South Carolina are limited and none of the studies performed to date have examined impacts on fish. In addition, no consideration was given to the seasonal nature of potential impacts of dredging and dredged material disposal, or to the potential cumulative impact of nourishing approximately 24 miles of shoreline. Accordingly, we believe that the conclusion of "no serious impact" in the DEIS is premature and should be reassessed.

RESPONSE: The District is aware of limited data available on the impacts of offshore borrow on fishery resources. However, many studies have been conducted on impacts of the same on benthos and the literature indicates minor impacts with quick recovery. Fish are not expected to be affected by the dredge but they may be secondarily affected by temporary disruption to the life cycle of benthos caused by dredging. The cumulative impact of this project is not expected to be significant in view of the three phased approach to construction and quick recovery of benthos. Consideration was not given to the seasonal nature of the impacts of this project because the project is not to be constructed on a seasonal basis. A thorough plan is being developed to monitor the physical and biological impacts of this beach nourishment project. This monitoring plan will be designed to distinguish natural seasonal damages in community structure from changes attributable to nourishment activities.

COMMENT (12): Page 33, paragraph 1. It is not clear if consultation with the NMFS, as required under Section 7 of the Endangered Species Act, was conducted. The DEIS should address status and results of such consultation.

RESPONSE: Consultation with the NMFS, as required under Section 7 of the Endangered Species Act was conducted. A list of species for which the NMFS is responsible was requested September 11, 1991 (page 22 of the DEIS). A biological assessment was prepared for this list with a "no effect" finding. An "effect" finding for nesting sea turtles was further coordinated with the U.S. Fish & Wildlife Service.

10.0 List of Preparers

Jim Woody, Biologist
U.S. Army Corps of Engineers
Charleston District
15 years employed by Corps of Engineers

Millard Dowd, Coastal Engineer
U.S. Army Corps of Engineers
Charleston District
22 years employed by Corps of Engineers

Russell Jackson, Economist
U.S. Army Corps of Engineers
Charleston District
6 months employed by Corps of Engineers

Ursala Smalls, Student Trainee Engineer
U.S. Army Corps of Engineers
Charleston District
3 years employed by Corps of Engineers

11.0 Distribution List

Honorable Strom Thurmond, U.S. Senator
Honorable Ernest F. Hollings, U.S. Senator
Honorable Robert M. Tallon, U.S. Representative
Honorable A. Ravenel, Jr., S.C. State Senator
Honorable J. J. Snow, Jr., S.C. State Representative
Honorable R. L. Altman, S.C. State Representative
Honorable D. L. Hinds, S.C. State Senator
Honorable F. Gilbert, S.C. State Senator
Honorable J. Y. McGill, S.C. State Senator
Honorable J. M. Long, S.C. State Senator
Honorable D. Elliott, S.C. State Representative
Honorable K. S. Corbett, S.C. State Representative
Honorable T. G. Keegan, S.C. State Representative
Honorable L. M. Martin, S.C. State Representative
Honorable Carroll A. Campbell, S.C. State Representative
U. S. Geological Survey
Advisory Council on Historic Preservation
Agriculture Stabilization & Conservation Service
U. S. Forest Service
Soil Conservation Service
U. S. Department of Energy
U. S. Environmental Protection Agency
Federal Emergency Management Administration
Federal Maritime Commission
U. S. Department of Health and Human Services
U. S. Department of Housing and Urban Development
U. S. Department of Interior
U. S. Coast Guard
Federal Highway Administration
U. S. Department of Commerce
S. C. State Clearinghouse
S. C. Sierra Club
S. C. Wildlife Federation
S. C. Wildlife Society
S. C. Coastal Conservation League
S. C. League of Women Voters
S. C. Nature Conservancy
National Audubon Society
City of Myrtle Beach
Town of Surfside
Town of Garden City Beach
City of North Myrtle Beach
Horry County Planning Department

Mailing list of individuals receiving copies of the DEIS is available upon request.

12.0 References

1 U S Army Engineer Waterway Experiment Station. Environmental Effects of Dredging Technical Notes Sediment Resuspension by Selected Dredges. EEDP - 09 - 2 March 1988.

2 Van Dolah, Robert F. and Knott, David M., December 1984 A Biological Assessment of Beach and Nearshore Areas Along the South Carolina Grand Strand. Marine Resources Department, Charleston, SC.

3 Baca, B.J., and T.E. Lankford, 1988. Myrtle Beach Nourishment Project. Biological Monitoring Report, Years 1,2,3. Coastal Science and Engineering, Columbia, SC.

4 Thompson, J.R., 1973. Ecological Effects of Offshore Dredging and Beach Nourishment: A Review. U S Army Corps of Engineers, Coastal Engineering Research Center, Ft. Belvoir, VA. Misc. paper 1 - 73.

5 Van Dolah, et. al., March 1992. A Physical & Biological Monitoring Study of the Hilton Head Beach Nourishment Project: Report to Town of Hilton Head and the South Carolina Coastal Council; Marine Resources Department, Charleston, SC.

6 Cruickshank, Michael; et. al. 1987. Marine Mining on the Outer Continental Shelf U S Department of Interior, Minerals Management Service

7 U S Army Corps of Engineers, 1990. Final EIS; Atlantic Coast of New Jersey: Sandy Hook to Barngate Inlet. Beach Erosion Conservation Project. USACOE, New York District

8 Dolan, Robert; Fucella, Joseph; Donohue, Cinde - July 1992. Final Report Monitoring and Analysis of Beach Nourishment Placed on Pea Island, North Carolina, Alligator National Wildlife Refuge 1991-1992.

9 Reilly, Jr., Francis J. and Bellis, Vincent J., March 1983. Miscellaneous Reprot No. 83-3, The Ecological Impact of Beach Nourishment with Dredged Materials on the Intertidal Zone at Bogue Banks, North Carolina. U S Army Corps of Engineers, Coastal Engineering Research Center.

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Letters of Comment

GEORGETOWN
COUNTY
SOUTH
CAROLINA

Post Office Drawer 1270
715 Prince Street
Georgetown, South Carolina 29442
Telephone (803) 546-4189
Fax (803) 546-4730

October 5, 1992

Lt. Colonel Mark Vincent
District Engineer
Department of the Army
Charleston District, Corps of Engineers
Post Office Box 919
Charleston, SC 29402

Dear Sir:

In reference to SACEN-PR (1105), I want to make the following comments about the Draft Environmental Impact Statement:

(1) Several times the report lists Hurricane Hugo as striking in 1987. The correct date is 1989.

(2) Page 15 4.1 a - General - The last sentence indicates the study area is in Horry County. About one half of Garden City is in Georgetown County.

Sincerely,

Gordon W. Hartwig
County Administrator

GWH:kl

17.0

Appendix 1
Letters of Comment

South Carolina
Wildlife & Marine
Resources Department

Equal Opportunity Agency

James A. Timmerman, Jr., Ph.D.
Executive Director
Larry D. Cartee
Asst. Executive Director

November 18, 1992

Lt. Colonel Mark E. Vincent
District Engineer
Corps of Engineers
P. O. Box 919
Charleston, SC 29402-0919

REF: Environmental Impact Statement; Myrtle Beach & Vicinity Shore Protection Project

Dear Sir:

Personnel with the South Carolina Wildlife and Marine Resources Department have reviewed the Draft Environmental Impact Statement (DEIS) for the Myrtle Beach and Vicinity Shore Protection Project and offer the following comments.

A public notice concerning the Myrtle Beach Shoreline Protection Project was advertised during July of this year. In response to this notice, our agency raised a number of concerns regarding potential impacts of the proposed project and suggested issues which should be addressed in the development of an EIS for this project. The current DEIS fails to adequately address some of these concerns and makes several assumptions that may not be valid based on existing data. Two issues of particular concern are the possible effects on hard bottom habitats and turtle populations.

The DEIS recognizes existing live bottom communities in the vicinity of offshore borrow sites, and states that these areas can be completely avoided during borrow activities. The current document lacks specifics on methods to be used in avoiding live bottom habitats. Given the sensitivity of live bottom habitats and the level of accuracy associated with dredging operations, we feel it necessary to maintain buffer areas around live bottom communities. Buffers of at least 200 meters should be maintained between dredging operations and identified live bottoms. Where feasible, a 500 meter buffer would be preferable. We also feel that the environmental review for this project should consider changes in live bottom communities, including monitoring prior to future renourishment projects to revalidate the presence or absence of these communities.

STATE OF SOUTH CAROLINA
Office of Comptroller General

EARLE E. MORRIS, JR.
COMPTROLLER GENERAL

305 WADE HAMPTON OFFICE BUILDING
POST OFFICE BOX 11228
COLUMBIA, S.C. 29211
TELEPHONE: (803) 734-2121
FAX: (803) 734-2064

October 6, 1992

LTC Mark E. Vincent
District Engineer
Department of the Army
Post Office Box 919
Charleston, South Carolina 29402-0919

Dear LTC Vincent:

Thank you for your letter and the Environmental Impact Statement of the Myrtle Beach Shore Protection Project and Horry and Georgetown Counties.

After I have had a chance to review the document, if I have any comments, I shall be in touch with you directly prior to November 16, 1992.

I appreciate having this information on these projects and I hope the related issues can be resolved favorably for all concerned.

Sincerely,

Earle Morris, Jr.

EARLE E. MORRIS, JR.

EEMJR:mos

Live bottom communities have also been identified in the nearshore zone off Myrtle Beach. There is no evidence that impacts to the nearshore hard bottom habitats will be short-term. In fact, our department would expect just the opposite, at least during the 50 year project period. Potential impacts to these resources as a result of beach nourishment and subsequent sand migration are not addressed in the DEIS. We recommend that nearshore live bottom habitats be mapped and a program developed to monitor the movement of discharged materials and its impact on these communities. This information will be essential in the environmental review of future renourishment projects in this area.

The recovery rate of benthic communities need to be fully documented, especially since several previous studies have documented relatively long-term impacts at these sites on other areas of the region. The DEIS indicates that benthic recovery rates will be monitored, but the document should not suggest that impacts will probably be minimal. In fact, impacts on the benthic resources will probably be significant since these communities are largely restricted to the upper 15-20 cm of bottom sediments. Although it is likely that the proposed dredging method will only result in short-term impacts, the effects should be monitored to ensure that this is the case.

The review of impacts to threatened and endangered species in the current document is limited to nesting sea turtles. Sea turtles are present in offshore waters proposed for dredging and the potential exists for mortality or turtles as a result of entrainment during hopper dredge operations. For this reason, we feel attention to this issue is warranted. Dredging operations should be monitored to avoid negative impacts to turtles and to ensure no loss of these animals. We recommend that an observer be on board dredging vessels during the warmer months (April 1 - November 30) and all monitoring results coordinated with our department.

We ask that the above outlined concerns and recommendations be given careful consideration in the preparation of the Final Environmental Impact Statement for this project.

Sincerely,

James A. Timmerman, Jr.
Executive Director

JATjr/sa

cc: Marine (EES)

SOUTH CAROLINA COASTAL COUNCIL

Ashley Corporate Center
4130 Faber Place
Suite 300
Charleston, S.C. 29405
(803) 744-5838
FAX 744-5847

William W. Jones, Jr.
Chairman

H. Wayne Beam, Ph.D.
Executive Director

September 16, 1992

LTC Mark E. Vincent
District Engineer
U. S. Army Corps of Engineers
P. O. Box 919
Charleston, S. C. 29402

Re: Myrtle Beach & Vicinity Storm
Damage Reduction Project
Horry & Georgetown Counties
P/N 92-2R-199

Dear Colonel Vincent:

The staff of the S. C. Coastal Council has reviewed the above referenced public notice and certifies that the project will be consistent to the maximum extent practicable with the State's Coastal Zone Management Program. The Council supports the comments offered by the U. S. Fish & Wildlife Service, the National Marine Fisheries Service and the S. C. Wildlife & Marine Resources Department. It is recommended that the beach renourishment be monitored in the following format:

1. Eight sets of survey data from all Coastal Council monitoring stations within the construction limits and stations within 2,000 feet of each end of the project must be submitted to the Coastal Council.

2. Surveys for year one will be taken at three month intervals, beginning at the time of project construction completion.

3. Semi-annual surveys of the project beach during years two and three after project construction must be performed and submitted to the Coastal Council.

4. All surveys should be beach profiles which begin at the most landward of the following three locations: primary oceanfront sand dune, erosion constrol device, or the landward limit of the

fill material; extend perpendicular to the shoreline; and terminate at low tide wading depth (approximately -5 ft. MSL).

Sincerely,

H. Stephen Snyder

H. Stephen Snyder
Director of Planning
and Certification

ast
AST:0264a

cc: Dr. H. Wayne Beam
Mr. Christopher L. Brooks
Ms. Debra Hernandez
U. S. Fish & Wildlife Service
S. C. Wildlife & Marine Resources Department
National Marine Fisheries Service
S. C. Department of Health & Environmental Control

Office of the Governor - Grant Services

South Carolina Project Notification and Review

1205 Pendleton Street
Room 477
Columbia, SC 29201

State Application Identifier EIS-921011-011
Suspense Date 10/29/92

H. Stephen Snyder
South Carolina Coastal Council

The Grant Services Unit, Office of the Governor is authorized to operate the South Carolina Project Notification and Review System (SCPNRS). Through the system the appropriate state and local officials are given the opportunity to review, comment, and be involved in efforts to obtain and use federal assistance, and to assess the relationship of proposals to their plans and programs.

Please review the attached information, mindful of the impact it may have on your agency's goals and objectives. Document the results of your review in the space provided. Return your response to us by the suspense date indicated above. Your comments will be reviewed and utilized in making the official state recommendation concerning the project. The recommendation will be forwarded to the cognizant federal agency.

<u>If you have no comments, return of this form is still required.</u>

If you have any questions, call me at (803) 734-0435.

Kathy Reis
Kathy Reis

- [x] Project is consistent with our goals and objectives.
- [ ] Request a conference to discuss comments.
- [ ] Please discontinue sending projects with this CFDA# to our office for review.
- [ ] Comments on proposed Application is as follows:

Please see attached letter.

Signature: [signature], Jr.   Date: 11/13/92

Title: Director of Planning and Certification   Phone: 744-5838

PRT John William Lawrence, *Executive Director*

Division of Engineering & Planning
B. Beth McClure, *Director*
(803) 734-0175
(803) 734-1042 FAX

October 13, 1992

LtC. Mark E. Vincent
Department of the Army
Charleston District, Corps of Engineers
P.O. Box 919
Charleston, SC 29402-0919

RE: Draft of the Environmental Impact Study for the Myrtle Beach and Vicinity Shoreline Protection Project

Dear LtC. Vincent:

After reviewing the draft copy of the Environmental Impact Study for the Myrtle Beach and Vicinity Shoreline Protection Project, there are two comments I wish to submit:

1. Page 21-4.2.6 Entitled Threatened and Endangered Species- It is not clear if the Fish and Wildlife species list is the National list or the South Carolina list. As you know, some species listed in the National list as threatened are listed as endangered on the South Carolina list. Also a legend as to the "status" column's abbreviations would help clarify the lists of the Fish and Wildlife Service and the National Marine Fisheries Service.

2. Page 1, 8, 10, 14 and 15 make reference to the National Geodetic Verticle Datum, N.G.V.D., assumed to be 1929 datum while pages 16 and 30 reference Mean Low Water Datum and while page 19 references Mean Sea Level. Referencing three different datums can be confusing; and with only the study's information, it is impossible to accurately convert between the datums. Since there is a small numerical difference between N.G.V.D. and Mean Sea Level and an even bigger difference between N.G.V.D., Mean Sea Level, and Mean Low Water, I would recommend the study be on a single datum. You might even find it to be more advantageous to convert to the North America Datum (NAD) 1988 depending on your past data and future accuracy requirements.

I hope that you find these comments to be helpful, and I look forward to the implementation of the shoreline protection project. Should you wish to discuss these items or any other issues, please advise.

Sincerely,

Beth McClure

Beth McClure, Director
Division of Engineering and Planning

cc: J.W. Lawrence
Executive Director, SC PRT

BBM/lm

C:MEVMBSHO

Office of the Governor • Grant Services
South Carolina Project Notification and Review

1205 Pendleton Street
Room 477
Columbia, SC 29201

State Application Identifier EIS-921011-011
Suspense Date 10/29/92

Earl F. Brown, Jr.
South Carolina Human Affairs Commission

The Grant Services Unit, Office of the Governor is authorized to operate the South Carolina Project Notification and Review System (SCPNRS). Through the system the appropriate state and local officials are given the opportunity to review, comment, and be involved in efforts to obtain and use federal assistance, and to assess the relationship of proposals to their plans and programs.

Please review the attached information, mindful of the impact it may have on your agency's goals and objectives. Document the results of your review in the space provided. Return your response to us by the suspense date indicated above. Your comments will be reviewed and utilized in making the official state recommendation concerning the project. The recommendation will be forwarded to the cognizant federal agency.

<u>If you have no comments, return of this form is still required.</u>

If you have any questions, call me at (803) 734-0435.

Kathy Reis
Kathy Reis

- [x] Project is consistent with our goals and objectives.
- [ ] Request a conference to discuss comments.
- [ ] Please discontinue sending projects with this CFDA# to our office for review.
- [ ] Comments on proposed Application is as follows:

Signature: Earl F. Brown Jr. Date: 11-22-92

Title: Executive Director Phone: 253-6322

Office of the Governor • Grant Services

South Carolina Project Notification and Review

1205 Pendleton Street
Room 477
Columbia, SC 29201

State Application Identifier EIS-921011-011
Suspense Date 10/29/92

Charles Logan
S.C. Land Resources Conservation Commission

The Grant Services Unit, Office of the Governor is authorized to operate the South Carolina Project Notification and Review System (SCPNRS). Through the system the appropriate state and local officials are given the opportunity to review, comment, and be involved in efforts to obtain and use federal assistance, and to assess the relationship of proposals to their plans and programs.

Please review the attached information, mindful of the impact it may have on your agency's goals and objectives. Document the results of your review in the space provided. Return your response to us by the suspense date indicated above. Your comments will be reviewed and utilized in making the official state recommendation concerning the project. The recommendation will be forwarded to the cognizant federal agency.

<u>If you have no comments, return of this form is still required.</u>

If you have any questions, call me at (803) 734-0435.

Kathy Reis
Kathy Reis

- [X] Project is consistent with our goals and objectives.
- [ ] Request a conference to discuss comments.
- [ ] Please discontinue sending projects with this CFDA# to our office for review.
- [ ] Comments on proposed Application is as follows:

RECEIVED
GRANT SERVICES

We appreciate the opportunity to respond to this project. Please contact the Commission at 734-9100 if you desire additional information.

Signature: ______________ Date: October 23, 1992

Title: Deputy Director, Conservation Programs Phone: 803-734-9100

Office of the Governor • Grant Services
South Carolina Project Notification and Review

1205 Pendleton Street
Room 477
Columbia, SC 29201

State Application Identifier EIS-921011-011
Suspense Date 10/29/92

Steve Davis
S.C. Department of Health and Enviromental Control

The Grant Services Unit, Office of the Governor is authorized to operate the South Carolina Project Notification and Review System (SCPNRS). Through the system the appropriate state and local officials are given the opportunity to review, comment, and be involved in efforts to obtain and use federal assistance, and to assess the relationship of proposals to their plans and programs.

Please review the attached information, mindful of the impact it may have on your agency's goals and objectives. Document the results of your review in the space provided. Return your response to us by the suspense date indicated above. Your comments will be reviewed and utilized in making the official state recommendation concerning the project. The recommendation will be forwarded to the cognizant federal agency.

If you have no comments, return of this form is still required.

If you have any questions, call me at (803) 734-0435.

Kathy Reis
Kathy Reis

- [ ] Project is consistent with our goals and objectives.
- [ ] Request a conference to discuss comments.
- [ ] Please discontinue sending projects with this CFDA# to our office for review.
- [x] Comments on proposed Application is as follows:

SCDHEC must issue water quality certification pursuant to Section 401 of the Federal Clean Water. Certification will be issued if the work will not violate State water quality standards.

Signature: Sally C. Knowles

Date: 10/13/92

Title: Manager, Water Quality Certification and Wetlands Programs Section

Phone: 4-5229

92-11066-SCR-   LT

Office of the Governor • Grant Services

South Carolina Project Notification and Review

1205 Pendleton Street
Room 477
Columbia, SC 29201

RECEIVED
OCT - 8 1992
S. C. DEPARTMENT OF
ARCHIVES & HISTORY

State Application Identifier
EIS-921011-011
Suspense Date
10/29/92

Nancy Brock
South Carolina Department of Archives & History

The Grant Services Unit, Office of the Governor is authorized to operate the South Carolina Project Notification and Review System (SCPNRS). Through the system the appropriate state and local officials are given the opportunity to review, comment, and be involved in efforts to obtain and use federal assistance, and to assess the relationship of proposals to their plans and programs.

Corps

Please review the attached information, mindful of the impact it may have on your agency's goals and objectives. Document the results of your review in the space provided. Return your response to us by the suspense date indicated above. Your comments will be reviewed and utilized in making the official state recommendation concerning the project. The recommendation will be forwarded to the cognizant federal agency.

<u>If you have no comments, return of this form is still required.</u>

If you have any questions, call me at (803) 734-0435.

Kathy Reis
Kathy Reis

- [ ] Project is consistent with our goals and objectives.
- [ ] Request a conference to discuss comments.
- [ ] Please discontinue sending projects with this CFDA# to our office for review.
- [ ] Comments on proposed Application is as follows:

Signature: [signature]   Date: 10/20/92

Title: [illegible]   Phone: 734-8006

South Carolina Department of Archives and History

1430 Senate Street, P.O. Box 11,669, Columbia, South Carolina 29211 (803) 734-8577
State Records (803) 734-7914; Local Records (803) 734-7917

October 20, 1992

Ms. Kathy Reis
SC State Clearinghouse
1205 Pendelton Street
Columbia, SC 29201

Re: Myrtle Beach Shore
Protection Project
Horry and Georgetown Counties
EIS-921011-011

Dear Ms. Reis:

This letter is written concerning the project notification listed above. We have previously commented on this project to Jon Guerry Taylor, P.E., Inc. Our comments of May 26, 1992 are enclosed for your reference.

Please do not hesitate to call me or Ms. Nancy Brock, Review and Compliance Branch Supervisor, at 734-8609 if you have any questions.

Sincerely,

Ian D. Hill
Intergovernmental Review Coordinator
State Historic Preservation Office

Mr. Richard Jackson,
Corps of Engineers
Enclosure

4½- N?BC-HK-JK

South Carolina Department of Archives and History

1430 Senate Street, P.O. Box 11,669, Columbia, South Carolina 29211 (803) 734-8577
State Records (803) 734-7914; Local Records (803) 734-7917

May 26, 1992

Ms. Linda Pullano
Project Manager
Jon Guerry Taylor, P.E., Inc.
P.O. Box 1082
Mt. Pleasant, SC 29465

Re: Spoil Easements Reaches 11 and 12, Horry County, South Carolina

Dear Ms. Pullano:

I have reviewed the project information supplied by your office. It appears that the two areas in question have been used in the past as spoil disposal units. This was confirmed by your office in our telephone conversation of May 26, 1992.

We believe that the history of land surface disturbance makes it unlikely that intact cultural resources exist within the boundaries of Reach 11 and Reach 12. Our office does not recommend any further archaeological consideration of these two areas.

Please notify our office immediately if archaeological deposits are exposed during the construction phase of the project. We will respond with management recommendations within 48 hours of notification.

I may be contacted at 803\734-8478, if you have any questions or comments concerning this matter.

Sincerely,

Lee Tippett

Lee Tippett
Staff Archaeologist
State Historic Preservation Office

Office of the Governor • Grant Services

South Carolina Project Notification and Review

1205 Pendleton Street
Room 477
Columbia, SC 29201

State Application Identifier EIS-921011-011
Suspense Date 10/29/92

Carlisle Roberts, Jr.
Governor's Div. of Natural Resources

The Grant Services Unit, Office of the Governor is authorized to operate the South Carolina Project Notification and Review System (SCPNRS). Through the system the appropriate state and local officials are given the opportunity to review, comment, and be involved in efforts to obtain and use federal assistance, and to assess the relationship of proposals to their plans and programs.

Please review the attached information, mindful of the impact it may have on your agency's goals and objectives. Document the results of your review in the space provided. Return your response to us by the suspense date indicated above. Your comments will be reviewed and utilized in making the official state recommendation concerning the project. The recommendation will be forwarded to the cognizant federal agency.

<u>If you have no comments, return of this form is still required.</u>

If you have any questions, call me at (803) 734-0435.

Kathy Reis
Kathy Reis

- [X] Project is consistent with our goals and objectives.
- [ ] Request a conference to discuss comments.
- [ ] Please discontinue sending projects with this CFDA# to our office for review.
- [ ] Comments on proposed Application is as follows:

Signature: R. W. [illegible] Date: 10/9/92

Title: Dep. Dir. Ag. + Nat Res. Phone: 734-0336

Office of the Governor • Grant Services

South Carolina Project Notification and Review

1205 Pendleton Street
Room 477
Columbia, SC 29201

State Application Identifier EIS-921011-011
Suspense Date 10/29/92

William L. McIlwain
S.C. Dept. of Highways & Public Transportation

The Grant Services Unit, Office of the Governor is authorized to operate the South Carolina Project Notification and Review System (SCPNRS). Through the system the appropriate state and local officials are given the opportunity to review, comment, and be involved in efforts to obtain and use federal assistance, and to assess the relationship of proposals to their plans and programs.

Please review the attached information, mindful of the impact it may have on your agency's goals and objectives. Document the results of your review in the space provided. Return your response to us by the suspense date indicated above. Your comments will be reviewed and utilized in making the official state recommendation concerning the project. The recommendation will be forwarded to the cognizant federal agency.

<u>If you have no comments, return of this form is still required.</u>

If you have any questions, call me at (803) 734-0435.

Kathy Reis
Kathy Reis

- [ ] Project is consistent with our goals and objectives.
- [ ] Request a conference to discuss comments.
- [ ] Please discontinue sending projects with this CFDA# to our office for review.
- [ ] Comments on proposed Application is as follows:

If upland borrow sites are used (pp 11-12), they could impact future projects Conway Bypass and/or Carolina Bays Parking.

For further information please contact in our Columbia Office Project Engineer Elrod at (803) 737-1564.

Signature: W. L. McIlwain
W. L. McIlwain
Preconst. Eng. Mgmt. Coord.

Date: Oct. 12, 1992

Title:

Phone: 737-1390

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Affairs
Richard B. Russell Federal Building,
75 Spring Street, S.W.
Atlanta, Georgia 30303

Federal

November 5, 1992

ER 92/914

Lt. Col. James T. Scott
District Engineer, U.S. Army
Corps of Engineers
P.O. Box 919
Charleston, South Carolina 29402-0919

Dear Colonel:

We have reviewed the Draft Environmental Impact Statement for the Myrtle Beach and Vicinity, Horry and Georgetown Counties, South Carolina, and have the following comments:

The document is generally adequate in its description of resources, and the impact that the project will have on those resources, that are of interest to this Department. However, there is one additional area that the final document should discuss. The coast of South Carolina is noted for its exceptional deposits of heavy sands that comprise the greatest resource of that material in the United States. Material found in the sands include the minerals ilmenite, rutile, zircon, and monazite from which can be obtained the elements titanium, zirconium, thorium, cesium, lanthium, and rare earth elements. The heavy sands are not being mined in South Carolina now because material can be imported cheaper than it can be mined in the United States. Still, in a time of national emergency, the deposits in South Carolina could become critical. The richest deposits are toward the southern end of the state. Exploration has shown the heavy sands in the area of this project are of low grade compared with the deposits further south and likely would not be mined. Because of the national importance of these deposits, however, the document should include a discussion of the heavy sand resources and explain why this particular project would have no significant impact upon them.

Thank you for the opportunity to comment on this statement.

Sincerely yours,

James H. Lee

James H. Lee
Regional Environmental Officer

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

345 COURTLAND STREET, N.E.
ATLANTA, GEORGIA 30365

NOV 13 1992

District Engineer
Charleston District, Corps of Engineers
P.O. Box 919
Charleston, SC 29402

Attn: Mr. Richard Jackson

Subject: Draft Environmental Impact Statement (EIS) for Shoreline Protection at Myrtle Beach and Vicinity Beaches in Horry and Georgetown Counties, SC

Dear Lieutenant Colonel Vincent:

Pursuant to Section 309 of the Clean Air and Section 102(2)(C) of the National Environmental Policy Act (NEPA), EPA, Region IV has reviewed the subject document which discusses the consequences of constructing 22.6 miles of artificially constructed beach. The authorized federal project calls for construction to proceed in three separable reaches, North Myrtle Beach, Myrtle Beach, and Surfside Beach/Garden City. This action is being taken to supplement previous state and local efforts to maintain a shoreline beach in the face of erosive coastal tides and recurrent winter storms as well as catastrophic events such as hurricanes,e.g., Hugo,1989.

EPA remains equivocal regarding the issue of pumping sand onto an eroding shoreface. Generally, we have not had significant opposition to beach nourishment when it provides a disposal site for a proximate, already authorized navigation project. However, the key factor in our concurrence was whether or not biologically sensitive resources would be adversely affected through the use of this disposal method. In this particular case the value of the threatened structures, declining width of the recreational beach, and the perceived need to provide continued economic potential to shorefront property owners serve as the rationale for beach nourishment.

The purpose and needs statement notes that these societal factors subsume the minor environmental losses resulting from the proposed beach fill. The basis for the characterization of minor losses is the observation that the surf zone is inherently unstable. We acknowledge that the surf zone places pronounced stresses on the biota which reside there, however, these organisms are evolutionarily attuned to these perturbations and their natural seasonal rhythms. The magnitude of the activities associated with renourishment transcends all but the most catastrophic natural processes. Moreover, the necessity of subsequent renourishment due to continuing erosion means that the periods of natural equilibrium can be short.

We have some concerns about this proposal from a cumulative standpoint. We would like to know how many other coastal areas of the Charleston District are experiencing similar erosion and/or other marine processes which will require nourishment activities to protect development immediately adjacent to the ocean? The cost potential, environmental and otherwise, of providing similar protection to these areas needs to be factored into federal agency planning as a total package rather than as increments.

An unstated problem at Myrtle Beach is the election of home owners, businessmen, etc., in conformance with the current zoning regulations to intensify development in this attractive, but high risk area. Given the amenities associated with living on the shoreline, this may be understandable. Nonetheless, Corps of Engineers' publications have well documented that these coastal areas are dynamic features experiencing almost daily fluctuations due to marine processes.

An examination of the papers-- "Saving the American Beach" (results of the Skidaway Institute of Oceanography Conference of America's Eroding Shoreline, March 25-27, 1981), "Greenhouse Effect and Sea Level Rise - A Challenge for This Generation," edited by Michael Barth and James Titus, or "The Beaches are Moving" by Wallace Kaufman and Orrin Pilkey, have been helpful in our understanding of the long-term overall public interest in these kinds of projects. Quite simply, given the comprehensive nature of the problem and the magnitude of the forces involved, we are uncertain that maintenance of an increasing number of these nourishment projects is feasible.

All of the above notwithstanding we are sensitive to the economic and societal benefits accruing from individual beach nourishment projects. However, the local sponsors should be made aware of the possibility that ultimate economic losses could actually be greater due to continued intensification of land use predicated in large measure on the assumption that a beach will always be present in front of the property. These observations may not prove especially compelling to the local sponsors right now, but we would be remiss not to indicate that the technical insight/understanding on the long-term effectiveness of beach nourishment has been called into doubt by some coastal geologists.

In this regard, an important point to emphasize is that "short-term" protection is all that is being offered. At the end of the project life it is conjectural whether the present erosion situation will be any different. The EIS did not indicate whether the exact cause of the beach losses is known. At some point a study to determine the causal reason for this erosion should be considered in an attempt to see if a more lasting solution is available. While not seriously considered, the nonstructural alternative of building relocation may provide the only long-term solution to the situation. The nourishment proposal may merely postpone the inevitable. In the light of recent decisions to restructure federal funding as well as changes in the cost sharing mechanisms, subsequent evaluations should factor in the possibility that the local sponsor may have to increase its financial commitment over the projected life of the project.

A rating of EC-2 was assigned. That is, we have some significant environmental concerns about certain aspects of this proposal and request additional information and evaluation of the items in the detailed comments.

Thank you for the opportunity to comment on this action. If we can be of further assistance in this matter, Dr. Gerald Miller (404-347-3776) will serve as initial point of contact.

Sincerely,

Heinz Mueller

Heinz J. Mueller, Chief
Environmental Policy Section
Federal Activities Branch

Detailed Comments/Observations

The ultimate use of the selected borrow sites (surfside and cane north and south) should be examined in the following contexts: long-term effect on the sand budget of the adjacent shoreline, compatibility of the borrow with native beach material, and their percentage of fines. The shoreline of these beach sites is currently degrading. If the material from the borrow site is moved directly onto the shoreface, how will this affect future onshore sediment movement via natural incremental processes? We are concerned that the present instability may be exacerbated and/or the maintenance frequency may have to be shortened. The possibilities associated with what is effectively a mining action should be determined now rather than after the fact.

We assume that the computer model, DUNE or an analog, was used to evaluate this project. We are interested in the results of this modelling since one of its basic components in determining storm reduction benefits predicates that the amount of material eroded must equal the amount deposited. If the offshore area has been mined of material, then it would appear that the model results would be influenced. The extent of the "influence" should be determined during this planning phase.

A large number of vibracore samples were taken throughout the borrow area. A comparison of the textural classes of this borrow sand has already been made with the current material on the subject beaches. However, since the native beach has been modified by the addition of sand from various other sources, compatibility may be more problematic than the text implies. It may be necessary to shorten the frequency of renourishment due to increased erosion in this regard. The consequences, environmental and otherwise, of this possibility should be examined in the final EIS.

Additionally, these cores should be examined to determine the percentage of fines in the proposed fill. It has been our experience that even a small percentage of silt and clay fractions in beach fill can lead to long-term turbidity problems at a renourished beach. The percentage of fines and dissimilar fill material determine the degree to which the beach will be "overbulked" to factor in losses due to wave action.

The storm damage model together with its component elements used for this project should be discussed. We are particularily interested in the assumptions used in the development of an estimate of annual storm damages compared to different scenarios of sea level rise. We would like to be able to determine how the potential for an increase in the present rate of sea level rise would influence this project. If an accelerated rise does prove to be the case, the details of the impact(s) should be assessed.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Office of the Chief Scientist
Washington, D.C. 20230

November 6, 1992

Colonel Mark E. Vincent
District Engineer
Department of the Army
Corps of Engineers
P.O. Box 919
Charleston, South Carolina 29402-0919

Dear Colonel Vincent:

Enclosed are comments on the Draft Environmental Impact Statement for the Myrtle Beach and Vicinity, Shore Protection Project, South Carolina. We hope our comments will assist you. Thank you for giving us an opportunity to review the document.

Sincerely,

David Cottingham

David Cottingham
Director
Ecology and Conservation Office

Enclosure

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9450 Koger Boulevard
St. Petersburg, Florida 33702

November 5, 1992

Lt. Colonel Mark E. Vincent
District Engineer, Charleston District
Department of the Army, Corps of Engineers
P.O Box 919
Charleston, South Carolina 29402-0919

Dear Colonel Vincent:

The National Marine Fisheries Service (NMFS) has reviewed the Draft Environmental Impact Statement (DEIS) prepared by the U.S. Army Corps of Engineers, Charleston District, concerning the Myrtle Beach and Vicinity, Shore Protection Project, Horry and Georgetown Counties, South Carolina. The following comments are provided for your use in planning for the project and in preparation of the final EIS.

General Comments

The DEIS does not adequately address potential adverse impacts on NMFS trust resources. The description of hard and live bottom habitat found in the project area is confusing. Sufficient detail is not presented to assess project impacts on the nearshore environment in connection with placement of sediment for beach nourishment. The DEIS also does not adequately describe impacts that may occur in the vicinity of the offshore borrow sites.

The DEIS also fails to adequately address the cumulative impact of this type of activity on living marine resources. We are concerned that habitat alteration associated with this and numerous similar projects along the South Carolina coast will result in a reduction of forage species such as macroinvertebrates and, subsequently, harvestable fish that rely on these organisms. In the absence of this information, we find no basis for the determination that the proposed action will have "no serious impact on fisheries."

Specific Comments

1.0 Summary

1.2 Authorized Project

Page 3, paragraph 2. The total project length should be clarified. The project length is given on Page 1 is 22.6 miles. Page 11, paragraph 1, specifies 25.7 miles and page 30, paragraph 4, specifies 23.9 miles.

Page 3, paragraph 1. We disagree with the statement that beach nourishment would "benefit a variety of invertebrates, birds, and fish." The likely "best case" scenario is one in which the adverse impacts would be of short duration and existing animal populations quickly return to predisposal levels. Consequently, documentation of any anticipated benefits to living marine resources, as referenced in the DEIS, is needed.

Page 3, paragraph 2. We disagree with the determination that the loss of organisms at the offshore borrow sites and on the intertidal beach are "insignificant." The ecological roles of these habitats and their associated fauna are not described, but may be significant with regard to the survival and abundance of resident and migratory species such as spot, summer flounder, bluefish, whiting, Florida pompano, and others. Although the magnitude of impact associated with dredging and dredged material disposal in these habitats varies seasonally, the significance of this relationship is not discussed. The importance and need for seasonal work restrictions should be addressed, particularly with regard to benthic and epibenthic population recovery.

The DEIS states that a monitoring plan is being developed to assess project related impacts on the intertidal disposal and offshore borrow site benthos; however, monitoring of project impacts on finfish is not included. Information on the impacts of beach nourishment on finfish is needed, especially with regard to the effects of periodic elimination of nearshore forage species such as mole crab (Emerita talpoida) and donax (Donax spp). Therefore, we recommend that fish monitoring, including effects on feeding and forage species abundance, be performed and that the NMFS be consulted in connection with development of the monitoring plan. Additionally, other project related effects such as increased turbidity levels and changes in substrate composition should be addressed with respect to possible impacts on fishery resources.

3.0 Alternatives Considered

3.4 Borrow Areas

Page 14, paragraph 1, line 4. Much of the area within 5,000 feet of the shore is "hard bottom." However, it is unclear how this term is used and whether it is synonymous with the biological description of "live bottom." If extensive live bottom habitat is located within 5,000 feet of shore, any significant offshore migration of sand could adversely impact this important habitat. Accordingly, the DEIS should address the impact of beach nourishment and possible movement of sand onto live bottom areas.

4.0 Affected Environment

4.2 Biological Resources

a. Vegetation and Wildlife

Page 21, paragraph 1. No information is provided in this section regarding the size, frequency, and distribution of "hard bottom" habitat in the project area. Although a bottom survey of the project area was performed, we are concerned that the small size of some live bottom areas may have resulted in an underestimation of the occurrence of hard and live bottom habitats in the project area. More detail needs to be provided regarding the techniques used to assess the occurrence of hard and live bottom habitat in the project area.

5.0 Environmental and Socioeconomic Consequences

5.2 Biological Resources

a. Fish and Wildlife

Page 30, paragraph 3. See comments on the proposed monitoring plan in 1.4 Environmental Impacts, page 3, paragraph 2.

Page 31, paragraph 2, line 8. The basis for the determination that recovery would occur in three-to-six months should be provided. This section also does not address the cumulative impact on fisheries of depositing sand on about 24 miles of beach. Assuming that a 200-foot-wide fill zone is created (no cross sectional drawings were provided), approximately 581.8 acres of intertidal/nearshore habitat would be altered. In this regard, the effects of periodic maintenance work, occurring at eight year intervals, should also be described.

Page 32, paragraph 1, line 2. See our previous comments on the need for additional information on live bottom survey techniques. To our knowledge, the study referenced in this section has not been provided for our review. In view of the importance of this information, we request that the report be included as an appendix to the DEIS.

Page 32, paragraph 2. We disagree with the determination that "This project will have no serious impact on marine fisheries." Studies of beach nourishment in South Carolina are limited and none of the studies performed to date have examined impacts on fish. In addition, no consideration was given to the seasonal nature of potential impacts of dredging and dredged material disposal, or to the potential cumulative impact of nourishing approximately 24 miles of shoreline. Accordingly, we believe that the conclusion of "no serious impact" in the DEIS is premature and should be reassessed.

Studies on the ecological effects of beach nourishment in other states may provide some insight regarding possible impacts and we recommend that they be reviewed. The following is a list of relevant literature that may be useful in addressing the issues we have raised:

Goldberg, W.M. 1988. Biological effects of beach restoration in South Florida: the good, the bad, and the ugly. In Tait, L.D. (eds). 1988. Beach Preservation Technology '88': Problems and advancements in beach nourishment-proceedings. Florida Shore and Beach Preservation Association, Inc., Tallahassee, Florida.

Nelson, W.G. and G.W. Collins. 1987. Effects of beach nourishment on the benthic macrofauna and the fishes of the nearshore zone at Sebastian Inlet State Recreation Area, Technical Report 87-14, Department of Oceanography and Ocean Engineering. Florida Inst. Tech. to U.S. Army Corps of Engineers, Jacksonville District. 180 pp.

Rakocinski, C., S.E. Lecroy, J.A. McLelland, and R.W. Heard. 1991. Responses by macroinvertebrates communities to beach nourishment at Perdidio Key, Florida. Gulf Coast Research Laboratory. Annual Report for the National Park Service, Gulf Islands National Seashore, Gulf Breeze, Florida. 69 pp.

Reilly, F.J. and V.J. Bellis. 1978. A Study of the ecological impact of beach nourishment with dredged materials on the intertidal zone. East Carolina University Institute for Coastal and Marine Resources. Technical Report No. 4, Greenville, NC. 107 pp.

Page 33, paragraph 1. It is not clear if consultation with the NMFS, as required under Section 7 of the Endangered Species Act, was conducted. The DEIS should address status and results of such consultation.

We appreciate the opportunity to provide these comments.

Sincerely,

David W. Rackley

for Andreas Mager, Jr.
Assistant Regional Director
Habitat Conservation Division

DEPARTMENT OF THE ARMY
SOUTH ATLANTIC DIVISION, CORPS OF ENGINEERS
ROOM 313, 77 FORSYTH ST., S.W.
ATLANTA, GEORGIA 30335-6801

REPLY TO
ATTENTION OF:

CESAD-PD-R (1105-2-10c) 1 November 1993

MEMORANDUM FOR COMMANDER, CHARLESTON DISTRICT, ATTN: CESAC-EN-PR

SUBJECT: Record of Decision (ROD) Myrtle Beach and Vicinity Shore Protection, South Carolina

The subject ROD was signed by CESAD Acting Commander and is enclosed. You should provide copies of this ROD to agencies, organizations, and members of the public that have expressed concern or interest in this project.

FOR THE COMMANDER:

Merlin E. Foreman

Encl

MERLIN E. FOREMAN, P.E.
Director of Planning

RECORD OF DECISION
MYRTLE BEACH AND VICINITY
SHORE PROTECTION
HORRY AND GEORGETOWN COUNTIES
SOUTH CAROLINA

Upon careful consideration of the social, environmental, and economic effects, as well as the engineering feasibility of various practicable alternatives, I have decided to recommend for construction the Myrtle Beach and Vicinity Shore Protection Project as described in the Final Environmental Impact Statement (FEIS) and supporting documents. The recommended project reduces shoreline erosion and storm damage to Myrtle Beach and vicinity. The project calls for the initial placement of 5.1 million cubic yards (cy) of material on three separate reaches of the project beaches totaling approximately 25 linear miles. This material will come from offshore borrow sites. There are sufficient quantities of material at three specified sites for initial construction and all periodic nourishment efforts. Periodic nourishment will take place once every eight to ten years or as required.

Structural and non-structural alternatives were evaluated in the FEIS along with the no action alternative. The recommended plan was selected based on criteria in Principals and Guidelines. The recommended project is the National Economic Development (NED) Plan. The recommended project would have short-term adverse impacts due to turbidity and loss of some benthic organisms when material is removed from the borrow area and placed on the beach. A monitoring plan has been developed that will determine recovery rate of benthic organisms. This information will be used in planning subsequent beach renourishment efforts. Any sea turtle nests that are encountered during beach nourishment activities will be relocated by qualified personnel.

All practicable means to avoid, minimize, and compensate for adverse environmental effects for the sand placement and the borrow sites have been adopted and will be implemented. The FEIS considered the requirements of all appropriate Federal, state and local policies, laws, executive orders, and regulations. The recommended project is in full compliance with all these requirements and all concerns regarding the recommended project have been resolved.

No significant new issues were raised by comment letters on the FEIS, with the exception that the U.S. Fish and Wildlife Service noted the recent listing of the sea beach amaranth as a threatened plant species. The Charleston District has conducted a survey for this species and provided the results to the U.S. Fish and Wildlife Service through followup consultation under the Endangered Species Act. The sea beach amaranth will not be adversely affected, and will likely benefit as a result of the product.

In summary, I find that the recommended project is the most feasible solution and represents the course of action which, on balance, best serves the overall public interest.

26 Oct 93
Date

James H. Simms
James H. Simms
Colonel, U.S. Army
Acting Division Engineer

Appendix 2

Endangered/Threatened Species Coordination

BIOLOGICAL ASSESSMENT for

MYRTLE BEACH

STORM DAMAGE REDUCTION PROJECT

HORRY and GEORGETOWN COUNTIES,

SOUTH CAROLINA

U.S. Army Corps of Engineers
Charleston District

September 2006

Biological Assessment for Myrtle Beach
Storm Damage Reduction Project
Horry and Georgetown Counties,
South Carolina

September 2006

1.0 BACKGROUND AND AUTHORIZATION

The Myrtle Beach Storm Damage Reduction Project was authorized for construction by Section 101 of the Water Resources Development Act of 1990, Public Law 101-640. Section 934 of the Water Resources Development Act of 1986 (WRDA86), Public Law 99-662, authorized the Government to extend the Federal participation in periodic beach nourishment until 2046. The final Environmental Impact Statement (EIS) was completed in January 1993 with the Record of Decision (ROD) being signed on 1 November 1993.

The authorized project calls for construction of a separate protective beach in three separable reaches, North Myrtle Beach (Reach 1), Myrtle Beach (Reach 2), and Garden City/Surfside Beach (Reach 3). The total project reach is 25.4 miles. Initial construction, as identified in the October 1987 Feasibility Report, consisted of constructing a protective berm to an elevation of between 7 and 11 feet above the National Geodetic Vertical Datum (NGVD) and a top width of 15 feet for all three project reaches. These project dimensions were later modified with the completion of a General Design Memorandum in March 1993. The authorized project recommended utilization of borrow material obtained from inland sites, and that additional offshore investigation be performed during preconstruction studies. The offshore borrow sites were eventually chosen to be mined for the initial nourishment of all three reaches. In addition to being separable reaches, each reach also has differing non-federal sponsors.

2.0 PROPOSED PROJECT

The project is anticipated to be constructed with a hopper dredge, booster pump, and land based heavy equipment (i.e. bulldozers and front-end loaders). The borrow area will be subdivided into separate smaller zones. The dredge will remove the sand to a depth not to exceed ten feet within the borrow areas. The contract specifications will require the contractor remove material completely from one borrow zone prior to moving to another borrow zone. In addition to borrow area requirements, the contract specifications will require that the contractor control his beach placement techniques. The beach renourishment is anticipated to continue 24 hours per day, 7 days per week for a period of approximately 15 months including mobilization. Noise pollution and construction activities will be monitored to ensure minimum disturbance to the surrounding community.

Initial construction of Reach 1 of the project was completed in May 1997. Initial placement consisted of 57.7 cubic yards per linear foot of beach. This quantity includes material for the protective berm, advanced nourishment and overfill ratio, for a total placement of 2,622,900 cubic yards. Future renourishment of 490,000 cubic yards was planned for every ten years. According to this plan, North Myrtle Beach (Reach 1) would be due its first renourishment in 2007. Based on current conditions Reach 1 is in need of 702,600 cubic yards to restore the project to full dimension.

The first nourishment cycle of Reach 2 was completed in December 1997. Initial placement consisted of 47.1 cubic yards per linear foot of beach. This quantity includes material for the protective berm, advanced nourishment and overfill ratio, for a total placement of 2,250,000 cubic yards. Future renourishment of 440,000 cubic yards was planned for every eight years with the final nourishment being 550,000 cubic yards for the last ten years of project life. According to this plan, Myrtle Beach (Reach 2) was due its first renourishment in 2005. Due to the lack of available funds, the first renourishment was rescheduled for 2008. The current effort would require a volume of 1,442,500 cubic yards of material to return the beach to the full design template.

Reach 3 of the Myrtle Beach, South Carolina Shore Protection Project would provide restoration of approximately 7.7 linear miles of beach in Horry and Georgetown Counties extending from 1.2 miles south of the Horry/Georgetown County line to Myrtle Beach State Park in Horry County. Initial project construction was completed in November 1998 with placement of 1,517,494 cubic yards. Full project restoration provides for restoration of the advance nourishment over the entire 7.7-mile project length with a volume of 773,000 cubic yards.

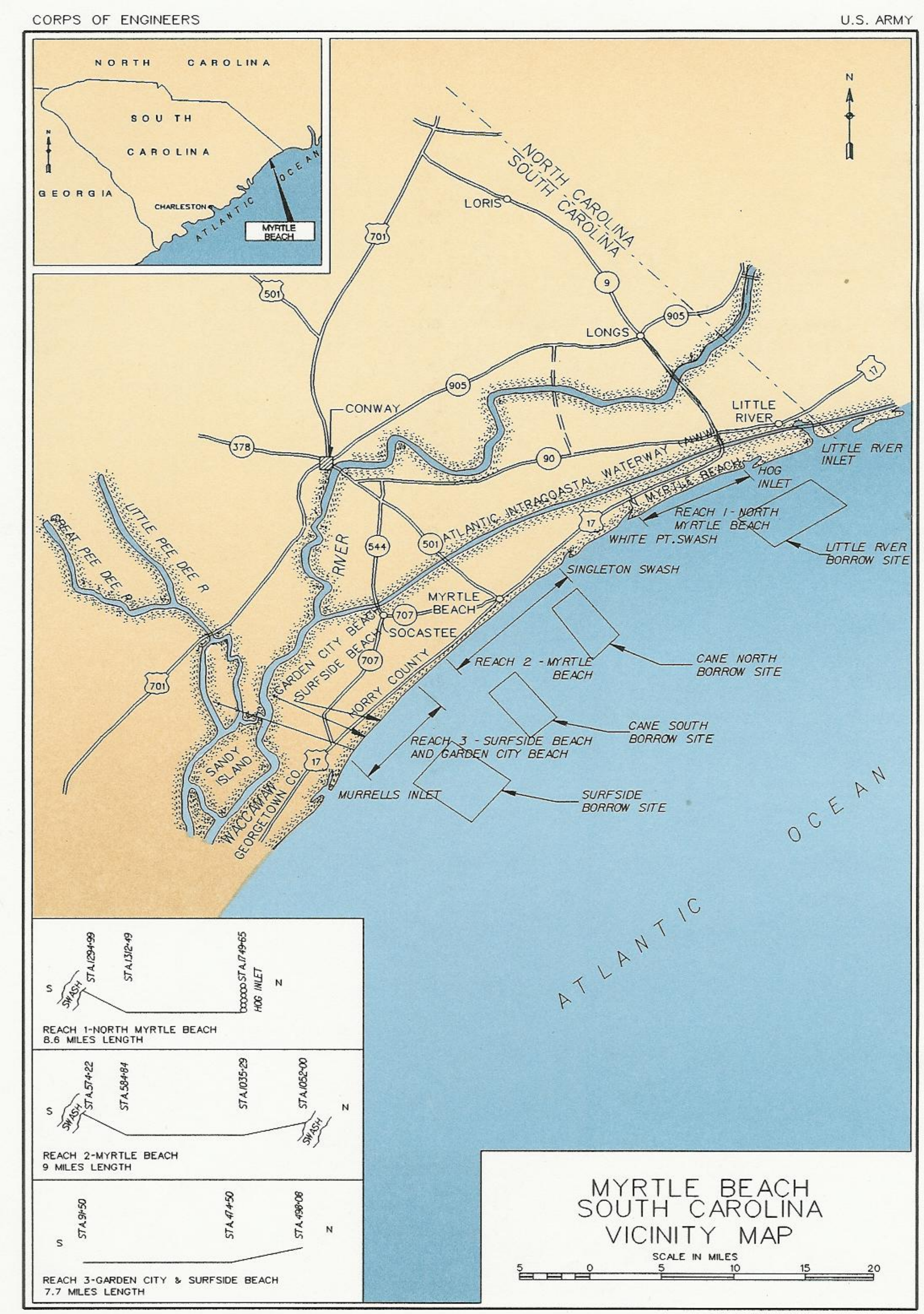
Four offshore borrow sites are identified in the March 1993 General Design Memorandum for the project as depicted in Figure 1 (on the following page). The four borrow sites with their intended project nourishment area in parenthesis and available sand quantity as identified in the GDM is provided in Table 1.

Table 1
Borrow Area Capacity

Borrow Area	Capacity
Little River (Reach 1)	18.1 million cy
Cane North (Reach 2)	6.7 million cy
Cane South (Reach 2)	12.3 million cy
Surfside (Reach 3)	34.4 million cy

3.0 PRIOR CONSULTATIONS

Formal Section 7 consultation was conducted in 1992 regarding the Myrtle Beach project. The conclusion of the biological opinion rendered by the U.S. Fish and Wildlife Service (FWS) at that time determined that the nourishment, as proposed, had the potential to effect but was not likely to jeopardize the continued existence of the loggerhead sea turtle (*Caretta caretta*). The conclusion of the Biological Opinion rendered by the FWS was that the dredging project was not likely to adversely affect sea-beach amaranth (*Amaranthus pumilus*).


CORPS OF ENGINEERS
U.S. ARMY
NORTH CAROLINA
SOUTH CAROLINA
GEORGIA
CHARLESTON
ATLANTIC OCEAN
MYRTLE BEACH
NORTH CAROLINA
SOUTH CAROLINA
LORIS
LONGS
CONWAY
LITTLE RIVER
LITTLE RVER INLET
HOG INLET
ATLANTIC INTRACOASTAL WATERWAY (AIWW)
N. MYRTLE BEACH
REACH 1 - NORTH MYRTLE BEACH
WHITE PT. SWASH
LITTLE RVER BORROW SITE
SINGLETON SWASH
LITTLE PEE DEE R
GREAT PEE DEE R
RIVER
MYRTLE BEACH
SOCASTEE
GARDEN CITY BEACH
SURFSIDE BEACH
HORRY COUNTY
REACH 2 - MYRTLE BEACH
CANE NORTH BORROW SITE
CANE SOUTH BORROW SITE
REACH 3 - SURFSIDE BEACH AND GARDEN CITY BEACH
SANDY ISLAND
WACCAMAW
GEORGETOWN CO.
MURRELLS INLET
SURFSIDE BORROW SITE
ATLANTIC OCEAN
STA.1294+99
STA.1312+49
STA.1749+65
SWASH
HOG INLET
REACH 1-NORTH MYRTLE BEACH
8.6 MILES LENGTH
STA.574+22
STA.584+84
STA.1035+29
STA.1052+00
REACH 2-MYRTLE BEACH
9 MILES LENGTH
STA.91+50
STA.474+50
STA.498+08
REACH 3-GARDEN CITY & SURFSIDE BEACH
7.7 MILES LENGTH
MYRTLE BEACH
SOUTH CAROLINA
VICINITY MAP
SCALE IN MILES
5 0 5 10 15 20

4.0 LIST OF SPECIES

4.1 U.S. Department of Interior

The following species have been listed by the U.S. Department of Interior as occurring or possibly occurring in Georgetown or Horry County, South Carolina (from list dated March 2006).

Key
E = Federally endangered
T = Federally threatened
CH = Critical Habitat
SC = Species of concern. These species are rare or listed in distribution but are not currently legally protected under the Endangered Species Act.
* = Contact NMFS for more information on this species

Common Name	Scientific Name	Status	Occurrences
West Indian manatee	*Trichechus manutus*	E	Known
Red-cockaded woodpecker	*Picoides borealis*	E	Known
Bald eagle	*Haliaeetus leucocephalus*	T	Known
Wood stork	*Mycteria americana*	E	Known
Piping plover	*Charadrius melodus*	T, CH	Known
Kemp's ridley sea turtle	*Lepidochelys kempii**	E	Known
Leatherback sea turtle	*Dermochelys coriacea**	E	Known
Loggerhead sea turtle	*Caretta caretta*	T	Known
Green sea turtle	*Chelonia mydas**	T	Possible
Shortnose sturgeon	*Acipenser brevirostrum**	E	Known
Sea-beach amaranth	*Amaranthus pumilus*	T	Known
Pondberry	*Lindera melissifolia*	E	Possible
Canby's dropwort	*Oxypolis canbyi*	E	Possible
Chaff-seed	*Schwalbea americana*	E	Known
Southern Dusky Salamander	*Desmognathus auriculatus*	SC	Possible
Georgia lead-plant	*Amorpha georgiana var. georgiana*	SC	Known
One-flower balduina	*Balduina uniflora*	SC	Known
Ciliate-leaf tickseed	*Coreopsis integrifolia*	SC	Known
Venus' fly-trap	*Dionaea muscipula*	SC	Known
Dwarf burhead	*Echinodorus parvalus*	SC	Known
Harper's fimbristylis	*Fimbristylis perpusilla*	SC	Known
Southern bog-button	*Lachnocaulon beyrichianum*	SC	Known
Pondspice	*Litsea astivalis*	SC	Known
Carolina bogmint	*Macbridea caroliniana*	SC	Known
Piedmont cowbane	*Oxypolis ternata*	SC	Known
Carolina grass-of parnassus	*Parnassia caroliniana*	SC	Known

Pineland plantain	*Plantago sparsiflora*	SC	Known
Crested fringed orchid	*Pteroglossaspis ecristata*	SC	Known
Well's Pyxie Moss	*Pyxidanthera barbulata var. barbulata*	SC	Known
Wire-leaved dropseed	*Sporobolus teretifolius*	SC	Known
Pickering's morning-glory	*Stylisma pickerngii var. pickeringii*	SC	Known
White false-asphodel	*Tofieldia glabra*	SC	Known
Kirtland's Warbler	*Dendroica kirtlandii*	E	Possible
Bachman's sparrow	*Aimophia aestivalis*	SC	Known
Henslow's sparrow	*Ammodramus henslowii*	SC	Known
Red knot	*Calidris canutus*	SC	Possible
Swallow-tailed kite	*Elanoides forficatus forficatus*	SC	Known
American kestrel	*Falco sparverius*	SC	Possible
American oystercatcher	*Haematopus palliatus*	SC	Known
Loggerhead shrike	*Lanius ludovicianus*	SC	Possible
Painted bunting	*Passerina ciris ciris*	SC	Possible
Gull-billed tern	*Sterna nilotica*	SC	Known
Southern hognose snake	*Heterodon simus*	SC	Possible
Northern pine snake	*Pituophis melanoleucus melanoleucus*	SC	Known
Savannah or Piedmont cowbane	*Oxypolis ternate*	SC	Known
Awned meadowbeauty	*Rhexia aristosa*	SC	Known
Reclined meadow-rue	*Thalictrum subrotundum*	SC	Known
Dune bluecurls	*Trichostema sp.*	SC	Known
Black-throated green warbler	*Dendroica virens*	SC	Possible
Black rail	*Laterallus jamaicensis*	SC	Possible
Swainson’s warbler	*Limnothlypis swainsonii*	SC	Known
Carolina pygmy sunfish	*Elassoma boehlkei*	SC	Known
Pine or Gopher snake	*Pituophis melanoleucus melanoleucus*	SC	Known
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	SC	Known

4.2 The National Marine Fisheries Service

The NMFS provided a list indicating the following threatened (T) and endangered (E) species and critical habitats for South Carolina waters under that agency’s jurisdiction within the South Atlantic area of the United States.

Listed Species

Common Name	Scientific Name	Status	Date Listed
Marine Mammals			
Blue whale	*Balaenoptera musculus*	E	12/02/70
Finback whale	*Balaenoptera physalus*	E	12/02/70

Humpback whale	*Megaptera novaeangliae*	E	12/02/70
Right whale	*Eubaleana glacialis*	E	12/02/70
Sei whale	*Balaenotera borealis*	E	12/02/70
Sperm whale	*Physeter macrocephalus*	E	12/02/70
Turtles			
Green sea turtle	*Chelonia mydas*	T*	07/28/78
Hawksbill sea turtle	*Eretmochelys imbricata*	E	06/02/70
Kemp's ridley sea turtle	*Lepidochelys kempii*	E	12/02/70
Leatherback sea turtle	*Dermochelys coriacea*	E	06/02/70
Loggerhead sea turtle	*Caretta caretta*	T	07/28/78
Fish			
Shortnose sturgeon	*Acipenser brevirostrum*	E	03/11/67

Species Proposed for Listing: None
Designated Critical Habitat: None
Proposed Critical Habitat: None
Candidate Species: None

Species of Concern:

Common Name	Scientific Name
Fish	
Dusky shark	*Carcharhinus obscurus*
Sand tiger shark	*Odontaspis Taurus*
Night shark	*Carcharinus signatus*
Atlantic sturgeon	*Acipenser oxyrhynchus oxyrhynchus*
Speckled hind	*Epinephelus drummondhayi*
Warsaw grouper	*Epinephelus nigritus*
White Marlin	*Tetrapturus albidus*
Ivory bush coral	*Oculina varicosa*

* Green turtles are listed as threatened, except for breeding populations of green turtles in Florida and on the Pacific Coast of Mexico, which are listed as endangered.

5.0 GENERAL EFFECTS ON LISTED SPECIES/CRITICAL HABITAT

Since all aspects of the proposed work will occur on the ocean beach or on a marine shoal, the project will not affect any listed species occurring in forested or freshwater habitats. Thus, the bald eagle, red-cockaded woodpecker, wood stork, Canby's dropwort, Pondberry, chaff-seed will not be affected by this construction effort.

Species that could be present in the project area during the proposed action are the shortnose and Atlantic sturgeons, and the hawksbill, Kemp's ridley, leatherback, loggerhead, and green sea turtles. However, loggerheads are the primary sea turtle nesters in this area. The West Indian manatee rarely visits the area; however, some sightings have been recorded over the years. The piping plover winters in this area and critical habitat has been designated adjacent the project area. Further, there are no known populations of sea-beach amaranth in the project area; however, the project footprint is within the range of the plant. On the open ocean, the blue, finback, humpback, right, sei and sperm whales are occasionally sited and are subject to influence by vessel traffic.

6.0 SPECIES ASSESSMENTS

6.1 Manatee

The West Indian manatee (*Trichechus manatus*) was listed as endangered on March 11, 1967, under a law that preceded the Endangered Species Act of 1973, as amended (16 USC 1531 et seq.). Additional Federal protection is provided for this species under the Marine Mammal Protection Act of 1972, as amended (16 USC 1461 et seq.) The manatee population in the United States is confined during the winter months to the coastal waters of the southern half of peninsular Florida and to springs and warm water outfalls as far north as southeast Georgia (COE, 2001). However, during the summer months, they may migrate as far north as coastal Virginia on the East Coast and west to Louisiana on the Gulf of Mexico (COE, 2001). The manatee is an uncommon summer resident of the South Carolina coast with occasional visual reports. There is no designation of critical habitat for the West Indian manatee in South Carolina.

Effect Determination

To ensure the protection of manatees, all Federal and contract personnel associated with this project will be instructed on the potential presence of manatees and the need to avoid vessel or plant collisions with manatees. Manatees occur very infrequently in the waters near the project. It has been determined that the proposed project is not likely to adversely affect the manatee.

6.2 Kemp’s ridley, leatherback, loggerhead, green, and hawksbill sea turtles

There are five species of sea turtles on the Atlantic Coast, Kemp’s ridley sea turtle (*Lepidochelys kempii*), leatherback sea turtle (*Dermochelys coriacea*), loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas)*, and the hawksbill sea turtle (*Eretmochelys imbricata*). These five species of sea turtles are protected by the Convention on International Trade in Endangered Species (CITES). They are also listed as endangered or vulnerable in the Red Data Book by the International Union for the Conservation of Nature (IUCN). The hawksbill, Kemp's ridley and leatherback were listed as endangered by the U. S. Endangered Species Act in 1973. The green turtle and the loggerhead were added to the list as threatened in 1978. All species that appear on the United States list are also on the South Carolina list.

Sea turtles occupy different habitats, depending upon their species, sex and age (size). Hatchlings and smaller juvenile loggerheads appear to live in floating mats of sargassum in the open ocean. This seaweed offers cover, protection from predators and a source of food. Larger juveniles are generally seen in the same coastal habitat as the adults, especially during the summer.

Leatherbacks feed entirely on jellyfish, and they must often travel long distances to keep up with large concentrations of this food source drifting in the ocean currents. Green turtles are herbivorous and remain near pastures of turtle-preferred grasses. Often these pastures are not near their nesting beaches, so these turtles migrate hundreds of miles to nest. Loggerheads usually leave the cold, coastal waters in the winter and are often seen along the edge of the Gulf Stream. Hawksbills live on coral reefs almost year-round, feeding on sponges, sea squirts and other bottom organisms. Although the Kemp's ridley nests only on Mexico's Gulf Coast, small juveniles of this species and the green turtle occur along the South Carolina coast during the summer.

Since the reproductive cycles of all sea turtles are similar, a generalized version encompasses all. Mating takes place offshore, and the turtles must only mate once to fertilize all eggs laid during the nesting season. When nesting, the female crawls onto the beach, usually at night, and digs a hole in the sand with her hind flippers. After laying about 100 (number of eggs vary among species) white, leathery eggs, she covers them and returns to the sea. A single female may nest several times a season, usually at 2-week intervals. The eggs incubate about 60 days, depending on the weather. Hatchlings dig out of the sand at night and make their way to the sea using light cues for guidance. Destruction of nests and hatchling mortality at sea are usually high. It appears sea turtles' high number of eggs per clutch and several nestings per season have evolved to offset this high mortality rate. Nesting habits of the Kemp's ridley deviate from those of other sea turtles. The Kemp's ridley is the only species that nests during the day. Most sea turtles do not nest every year. They return on either a 2- or 3-year cycle to the same general area or beach. Of these six species, only the loggerhead is considered to be a regular nester in SC. There is no critical habitat designation for sea turtles in SC. For purposes of this assessment, the loggerhead is considered to be the only species likely to nest in the project area.

- **Loggerhead Sea Turtle.** The loggerhead sea turtle has a worldwide distribution and is found in temperate and subtropical waters. Major nesting areas in North America occur along the Southeast Coast from North Carolina to Florida. Loggerhead sea turtles regularly nest along the southern coast of South Carolina from Georgetown south (with limited occurrence to the north within the project area), usually from mid-May to August. Nesting is preferred on remote beaches away from human disturbance. The loggerhead is considered a turtle of shallow water with juveniles preferring bays and estuaries. An omnivore, crustaceans, mollusks, squid, jellyfish, fish, and plant materials are desirable foods. Stranding data reveals that up to 70% of all stranded sea turtles are loggerheads with the majority of strandings occurring from May to August. Therefore, it can be surmised that the potential presence of loggerheads in the project area would most-likely occur at this time. In Georgia, South Carolina and North Carolina the nesting season generally begins in mid-May and ends with the emergence of the last hatchling around the end of August. Nesting activity is greatest, however, in June and July. Loggerheads are known to nest from one to seven times within a nesting season; the mean is approximately 4.1. The interesting interval varies around a mean of about 14 days. There is general agreement that females mate prior to the nesting season (and possibly only once) and then lay multiple clutches of fertile eggs throughout some portion of the nesting season. Mean clutch size varies from about 100 to 126 along the southeastern United States coast. Loggerheads are nocturnal nesters, but exceptions to the rule do occur infrequently. Multi-annual re-migration intervals of two and three years are most common in loggerheads, but the number can vary from one to six years. The length of the incubation period is related to nest temperature. Sex determination in loggerhead hatchlings is temperature dependent and the species apparently lacks sex chromosomes. Natural hatching success rates of 73.4 percent and 55.7 percent have been reported in South Carolina. Loggerhead hatchlings travel for about 20 hours after they enter the sea and that takes them about 22 to 28 kilometers offshore. After leaving the beach, they become associated with *Sargassum* rafts/debris and ride these communities among ocean currents for a few years as juveniles. Upon reaching a mean straight carapace length (sCL) of 40 - 50 cm, they abandon the pelagic existence and migrate to near-shore and estuarine waters of the eastern United States, the Gulf of Mexico and the Bahamas and begin the subadult stage. As adults, loggerheads become migratory for the purpose of breeding. Reported tag recoveries suggest a "migratory path" from Georgia to Cape Hatteras, North Carolina with a single recovery of a Georgia tagged female on the Florida Gulf Coast (Tampa Bay). Little else is known of the scheduled travels of Georgia, South Carolina, and North Carolina nesters outside of the nesting season (NMFS, USFWS, 1991).

- **Affected sea turtle environment.**

Current range wide conditions for sea turtles.

It is not possible, at present, to estimate the size of the loggerhead population in United States territorial waters if one includes subadults. There is, however, general agreement that enumeration of nesting females provides a useful index to population size and stability. It is estimated that 14,150 females nest per year in the southeastern United States. This estimate was based on aerial survey data from 1983 and has been accepted as the best current approximation. Based on a mean of 4.1 nests per female, it is estimated that approximately 58,000 nests are deposited per year in the Southeast. Based on more extensive ground and aerial surveys throughout the Southeast in recent years (1987 to 1990), it is estimated that approximately 50,000-70,000 nests are deposited annually. These totals constitute about 35 to 40 percent of the loggerhead nesting known worldwide and clearly rank the southeastern United States aggregation as the second largest in the world (NMFS, USFWS, 1991).

Cumulative effects of actions in project area on sea turtles:

Very little is known about sea turtle diseases or natural mortality rates. However, it is believed that declines in populations are a direct result of human actions. Erosion of nesting beaches can result in partial or total loss of suitable nesting habitat. Dynamic coastal processes, including sea level rise, influence erosion rates. Man's interference with these natural processes through coastal development and associated activities has resulted in accelerated erosion rates and interruption of natural shoreline migration. Where beachfront development occurs, the site is often fortified to protect the property from erosion. Virtually all shoreline engineering is carried out to save structures, not dry sandy beaches, and ultimately, this results in environmental damage. One type of shoreline engineering, collectively referred to as beach armoring, includes sea walls, rock revetments, riprap, sandbag installations, groins and jetties. Beach armoring can result in permanent loss of a dry nesting beach through accelerated erosion and prevention of natural beach/dune accretion and can prevent or hamper nesting females from accessing suitable nesting sites. Clutches deposited seaward of these structures may be inundated at high tide or washed out entirely by increased wave action near the base of these structures. As these structures fail and break apart they spread debris on the beach that may further impede access to suitable nesting sites (resulting in higher incidences of false crawls) and trap hatchlings and nesting turtles. Sandbags are particularly susceptible to rapid failure and result in extensive debris on nesting beaches. Rock revetments, riprap and sand bags can cause nesting turtles to abandon nesting attempts or to construct improperly sized and shaped egg cavities when inadequate amounts of sand cover these structures. Approximately 21 percent (234 km) of

Florida's beaches, 10 percent (18 km) of Georgia's beaches and 10 percent (30 km) of South Carolina's beaches are armored (NMFS, USFWS, 1991).

Groins and jetties are designed to trap sand during transport in longshore currents or to keep sand from flowing into channels in the case of the latter. These structures prevent normal sand transport and accrete beaches on one side of the structure while starving neighboring beaches on the other side thereby resulting in severe beach erosion and corresponding degradation of suitable nesting habitat. Beach nourishment consists of pumping, trucking or scraping sand onto the beach to rebuild what has been lost to erosion. Beach nourishment can impact turtles through direct burial of nests and by disturbance to nesting turtles if conducted during the nesting season. Sand sources may be dissimilar from native beach sediments and can affect nest site selection, digging behavior, incubation temperature (and hence sex ratios), gas exchange parameters within incubating nests, hydric environment of the nest, hatching success and hatchling emergence success. Beach nourishment can result in severe compaction or concretion of the beach. Trucking of sand onto project beaches may increase the level of compaction (NMFS, USFWS, 1991). However, nourishment of beaches can provide suitable habitat for nesting above the high tide mark.

Significant reductions in nesting success have been documented on severely compacted nourished beaches. Compaction levels that have been evaluated at ten renourished east coast Florida beaches concluded that 50 percent were hard enough to inhibit nest digging, 30 percent were questionable as to whether their hardness affected nest digging and 20 percent were probably not hard enough to affect nest digging. They further concluded that, in general, beaches nourished from offshore borrow sites are harder than natural beaches, and, while some may soften over time through erosion and accretion of sand, others may remain hard for 10 years or more. Nourished beaches often result in severe escarpments along the mid-beach and can hamper or prevent access to nesting sites. Nourishment projects result in heavy machinery, pipelines, increased human activity and artificial lighting on the project beach. These activities are normally conducted on a 24-hour basis and can adversely affect nesting and hatching activities. Pipelines and heavy machinery can create barriers to nesting females emerging from the surf and crawling up the beach, causing a higher incidence of false crawls (non-nesting emergences). Increased human activity on the project beach at night may cause further disturbance to nesting females. Artificial lights along the project beach and in the nearshore area of the borrow site may deter nesting females and disorient or misorient emergent hatchlings from adjacent non-project beaches (NMFS, USFWS, 1991).

Beach nourishment projects require continual maintenance (subsequent nourishment) as beaches erode and hence their impacts, both positive and negative, to turtles are repeated on a regular basis. Beach nourishment projects conducted during the nesting season have the potential to result in the loss of some nests which may be inadvertently missed or misidentified as false crawls during daily patrols conducted to identify and relocate nests deposited on the project beach. Nourishment of highly eroded beaches (especially those with a complete absence of dry beach) can be beneficial to nesting turtles if conducted properly. Careful consideration and advance planning and coordination must be carried out to ensure timing, methodology and sand sources are compatible with nesting and hatching requirements (NMFS, USFWS, 1991).

Extensive research has demonstrated that the principal component of the sea- finding behavior of emergent hatchlings is a visual response to light. Artificial beachfront lighting from buildings, streetlights, dune crossovers, vehicles and other types of beachfront lights has been documented in the disorientation (loss of bearings) and misorientation (incorrect orientation) of hatchling turtles. The results of disorientation or misorientation are often fatal. As hatchlings head toward lights or meander along the beach their exposure to predators and likelihood of desiccation is greatly increased. Misoriented hatchlings can become entrapped in vegetation or debris, and many hatchlings are found dead on nearby roadways and in parking lots after being struck by vehicles. Hatchlings that successfully find the water may be misoriented after entering the surf zone or while in nearshore waters. Intense artificial lighting can even draw hatchlings back out of the surf (NMFS, USFWS, 1991).

The problem of artificial beachfront lighting is not restricted to hatchlings. It has been indicated that adult loggerhead emergence patterns were correlated with variations in beachfront lighting in south Brevard County, Florida, and that nesting females avoided areas where beachfront lights were the most intense. It has also been noted that loggerheads aborted nesting attempts at a greater frequency in lighted areas. Problem lights may not be restricted to those placed directly on or in close proximity to nesting beaches. The background glow associated with intensive inland lighting, such as that emanating from nearby large metropolitan areas, may deter nesting females and disorient or misorient hatchlings navigating the nearshore waters. Cumulatively, along the heavily developed beaches of the southeastern United States, the negative effects of artificial lights are profound (NMFS, USFWS, 1991).

Residential and tourist use of developed (and developing) nesting beaches can result in negative impacts to nesting turtles, incubating egg clutches and hatchlings. The most serious threat caused by increased human presence on the beach is the disturbance to nesting females. Night-time human activity can cause nesting females to abort nesting attempts at all stages of the behavioral process. It has been reported that disturbance can cause turtles to shift their nesting beaches, delay egg laying, and select poor nesting sites. Heavy utilization of nesting beaches by humans (pedestrian traffic) may result in lowered hatchling emergence success rates due to compaction of sand above nests and pedestrian tracks can interfere with the ability of hatchlings to reach the ocean. Campfires and the use of flashlights on nesting beaches misorient hatchlings and can deter nesting females (NMFS, USFWS, 1991).

A variety of natural and introduced predators such as raccoons, foxes, ghost crabs and ants prey on incubating eggs and hatchling sea turtles. The principal predator is the raccoon (*Procyon lotor).* Raccoons are particularly destructive and may take up to 96 percent of all nests deposited on a beach. In addition to the destruction of eggs, certain predators may take considerable numbers of hatchlings just prior to or upon emergence from the sand (NMFS, USFWS, 1991).

Nest loss due to erosion or inundation and accretion of sand above incubating nests appear to be the principal abiotic factors that may negatively affect incubating egg clutches. While these factors are often widely perceived as contributing significantly to nest mortality or lowered hatching success, few quantitative studies have been conducted. Studies on a relatively undisturbed nesting beach indicated that excepting a late season severe storm event, erosion and inundation played a relatively minor role in destruction of incubating nests. Inundation of nests and accretion of sand above incubating nests as a result of the late season storm played a major role in destroying nests from which hatchlings had not yet emerged. Severe storm events (e.g., tropical storms and hurricanes) may result in significant nest loss, but these events are typically aperiodic rather than annual occurrences. In the southeastern United States, severe storm events are generally experienced after the peak of the hatching season and hence would not be expected to affect the majority of incubating nests. Erosion and inundation of nests are exacerbated through coastal development and shoreline engineering (NMFS, USFWS, 1991).

The effects of dredging are evidenced through degradation of habitat and/or incidental take of marine turtles. Channelization of inshore and nearshore habitat and the disposal of dredged material in the marine environment can destroy or disrupt resting or foraging grounds (including grass beds and coral reefs) and may affect nesting distribution through the alteration of physical features in the marine environment. Hopper dredges are responsible for incidental take and mortality of marine turtles during dredging operations. Other types of dredges (clamshell and pipeline) have not been implicated in incidental take (NMFS, USFWS, 1991).

Of all commercial and recreational fisheries conducted in the United States, shrimp trawling is the most damaging to the recovery of marine turtles. Incidental capture and drowning in shrimp trawls is believed to be the largest single source of mortality on juvenile through adult stage marine turtles in the southeastern United States. Most of these turtles are juveniles and subadults, the age and size classes most critical to the stability and recovery of marine turtle populations. Quantitative estimates of turtle take by shrimp trawlers in inshore waters have not been developed, but the level of trawling effort expended in inshore waters along with increasing documentation of the utilization of inshore habitat by loggerhead turtles suggest that capture and mortality may be significant. Trawlers targeting species other than shrimp tend to use larger nets than shrimp trawlers and probably also take sea turtles, although capture levels have not been developed. These fisheries include, but are not limited to bluefish, croaker, flounder, calico scallops, blue crab and whelk. Of these, the bluefish, croaker and flounder trawl fisheries likely pose the most serious threats. The harvest of sargassum by trawlers can result in incidental capture of post hatchlings and habitat destruction (NMFS, USFWS, 1991).

Effect Determination

The placement of sand and construction activities associated with the placement of sand on these beaches could adversely affect any existing sea turtle nests and sea turtles attempting to nest. The extent of nesting in the project footprint is considered to be relatively minor and irregular when compared with other beaches along the coast. The construction work is expected to be ongoing during the nesting season. Therefore, a standardized nest monitoring and relocation plan will be implemented during the turtle-nesting season. This monitoring will include morning patrols of the beach for signs of nesting activity as well as movement of nests that may be endangered by construction activities.

The Charleston District implements a standard beach monitoring protocol to measure beach hardness/compaction after placement of material on the beach. After the material is placed on the beach, any areas that are determined to have an in situ hardness greater than 500 Cone Penetrometer Units (CPU) is tilled in order to make it suitable for sea turtle nesting. The District does, however, recommend conducting cone penetrometer testing before and after the dredging in an effort to collect data, which can be correlated with the turtle nesting during the summer, and which may provide useful information for other beach renourishment projects.

Visual surveys for escarpments along the project area will be made during construction and immediately after completion. Escarpments exceeding 18 inches in height for a distance of 100 feet or more will be graded down.

All of the dredging for the proposed project will be accomplished with either a hopper or a hydraulic pipeline cutterhead dredge in the specified areas. There is a potential for interaction between turtles and dredge equipment at sea. If a hopper dredge is employed, monitoring will be performed by placing observers on vessels between April 1 and 30 November in accordance with the National Marine Fisheries South Atlantic Regional Biological Opinion (September, 1997)

This project is not being designed to enhance turtle habitat However, because turtles may attempt to nest here and false crawls may occur due to the lack of suitable habitat, it has been determined that the project may adversely affect the loggerhead and green sea turtle populations.

6.3 Shortnose sturgeon

The Shortnose Sturgeon occurs in Atlantic Seaboard Rivers from southern New Brunswick to northeastern Florida. Department of Commerce studies have shown that the shortnose sturgeon exists in many of the large coastal river systems in South Carolina including the Waccamaw, Pee Dee, Black, Santee, Cooper, Ashepoo, Combahee and Edisto Rivers. Little is known about the shortnose sturgeon population level, life history or ecology. Their status is probably due to exploitation, damming of rivers and deterioration of water quality. Because there is not a large coastal river associated with this project, there is a lack of suitable freshwater spawning areas for the sturgeon in the immediate project area.

Effect Determination

It is unlikely that the shortnose sturgeon occurs in the project area, however, should it occur, its habitat would be only minimally altered by the proposed project. Any shortnose sturgeon in the area should be able to avoid being taken by a slow moving dredge and will not be in danger from beach building activities. For these reasons, it has been determined that the proposed project is not likely to adversely affect the shortnose sturgeon.

6.4 Sea beach Amaranth

Sea beach amaranth (*Amaranthus pumilus*) is an annual plant historically native to the barrier island beaches of the Atlantic coast from Massachusetts to South Carolina. No other vascular plant occurs closer to the ocean. The species was federally listed as threatened by the U.S. Fish and Wildlife Service in 1993 (COE, 2001). Seabeach amaranth is listed as threatened and of national concern in South Carolina.

Germination takes place over a relatively long period of time, generally beginning in April and continuing at least through July. Upon germinating, this plant initially forms a small-unbranched sprig but soon begins to branch profusely into a clump, often reaching a foot in diameter and consisting of 5 to 20 branches. Occasionally a clump may get as large as a yard of more across, with hundreds of branches. The stems are fleshy and pink-red or reddish, with small rounded leaves that are 1.3 to 2.5 centimeters in diameter. The leaves are clustered toward the tip of the stem, are normally a somewhat shiny, spinach-green color, and have a small notch at the rounded tip. Flowers and fruits are relatively inconspicuous and are borne in clusters along the stems. Flowering begins as soon as plants have reached sufficient size, sometimes as early as June in the Carolinas but more typically commencing in July and continuing until their death in late fall or early winter. Seed production begins in July or August and reaches a peak in most years in September; it likewise continues until the plant dies (COE, 2001).

Sea beach amaranth occurs on barrier island beaches, where its primary habitat consists of overwash flats at accreting ends of islands and lower foredunes and upper strands of noneroding beaches. It occasionally establishes small temporary populations in other habitats, including sound side beaches, blowouts in foredunes and in dredged material placed for beach renourishment or disposal. Seabeach amaranth appears to be intolerant of competition and does not occur on well-vegetated sites. The species appears to need extensive areas of barrier island beaches and inlets, functioning in a relatively natural and dynamic manner. These characteristics allow it to move around in the landscape as a fugitive species, occupying suitable habitat as it becomes available (COE, 2001).

Sea beach amaranth is a "fugitive" species that cannot compete with dense perennial beach vegetation and only occurs in the newly disturbed habitat of a high-energy beach. It occurs on barren or sparsely-vegetated sand above the high water line, an area classified as marine wetland. This habitat usually disappears completely when seawalls or other hard structures are built along the shoreline. This loss of habitat from seawall construction and global sea level rise are thought to be major factors in the species' extirpation throughout parts of its historic range. It has been postulated that estuarine and coastal shore plants will suffer some of the most significant impacts as a result of global climate changes. Coastal development will prevent these species from migrating up slope to slightly higher ground if sea levels rise. To a large extent, this is already occurring as beaches are being fortified to prevent erosion. Beach renourishment projects eliminate existing plants if conducted during the summer and may bury the seed needed to reestablish the plant the following year if conducted during the winter. However, beach renourishment projects often rebuild the habitat this species requires. Fortification with seawalls and other stabilization structures or heavy vehicular traffic may eliminate seabeach amaranth populations locally. Any given site will become unsuitable at some time because of natural forces. However, if a seed source is no longer available in adjacent areas, seabeach amaranth will be unable to reestablish itself when the site is once again suitable or new favorable habitat is created. In this way, it can be progressively eliminated even from generally favorable stretches of habitat surrounded by permanently unfavorable areas (COE, 2001).

Historically, sea beach amaranth occurred in 31 counties in 9 states from Massachusetts to South Carolina. It has been eliminated from six of the States in its historic range. The only remaining large populations are in North Carolina. Surveys in South Carolina found that the number of plants along our coast dropped by 90% (from 1,800 to 188) as a result of Hurricane Hugo, subsequent winter storms and beach rebuilding projects that occurred in its wake. South Carolina populations are still very low and exhibit a further downward trend although 1998 was a better year than most with 279 plants identified along the coast. It is possible that the abundant rainfall associated with El Nino in the spring of 1998 produced a larger than normal population. The remaining populations in areas with suitable habitat are in constant danger of extirpation from hurricanes, webworm predation, and other natural and anthropogenic factors (COE, 2001). At the present time, there are no known populations of seabeach amaranth in the project area.

Effect Determination

Because there are no know populations of seabeach amaranth in the project area, there is also no known viable seed source. As such, the proposed project is not likely to adversely affect sea beach amaranth.

6.5 Piping plover and designated piping plover critical habitat

Piping plovers are small shorebirds approximately six inches long with sand-colored plumage on their backs and crown and white under parts. Breeding birds have a single black breast band, a black bar across the forehead, bright orange legs and bill, and a black tip on the bill. During the winter, the birds lose the black bands, the legs fade to pale yellow, and the bill becomes mostly black.

The piping plover breeds on the northern Great Plains, in the Great Lakes region, and along the Atlantic coast (Newfoundland to North Carolina); and winters on the Atlantic and Gulf of Mexico coasts from North Carolina to Mexico, and in the Bahamas West Indies.

Piping plovers nest along the sandy beaches of the Atlantic Coast from Newfoundland to North Carolina, the gravelly shorelines of the Great Lakes, and on river sandbars and alkali wetlands throughout the Great Plains region. They prefer to nest in sparsely vegetated areas that are slightly raised in elevation (like a beach berm). Piping plover breeding territories generally include a feeding area, such as a dune pond or slough, or near the lakeshore or ocean edge. The piping plover winters along the coast, preferring areas with expansive sand or mudflats (feeding) in close proximity to a sandy beach (roosting). The primary threats to the piping plover are habitat modification and destruction, and human disturbance to nesting adults and flightless chicks. A lack of undisturbed habitat has been cited as a reason for the decline of other shorebirds such as the black skimmer and least tern (COE, 2001).

The piping plover is an occasional visitor along the South Carolina coast during the winter months and individuals are occasionally sighted in the project area. However, there are no large wintering concentrations in the state. Piping plovers are considered a threatened species under the Endangered Species Act of 1973, as amended, when on their wintering grounds. The species is not known to nest in the project area; however, it may winter in the area. The USFWS has designated 15 areas along the South Carolina (SC) coast as critical habitat for the wintering populations of the piping plover. This includes approximately 138 miles of shoreline along the SC coast along margins of interior bays, inlets, and lagoons. There is a designated critical habitat to the north of Reach 1. However, there is no designation for any of the project area footprint.

Effect Determination

Direct loss of nests from the disposal of the dredged material will not occur, as the species is not known to nest in the project area. Piping plover foraging distribution on the beach during the winter months may be altered as beach food resources may be affected by disposal of material. Such disruptions will be temporary and of minor significance since the birds can easily fly to other loafing and foraging locations. Placement of material may provide additional foraging habitat for the piping plover. For these reasons, it has been determined that the proposed project is not likely to adversely affect the piping plover. It has also been determined that the proposed project is not likely to adversely modify designated critical habitat for wintering piping plovers.

6.6 Blue (NOAA Fisheries list), finback, humpback, right, sei, and sperm whales

The blue whale reaches lengths of up to 100 feet. Blue whales have weighed up to 160 tons. They feed on small shrimp-like crustaceans. The whales consume up to eight tons of these animals a day during their feeding period. A blue whale produced the loudest sound ever recorded from an animal, and some scientists have speculated that they may be able to remain in touch with each other over hundreds of miles. The number of blue whales in the southern hemisphere was severely depleted by whaling. Due to commercial whaling the size of the population is less than ten percent of what it was.

The finback whale is the second largest whale, reaching lengths of up to 88 feet and weighs up to 76 tons. The finback whale because of its crescent-shaped dorsal fin, and obvious characteristic, is easily seen at sea. Depending on where they live, finback whales eat both fish and small pelagic crustaceans, and squids. It sometimes leaps clear of the water surface, yet it is also a deeper diver than some of the other baleen whales. The finback's range is in the Atlantic from the Arctic Circle to the Greater Antilles, including the Gulf of Mexico. In the Pacific Ocean the Finback ranges from the Bering Sea to Cape San Lucas, Baja California.

The humpback whale reaches a maximum length of about 50 feet long and a maximum weight of about 37.5 tons. They are mostly black, but the belly is sometimes white. Flippers and undersides of the flukes are nearly all white. They are migratory. They eat krill and schooling fish. In the Atlantic they migrate from Northern Iceland and Western Greenland south to the West Indies, including the Northern and Eastern Gulf of Mexico. In the Pacific Ocean they migrate from the Bering Sea to Southern Mexico. The humpback is one of the most popular whales for whale watching on both the east and west coasts. Scientists estimate that there are 10,000 humpbacks worldwide, only about 8% of its estimated initial population.

The sei whale is one of the largest whales. It can reach a length of 60 feet and a weight of 32 tons. They feed primarily on krill and other small crustaceans, but also feed at times on small fish. The sei whale is the fastest of the baleen whales and can reach speeds of more than 20 miles per hour. In the Atlantic Ocean the Sei whale ranges from the Arctic Circle to the Gulf of Mexico. In the Pacific Ocean the Sei whale may range from the Bering Sea to Southern Mexico. The Sei whale is endangered due to past commercial whaling.

Unlike the other great whales on the endangered species list, the sperm whale is a toothed whale. It is the largest of the toothed whales reaching a length of 60 feet in males and 40 feet in females. Sperm whales are noted for their dives that can last up to an hour and a half and go as deep as 2 miles under the surface. It is the most abundant of all the endangered whales, with an estimated population of two million. Sperm whales feed mainly on squid, including the giant squid. They range in the Atlantic Ocean from the Arctic Circle to the Gulf of Mexico. In the Pacific Ocean the sperm whale ranges from the Bering Sea to Southern Mexico. The sperm whale was almost hunted to extinction for its oil (spermaceti). This oil was used in the manufacture of ointments, cosmetics, and candles. The sperm whales usually inhabit the offshore waters.

The right whale is the most endangered species of whale off of the U.S. coasts. The right whale got its name because it was the "right" whale to hunt. It was slow moving and floated after being killed. Current estimates indicate that presently no more than a few hundred exist. Right whales can reach a length of 60 feet and a weight of 100 tons. Although the species has been internationally protected since 1937, it has failed to show any signs of recovery.

Right whales have been observed along the eastern coast of North America from the Florida Keys north to the Gulf of St. Lawrence in Canada. They are found in relatively large numbers around Massachusetts and near Georges Bank in the spring, and then they migrate to two areas in Canadian waters by mid-summer. Most cows that give birth in any given year travel in the winter to the coastal waters of Georgia and Florida to calve and raise their young for the first three months. The Bay of Fundy, between Maine and Nova Scotia, appears to serve as the primary summer and fall nursery hosting mothers and their first-year calves. The calf will stay with its mother through the first year and it is believed that weaning occurs sometime in the fall. Calves become sexually mature in about 8 years. Females are believed to calve about every three to four years. Sightings of right whales and their occurrence in the inshore waters of the State, although very rare, are generally assumed to represent individuals seen during this migration.

Right whales feed primarily on copepods and euphausids. They swim very close to the shoreline, often noted only a few hundred meters offshore. Because of their habit of traveling near the coast, there is concern over impacts resulting from collisions with boats and ships. Some right whales have been observed to bear propeller scars on their backs resulting from collisions with boats (NMFS, 1984). Destruction or pollution of right whale habitat is not known to be a problem in the project area. There is no designation of critical habitat for whales in SC.

Effect Determination

Of these six species of whales being considered, only the right whale would normally be expected to occur within the project area during the construction period; therefore the other species of whales are not likely to be affected. The majority of right whale sightings occur from December through February. Since the proposed work is expected to occur during this time period, the dredge will be required to have endangered species observers standing watch on the bridge of the dredge to look for whales during construction. The presence of a hydraulic cutter-head pipeline or hopper dredge in this area should pose no direct impacts to the right whale, however, when relocating, the dredge and any supporting vessels are required to alter course and stop if necessary to avoid approaching whales. If whales are spotted during the day within 10 miles of the dredging operation, then the dredge is required to reduce transit speed at night, should it need to relocate during that time period. Corps contract specifications expressly require avoidance of right whales. For these reasons, it has been determined that the project as proposed is not likely to adversely affect the right whale. (The 29 October 1997 “National Marine Fisheries Service, Regional Biological Opinion on Hopper Dredging along the South Atlantic Coast” has jurisdiction on right whale effects)

7.0 SUMMARY OF PROTECTIVE MEASURES

Construction that takes place in the summer months (June through September) will include contract personnel being advised that there are civil and criminal penalties for harming, harassing, or killing manatees. The Contractor may be held responsible for any protected species harmed, harassed, or killed as a result of vessel collisions or construction activities. Failure of the Contractor to follow these specifications is a violation of the Endangered Species Act and could result in prosecution of the Contractor under the Endangered Species Act or the Marine Mammals Protection Act. The standard manatee conditions apply annually from 1 June to 30 September. The Contractor will be responsible for taking necessary precautions to avoid any contact with manatees. If manatees are sighted within 100 yards of the dredging area, all appropriate precautions will be implemented to insure protection of the manatee. The Contractor will be directed to stop, alter course, or maneuver as necessary to avoid operating moving equipment (including watercraft) any closer than 50 feet of the manatee. Operation of equipment closer than 50 feet to a manatee will necessitate immediate shutdown of that equipment.

A nest relocation program for sea turtles will be implemented to minimize impacts to nesting sea turtles only during the nesting season. This program will include daily patrols of disposal areas at sunrise, relocation of any nests laid in areas to be impacted by disposal of dredged material, and monitoring of hatching success of the relocated nests. If nest relocation is required, sea turtle nests will be relocated to an area suitable to both the USFWS and the SCDNR. A beach monitoring program (for hardness/escarpment formation) will be implanted. The Corps will perform any necessary maintenance of beach profile (tilling and shaping or knocking down escarpments) during construction and prior to the nesting season.

Construction taking place in the turtle nesting season, the staging areas for construction equipment will be located off the beach to the maximum extent practicable. Nighttime storage of construction equipment not in use will be off the beach to the maximum extent practicable to minimize disturbance to sea turtle nesting and hatching activities. In addition, all dredge pipes that are placed on the beach will be located as far landward as possible without compromising the integrity of the existing dune system. Temporary storage of pipes will be off the beach to the maximum extent possible. Temporary storage of pipes on the beach will be in such a manner so as to impact the least amount of nesting habitat and will likewise not compromise the integrity of the dune systems (placement of pipes perpendicular to the shoreline will be recommended as the method of storage).

Further, all on-beach lighting associated with the project will be limited to the immediate area of active construction during construction of this project. Such lighting will be shielded, low-pressure sodium vapor lights to minimize illumination of the nesting beach and nearshore waters. Lighting on offshore equipment will be similarly minimized through reduction, shielding, lowering, and appropriate placement of lights to avoid excessive illumination of the water, while meeting all U.S. Coast Guard and OSHA requirements. Shielded, low pressure sodium vapor lights will be highly recommended for lights on any offshore equipment that cannot be eliminated.

8.0 SUMMARY EFFECT DETERMINATION

This assessment has examined the potential impacts of the proposed project on designated habitat and listed species of plants and animals that are, or have been, present in the project area. Both primary and secondary impacts to habitat have been considered. Critical habitat has not been designated for whales, manatees, sea turtles, sturgeon, or seabeach amaranth in South Carolina; therefore, none would be affected. The USFWS designated critical habitat for the wintering piping plover in July 2001. Based on the analysis provided by this document, the following determinations have been made.

- It has been determined that the proposed project is not likely to adversely affect the manatee.
- It has been determined that the proposed project is not likely to adversely affect Kemp's ridley, leatherback, green, or hawksbill sea turtles.
- It has been determined that the proposed project is not likely to adversely affect the shortnose sturgeon.
- It has been determined that the proposed project is not likely to adversely affect the piping plover.

- It has been determined that the proposed project is not likely to adversely affect seabeach amaranth.
- It has been determined that the proposed project is not likely to adversely modify designated critical habitat for the wintering piping plover.
- It has been determined that the proposed project may adversely affect the nesting loggerhead and green sea turtle.

LITERATURE CITED

Federal Register, Volume 66, No. 132, Tuesday, July 10, 2001, Rules and Regulations.

U.S. Army Corps of Engineers. 2001. Biological Assessment for the Operations and Maintenance Dredging and Disposal for the Murrells Inlet Project, Georgetown County, South Carolina, April, 2001.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1991. Recovery Plan for U.S. Population of Loggerhead Turtle. National Marine Fisheries Service, Washington, D.C.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
176 Croghan Spur Road, Suite 200
Charleston, South Carolina 29407

January 19, 2007

Mr. Joseph A. Jones
Planning Branch
U.S. Army Corps of Engineers
69A Hagood Avenue
Charleston, SC 29403-5107

Attn: Shawn Boone

Re: Grand Strand Beach Renourishment
Georgetown and Horry Counties
FWS Log No. 2007-F-0041

Dear Mr. Jones:

This document is the Fish and Wildlife Service's (Service) biological opinion based on our review of the proposed beach renourishment along the shoreline of Georgetown and Horry Counties, South Carolina, and its effects on the loggerhead sea turtle (*Caretta caretta*), the green sea turtle (*Chelonia mydas*), and the leatherback sea turtle (*Dermochelys coriacea*) per section 7 of the Endangered Species Act (Act) of 1973, as amended (16 United States Code [U.S.C.] 1531 *et seq.*). Your September 21, 2006, request for formal consultation was received on September 25, 2006.

This biological opinion is based on information provided in the September 21, 2006, biological assessment, the August 10, 2006, site visit, the October 26, 2006, meeting, other sources of information, and further communication with related parties. A complete administrative record of this consultation is on file at the Charleston Field Office, 176 Croghan Spur Road, Suite 200, Charleston, South Carolina 29407.

CONSULTATION HISTORY

April 6, 2006 – The Service received the Charleston District, Corps of Engineers (Corps) letter dated April 4, 2006, notifying the Service of the project.

August 19, 2006 – The Service and the Corps conducted a site visit.

August 19, 2006 – The Service and the Corps conducted a site visit.

September 25, 2006 – The Service received the Corps' September 21, 2006, biological assessment.

October 23, 2006 – The Service provided a letter to the Corps that acknowledged receipt of all information necessary to initiate formal consultation on the proposed action, as required in the regulations governing interagency consultations (50 (Code of Federal Regulations) [CFR] 402.14)

October 26, 2006 – The Service attended a meeting for the proposed project.

PRIOR CONSULTATIONS

The Corps initiated formal consultation in 1992 on the Grand Strand project. The Service issued a non-jeopardy biological opinion on July 24, 1992, for the loggerhead sea turtle (*Caretta caretta*) and sea-beach amaranth (*Amaranthus pumilus*) for 22.6 miles of beach.

Table 1. Species evaluated for effects and those where the Service has concurred with a "not likely to be adversely affected" determination.

SPECIES	PRESENT IN ACTION AREA
Sea-beach amaranth	Possible
Piping plover	Possible
West Indian manatee	Possible
Kemp's ridley sea turtle	Possible
Hawksbill sea turtle	No

The above species are not likely to be adversely affected by this action because they are not likely to be or are not present in the action area. Therefore, they will not be discussed further in this biological opinion.

The Service has the responsibility for implementing recovery of sea turtles when they come ashore to nest. This opinion addresses nesting Loggerhead and Green sea turtles and hatchlings only, it does not address potential impacts of this project on sea turtles while in the open ocean. The National Oceanic and Atmospheric Administration-National Marine Fisheries Service (NOAA-NMFS) has jurisdiction over sea turtles in the marine environment.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

BACKGROUND AND AUTHORIZATION

The Myrtle Beach Storm Damage Reduction Project was authorized for construction by Section 101 of the Water Resources Development Act of 1990, Public Law 101-640. Section 934 of the Water Resources Development Act of 1986 (WRDA86), Public Law 99-662, authorized the Government to extend the Federal participation in periodic beach nourishment until 2046. The final Environmental Impact Statement (EIS) was completed in January 1993 with the Record of Decision (ROD) being signed on 1 November 1993.

The authorized project calls for construction of a separate protective beach in three separable reaches, North Myrtle Beach (Reach 1), Myrtle Beach (Reach 2), and Garden City/Surfside Beach (Reach 3). The total project reach is 25.4 miles. Initial construction, as identified in the October 1987 Feasibility Report, consisted of constructing a protective berm to an elevation of between 7 and 11 feet above the National Geodetic Vertical Datum (NGVD) and a top width of 15 feet for all three project reaches. These project dimensions were later modified with the completion of a General Design Memorandum in March 1993. The authorized project recommended utilization of borrow material obtained from inland sites, and that additional offshore investigation be performed during preconstruction studies. The offshore borrow sites were eventually chosen to be mined for the initial nourishment of all three reaches. In addition to being separable reaches, each reach also has differing non-federal sponsors.

PROPOSED PROJECT

The project will be constructed with a hopper dredge, booster pump, and land based heavy equipment (i.e. bulldozers and front-end loaders). The borrow area will be subdivided into separate smaller zones. The dredge will remove the sand to a depth not to exceed ten feet within the borrow areas. The contract specifications will require the contractor to remove material completely from one borrow zone prior to moving to another borrow zone. In addition to borrow area requirements, the contract specifications will require that the contractor control his beach placement techniques. The beach renourishment is anticipated to continue 24 hours per day, 7 days per week for about 15 months including mobilization. Noise pollution and construction activities will be monitored to ensure minimum disturbance to the surrounding community.

Initial construction of Reach 1 of the project was completed in May 1997. Initial placement consisted of 57.7 cubic yards (CY) per linear foot of beach. This quantity includes material for the protective berm, advanced nourishment and overfill ratio, for a total placement of 2,622,900 CY. Future renourishment of 490,000 CY was planned for every ten years.

According to this plan, North Myrtle Beach (Reach 1) would be due for its first renourishment in 2007. Based on current conditions Reach 1 is in need of 702,600 CY to restore the project to full dimension.

The first nourishment cycle of Reach 2 was completed in December 1997. Initial placement consisted of 47.1 CY per linear foot of beach. This quantity includes material for the protective berm, advanced nourishment and overfill ratio, for a total placement of 2,250,000 CY. Future renourishment of 440,000 CY was planned for every eight years with the final nourishment being 550,000 CY for the last ten years of project life. According to this plan, Myrtle Beach (Reach 2) was due its first renourishment in 2005. Due to the lack of available funds, the first renourishment was rescheduled for 2008. The current effort would require a volume of 1,442,500 CY of material to return the beach to the full design template.

Reach 3 of the Grand Strand Project would provide restoration of about 7.7 linear miles of beach in Horry and Georgetown Counties extending from 1.2 miles south of the Horry/Georgetown County line to Myrtle Beach State Park in Horry County. Initial project construction was completed in November 1998 with placement of 1,517,494 CY. Full project restoration provides for restoration of the advance nourishment over the entire 7.7-mile project length with a volume of 773,000 CY.

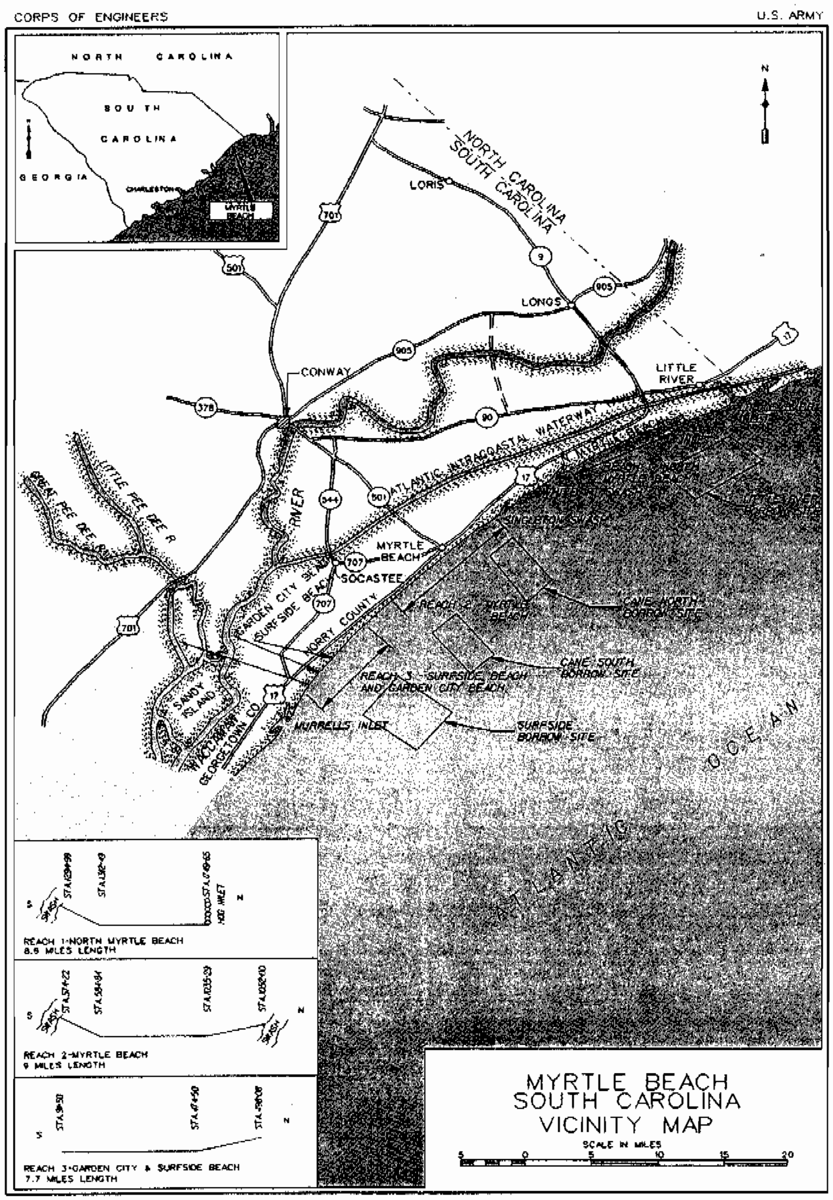
Reaches 1, 2, and 3 will also include a sand fencing and vegetation shore protection project. The purpose of this project is to stabilize and enhance the dunes in Georgetown and Horry Counties. This project consists of about 25.4 miles of grassing and fencing and is a cooperative effort with the Corps, the state of South Carolina, Georgetown County, Horry County, and the Municipality of Surfside Beach. The sand fencing effort will begin after October 31, 2007 and end no later than February 2007. Similar fencing and planting was completed in North Myrtle Beach, Myrtle Beach, Garden City, and Surfside Beach in the late 1990s and early 2000s. Work is scheduled to be performed only during daylight hours and a very limited amount of equipment such as small backhoes and tractors is expected to be used on the beach. Sand fencing will be the Corps' Charleston District standard design with 5.5 feet spacing between panels. The planting matrix will consist of the following plants: bitter panicum (*Panicum amarum "Northpa"*), sea oats (*Uniola paniulata*), seashore elder (*Iva imbricate*), and saltmeadow cordgrass (*Spartina patens*). Sweet grass (*Muhlenbergia "filipes"*) will be planted on the toe of the backside of the dune system. The plants will be spaced 2 feet on center. Plant rows will be spaced at 2 to 4 feet depending on which plant species is in the row. Fertilizer will be placed in the planting hole at the time of planting. The following growing season, a second application will broadcasted in the spring.

Four offshore borrow sites were identified in the March 1993 General Design Memorandum for the project as depicted in Figure 1. The four borrow sites with their intended project nourishment area in Table 2. The Cane North Borrow Pit will not be used during this project.

Table 2. Borrow Area Capacity for the Grand Strand Renourishment project

Borrow Area	Capacity
Little River (Reach 1)	18.1 million CY
Cane North (Reach 2)	6.7 million CY
Cane South (Reach 2)	12.3 million CY
Surfside (Reach 3)	34.4 million CY

Figure 1. Project Area for the Grand Strand Renourishment Project



Conservation Measures

Construction that takes place in the warmer months (water temperatures exceed 20 degrees Celcius) will abide by the *Standard Manatee Construction Conditions* (Florida Fish and Wildlife Commission [FWC] 2005). The Contractor will be responsible for taking necessary precautions to avoid any contact with manatees. If manatees are sighted within 100 yards of the dredging area, all appropriate precautions will be implemented to insure protection of the manatee. The Contractor will be directed to stop, alter course, or maneuver as necessary to avoid operating moving equipment (including watercraft) any closer than 50 feet of the manatee. Operation of equipment closer than 50 feet to a manatee will necessitate immediate shutdown of that equipment.

A nest relocation program for sea turtles will be implemented to minimize impacts to nesting sea turtles only during the nesting season. This program will include daily patrols of disposal areas at sunrise, relocation of any nests laid in areas to be impacted by disposal of dredged material, and monitoring of hatching success of the relocated nests. If nest relocation is required, sea turtle nests will be relocated to an area suitable to both the Service and the South Carolina Department of Natural Resources (SCDNR). Night sea turtle monitors will be hired to monitor the active project area for sea turtle emergences May 1 through August 31. The night monitors will coordinate with South Carolina United Turtle Enthusiasts (S.C.U.T.E.) volunteers and report any nesting attempts that occurred during the night to the volunteers. A beach monitoring program (for hardness/escarpment formation) will be implemented. The Corps will perform any necessary maintenance of beach profile (tilling and shaping or knocking down escarpments) during construction and prior to the nesting season.

Construction taking place during the turtle nesting season will have staging areas for construction equipment located off the beach to the maximum extent practicable. Nighttime storage of construction equipment not in use will be off the beach to the maximum extent practicable to minimize disturbance to sea turtle nesting and hatching activities. In addition, all dredge pipes that are placed on the beach will be located as far landward as possible without compromising the integrity of the existing dune system. Temporary storage of pipes will be off the beach to the maximum extent possible. Temporary storage of pipes on the beach will be in such a manner so as to impact the least amount of nesting habitat and will likewise not compromise the integrity of the dune systems (placement of pipes perpendicular to the shoreline will be recommended as the method of storage).

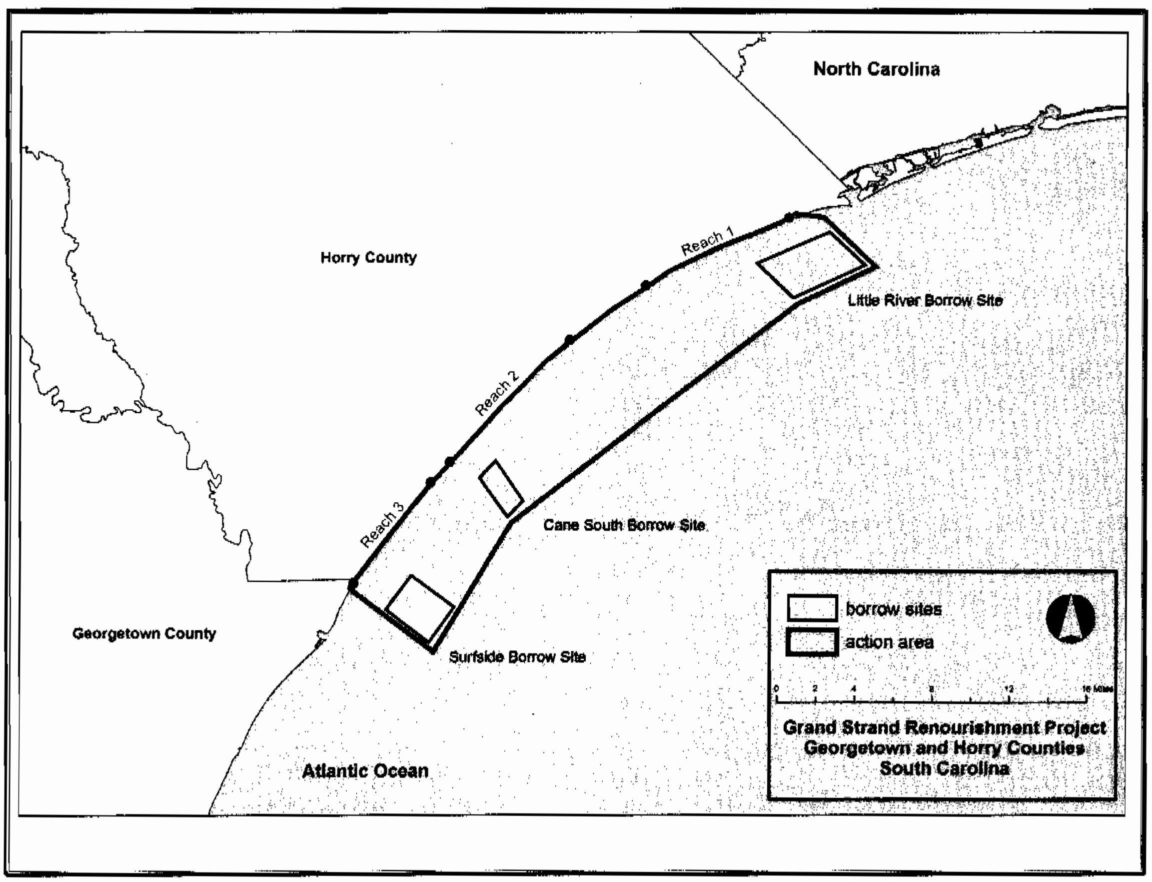
All on-beach lighting associated with the project will be limited to the immediate area of active construction during construction of this project. Such lighting will be shielded, low-pressure sodium vapor lights to minimize illumination of the nesting beach and nearshore waters. Lighting on offshore equipment will be similarly minimized through reduction, shielding, lowering, and appropriate placement of lights to avoid excessive illumination of the water, while meeting all U.S. Coast Guard and OSHA requirements. Shielded, low pressure sodium vapor lights will be highly recommended for lights on any offshore equipment that cannot be eliminated.

Relocation trawling will occur during April 1 through November 30 for the life of the project in order to reduce the risk of takes by the hopper dredge. Observers will be on board to record sea turtle takes. The Corps' draghead deflector engineer will inspect the rigid draghead deflector to ensure that the deflector has been tailored appropriately to the draghead. The inspector will assess whether the dredge operator appears to be familiar with the operation of the draghead deflector and provide necessary training where appropriate.

Action Area

The Service has described the action area to include all three reaches where sand will be deposited, the borrow sites, and the areas in between the reaches and borrow sites for reasons that will be explained and discussed in the "Effects of the Action" section of this consultation.

Figure 2. Action Area for the Grand Strand Renourishment Project



STATUS OF THE SPECIES/CRITICAL HABITAT

Three species of sea turtles are analyzed in this biological opinion: loggerhead sea turtles (*Caretta caretta*), green sea turtles (*Chelonia mydas*), and leatherback sea turtles (*Dermochelys coriacea*).

Species/critical habitat description

Loggerhead Sea Turtle

The loggerhead sea turtle (*Caretta caretta*), listed as a threatened species on July 28, 1978 (Service 1978), inhabits the continental shelves and estuarine environments along the margins of the Atlantic, Pacific, and Indian Oceans. Loggerhead sea turtles nest within the continental U.S. from Louisiana to Virginia. Major nesting concentrations in the U.S. occur on the coastal islands of North Carolina, South Carolina, and Georgia, and on the Atlantic and Gulf coasts of Florida (Hopkins and Richardson, 1984).

The loggerhead sea turtle grows to an average weight of about 200 pounds and is characterized by a large head with blunt jaws. Adults and subadults have a reddish-brown carapace. Scales on the top of the head and top of the flippers are also reddish-brown with yellow on the borders. Hatchlings are a dull brown color (NOAA-NMFS, 2002a). The loggerhead feeds on mollusks, crustaceans, fish, and other marine animals.

Major loggerhead sea turtle nesting beaches are located in the Sultanate of Oman, southeastern U.S., and eastern Australia. The species is widely distributed within its range. It may be found hundreds of miles out to sea, as well as in inshore areas such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers. Coral reefs, rocky places, and ship wrecks are often used as feeding areas. Nesting occurs mainly on open beaches or along narrow bays having suitable sand, and often in association with other species of sea turtles.

Recovery Criteria for the United States

The southeastern U.S. population of the loggerhead can be considered for delisting where, over a period of 25 years, the following conditions are met:

1. The adult female population in Florida is increasing and in North Carolina, South Carolina, and Georgia, it has returned to pre-listing levels (NC - 800, SC - 10,000, and GA - 2,000 nests per season). The above conditions must be met with the data from standardized surveys which would continue for at least five years after delisting.

2. At least 25 percent (348 miles) of all available nesting beaches (1,400 miles) are in public ownership, distributed over the entire nesting range and encompassing at least 50 percent of the nesting activity in each state.

3. All priority one tasks identified in the recovery plan have been successfully implemented.

No critical habitat has been designated for the loggerhead sea turtle.

Green Sea Turtle

The green sea turtle (*Chelonia mydas*) was federally listed as a protected species on July 28, 1978 (Service 1978). Breeding populations of the green turtle in Florida and along the Pacific Coast of Mexico are listed as endangered; all other populations are listed as threatened. The green turtle has a worldwide distribution in tropical and subtropical waters. Major green turtle nesting colonies in the Atlantic occur on Ascension Island, Aves Island, Costa Rica, and Surinam. Within the U.S., green turtles nest in small numbers in the U.S. Virgin Islands and Puerto Rico, and in larger numbers along the east coast of Florida, particularly in Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward Counties (NOAA-NMFS and Service, 1991a). Nesting also has been documented along the Gulf coast of Florida from Escambia County through Franklin County in Northwest Florida and from Pinellas County through Collier County in Southwest Florida (Florida Fish and Wildlife Conservation Commission (FWC) statewide nesting database). Green turtles have been known to nest in Georgia, but only on rare occasions (Georgia Department of Natural Resources statewide nesting database). The green turtle also nests sporadically in North Carolina and South Carolina (North Carolina Wildlife Resources Commission statewide nesting database; SCDNR statewide nesting database). Unconfirmed nesting of green turtles in Alabama has also been reported (Bon Secour National Wildlife Refuge nesting reports).

The green sea turtle grows to a maximum size of about 4 feet and a weight of 440 pounds. It has a heart-shaped shell, small head, and single-clawed flippers. The carapace is smooth and colored gray, green, brown and black. Hatchlings are black on top and white on the bottom (NOAA-NMFS, 2002b). Hatchling green turtles eat a variety of plants and animals, but adults feed almost exclusively on seagrasses and marine algae.

The green sea turtle has a worldwide distribution in tropical and subtropical waters. They are generally found in shallow waters (except when migrating) inside reefs, bays, and inlets. The sea turtle is attracted to lagoons and shoals with an abundance of marine grass and algae.

Major green turtle nesting colonies in the Atlantic occur on Ascension Island, Aves Island, Costa Rica, and Surinam. Open beaches with a sloping platform and minimal disturbance are required for nesting.

Recovery Criteria for the United States

The U.S. population of green sea turtles can be considered for delisting when, over a period of 25 years, the following conditions are met:

1. The level of nesting in Florida has increased to an average of 5,000 nests per year for at least six years. Nesting data must be based on standardized surveys.

2. At least 25 percent (65 miles) of all available nesting beaches (260 miles) are in public ownership and encompass at least 50 percent of the nesting activity.

3. A reduction in stage class mortality is reflected in higher counts of individuals on foraging grounds.

4. All priority one tasks identified in the Recovery Plan have been successfully implemented.

Critical habitat for the green sea turtle has been designated for the waters surrounding Culebra Island, Puerto Rico, and its outlying keys.

Leatherback Sea Turtle

The leatherback sea turtle (*Dermochelys coriacea*), listed as an endangered species on June 2, 1970 (Service 1970), nests on shores of the Atlantic, Pacific and Indian Oceans. Non-breeding animals have been recorded as far north as the British Isles and the Maritime Provinces of Canada and as far south as Argentina and the Cape of Good Hope (Pritchard, 1992). Nesting grounds are distributed worldwide, with the Pacific Coast of Mexico supporting the world's largest known concentration of nesting leatherbacks. The largest nesting colony in the wider Caribbean region is found in French Guiana, but nesting occurs frequently, although in lesser numbers, from Costa Rica to Columbia and in Guyana, Surinam, and Trinidad (NOAA-NMFS and Service, 1992; National Research Council, 1990a).

The leatherback regularly nests in the U.S. in Puerto Rico, the U.S. Virgin Islands, and along the Atlantic coast of Florida as far north as Georgia (NOAA-NMFS and Service, 1992). Leatherback turtles have been known to nest in Georgia, South Carolina, and North Carolina, but only on rare occasions (North Carolina Wildlife Resources Commission; SCDNR; and Georgia Department of Natural Resources statewide nesting databases). Leatherback nesting also has been reported on the northwest coast of Florida (LeBuff, 1990; FWC statewide nesting database); and in southwest Florida a false crawl (non-nesting emergence) has been observed on Sanibel Island (LeBuff, 1990).

This is the largest, deepest diving, and most migratory and wide ranging of all sea turtle species. The adult leatherback can reach 4 to 8 feet in length and weigh 500 to 2,000 pounds. The carapace is distinguished by a rubber-like texture, about 1.6 inches thick, made primarily of tough, oil-saturated connective tissue. Hatchlings are dorsally mostly black and are covered with tiny scales; the flippers are edged in white, and rows of white scales appear as stripes along the length of the back (NOAA-NMFS, 2002c). Jellyfish are the main staple of its diet, but it is also known to feed on sea urchins, squid, crustaceans, tunicates, fish, blue-green algae, and floating seaweed.

The leatherback sea turtle is distributed worldwide in tropical and temperate waters of the Atlantic, Pacific, and Indian Oceans. Non-breeding leatherbacks have been recorded as far north as British Columbia, Newfoundland, the British Isles, and the Maritime Provinces of Canada and as far south as Argentina and the Cape of Good Hope (Pritchard, 1992).

Leatherback turtles nest on shores of the Atlantic, Pacific and Indian Oceans. Adult females require sandy nesting beaches backed with vegetation and sloped sufficiently so the distance to dry sand is limited. Their preferred beaches are near deep water and generally rough seas.

Recovery Criteria for the United States

The U.S. population of leatherbacks can be considered for delisting when the following conditions are met:

1. The adult female population increases over the next 25 years, as evidenced by a statistically significant trend in the number of nests at Culebra, Puerto Rico, St. Croix, U.S. Virgin Island, and along the east coast of Florida.

2. Nesting habitat encompassing at least 75 percent of nesting activity in U.S. Virgin Islands, Puerto Rico, and Florida is in public ownership.

3. All priority one tasks identified in the recovery plan have been successfully implemented.

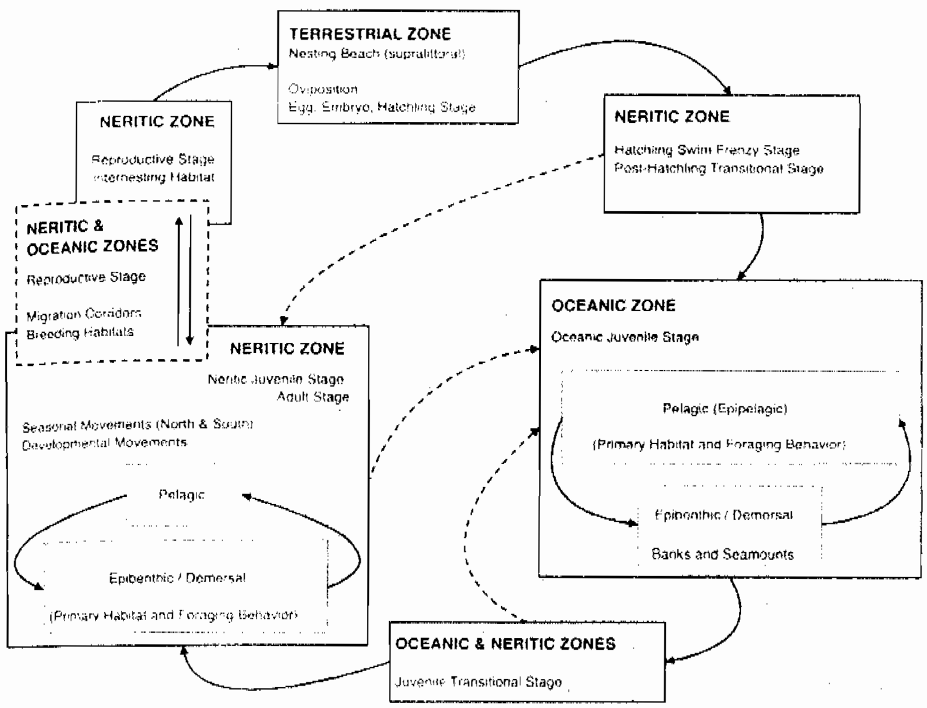
Marine and terrestrial critical habitat for the leatherback sea turtle has been designated at Sandy Point on the western end of the island of St. Croix, U.S. Virgin Islands (50 CFR 17.95).

Life history (growth, life span, survivorship and mortality)

Loggerhead Sea Turtle

Loggerheads are known to nest from one to seven times within a nesting season (Talbert *et al.*, 1980; Richardson and Richardson, 1982; Lenarz *et al.*, 1981, among others); the mean is about 4.1 (Murphy and Hopkins, 1984). The interval between nesting events within a season varies around a mean of about 14 days (Dodd, 1988). Mean clutch size varies from about 100 to 126 eggs along the southeastern United States coast (NOAA-NMFS and Service, 1991b). Nesting migration intervals of 2 to 3 years are most common in loggerheads, but the number can vary from 1 to 7 years (Dodd, 1988). Age at sexual maturity is believed to be about 20 to 30 years (Turtle Expert Working Group, 1998).

Figure 3. Life history stages of a loggerhead turtle (Bolten, 2003).



Green Sea Turtle

Green turtles deposit from one to nine clutches within a nesting season, but the overall average is about 3.3. The interval between nesting events within a season varies around a mean of about 13 days (Hirth, 1997). Mean clutch size varies widely among populations. Average clutch size reported for Florida was 136 eggs in 130 clutches (Witherington and Ehrhart, 1989). Only occasionally do females produce clutches in successive years. Usually 2, 3, 4, or more years intervene between breeding seasons (NOAA-NMFS and Service, 1991a). Age at sexual maturity is believed to be 20 to 50 years (Hirth, 1997).

Leatherback Sea Turtle

Leatherbacks nest an average of five to seven times within a nesting season, with an observed maximum of 11 (NOAA-NMFS and Service, 1992). The interval between nesting events within a season is about 9 to 10 days. Clutch size averages 80 to 85 yolked eggs, with the addition of usually a few dozen smaller, yolkless eggs, mostly laid toward the end of the clutch (Pritchard, 1992). Nesting migration intervals of 2 to 3 years were observed in leatherbacks nesting on the Sandy Point National Wildlife Refuge, St. Croix, U.S. Virgin Islands (McDonald and Dutton, 1996). Leatherbacks are believed to reach sexual maturity in 6 to 10 years (Zug and Parham,1996).

Population dynamics

Loggerhead Sea Turtle

Total estimated nesting in the southeast United States is about 50,000 to 90,000 nests per year (FWC statewide nesting database 2004, Georgia Department of Natural Resources statewide nesting database 2004, SCDNR statewide nesting database 2004, North Carolina Wildlife Resources Commission statewide nesting database 2004). In 1998, 85,988 nests were documented in Florida alone. However, in 2001, 2002, 2003, and 2004, this number dropped to 69,657, 62,905, 56,852, and 47,173, respectively. An analysis of nesting data from the Florida Index Nesting Beach Survey (INBS) Program from 1989 to 2004, a period encompassing index surveys that are more consistent and more accurate than surveys in previous years, has shown no detectable trend but, more recently (1998 through 2004), has shown evidence of a declining trend (Witherington, 2005, personal communication). Given inherent annual fluctuations in nesting and the short time period over which the decline has been noted, caution is warranted in interpreting the decrease in terms of nesting trends.

From a global perspective, the southeastern U.S. nesting aggregation is of paramount importance to the survival of the species and is second in size only to that which nests on islands in the Arabian Sea off Oman (Ross, 1982; Ehrhart, 1989; NOAA-NMFS and Service, 1991b). The status of the Oman loggerhead nesting population, reported to be the largest in the world (Ross, 1979), is uncertain because of the lack of long-term standardized nesting or foraging ground surveys and its vulnerability to increasing development pressures near major nesting beaches and threats from fisheries interactions on foraging grounds and migration routes (Possardt, 2005, personal communication). The loggerhead nesting aggregations in Oman, the southeastern U.S., and Australia have been estimated to account for about 88 percent of nesting worldwide (NOAA-NMFS and Service, 1991b). About 80 percent of loggerhead nesting in the southeastern U.S. occurs in six Florida counties (Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward counties) (NOAA-NMFS and Service, 1991b).

Green Sea Turtle

About 150 to 3,000 females are estimated to nest on beaches in the continental U.S. annually (FWC, 2005). In the U.S. Pacific, over 90 percent of nesting throughout the Hawaiian archipelago occurs at the French Frigate Shoals, where about 200 to 700 females nest each year (NOAA-NMFS and Service, 1998a). Elsewhere in the U.S. Pacific, nesting takes place at scattered locations in the Commonwealth of the Northern Marianas, Guam, and American Samoa. In the western Pacific, the largest green turtle nesting aggregation in the world occurs on Raine Island, Australia, where thousands of females nest nightly in an average nesting season (Limpus *et al.*, 1993). In the Indian Ocean, major nesting beaches occur in Oman where 30,000 females are reported to nest annually (Ross and Barwani, 1995).

Leatherback Sea Turtle

Recent estimates of global nesting populations indicate 26,000 to 43,000 nesting females annually (Spotila *et al.*, 1996). The largest nesting populations at present occur in the western Atlantic in French Guiana (4,500 to 7,500 females nesting/year) and Colombia (estimated several thousand nests annually), and in the western Pacific in West Papua (formerly Irian Jaya) and Indonesia (about 600 to 650 females nesting/year). In the United States, small nesting populations occur on the Florida east coast (100 females/year) (Florida FWC, 2003), Sandy Point, U.S. Virgin Islands (50 to 190 females/year) (Alexander *et al.*, 2002), and Puerto Rico (30 to 90 females/year).

Status and distribution

Loggerhead Sea Turtle

Genetic research involving analysis of mitochondrial DNA has identified five different loggerhead subpopulations/nesting aggregations in the western North Atlantic: (1) the Northern Subpopulation occurring from North Carolina to around Cape Canaveral, Florida (about 29° N.); (2) South Florida Subpopulation occurring from about 29° N. on Florida's east coast to Sarasota on Florida's west coast; (3) Dry Tortugas, Florida, Subpopulation, (4) Northwest Florida Subpopulation occurring at Eglin Air Force Base and the beaches near Panama City; and (5) Yucatán Subpopulation occurring on the eastern Yucatán Peninsula, Mexico (Bowen, 1994, 1995; Bowen *et al.*, 1993; Encalada *et al.*, 1998; Pearce, 2001). These data indicate that gene flow between these five regions is very low. If nesting females are extirpated from one of these regions, regional dispersal will not be sufficient to replenish the depleted nesting subpopulation.

The Northern Subpopulation has declined substantially since the early 1970s. Recent estimates of loggerhead nesting trends from standardized daily beach surveys showed significant declines ranging from 1.5% to 1.9% annually (Dodd, 2005, personal communication). Nest totals from aerial surveys conducted by the SCDNR showed a 3.3% annual decline in nesting since 1980. Overall, there is strong statistical evidence to suggest the Northern Subpopulation has sustained a long-term decline.

Data from all beaches where nesting activity has been recorded indicate that the South Florida Subpopulation has shown significant increases over the last 25 years. However, an analysis of nesting data from the Florida Index Nesting Beach Survey (INBS) Program from 1989 to 2002 (a period encompassing index surveys that are more consistent and more accurate than surveys in previous years), has shown no detectable trend and, more recently (1998 through 2002), has shown evidence of a declining trend (Witherington, 2003, personal communication.). Given inherent annual fluctuations in nesting and the short time period over which the decline has been noted, caution is warranted in interpreting the decrease in terms of nesting trends.

A near census of the Florida Panhandle Subpopulation undertaken from 1989 to 2002 reveals a mean of 1,028 nests per year, which equates to about 251 females nesting per year (Florida FWC, 2003). Evaluation of long-term nesting trends for the Florida Panhandle Subpopulation is difficult because of changed and expanded beach coverage. Although there are now 8 years (1997-2004) of INBS data for the Florida Panhandle Subpopulation, the time series is too short to detect a trend (Witherington, FWC, personal communication, 2005).

A near census of the Dry Tortugas Subpopulation undertaken from 1995 to 2001 reveals a mean of 213 nests per year, which equates to about 50 females nesting per year (Florida Fish and Wildlife Conservation Commission, 2003). The trend data for the Dry Tortugas Subpopulation are from beaches that were not included in Florida's INBS program prior to 2004 but have moderately good monitoring consistenCY. There are 7 continuous years (1995-2001) of data for this Subpopulation, but the time series is too short to detect a trend (Witherington, 2005, personal communication).

Nesting surveys in the Yucatán Subpopulation has been too irregular to date to allow for a meaningful trend analysis (Turtle Expert Working Group 1998, 2000). Anthropogenic (human) factors that impact hatchlings and adult female turtles on land, or the success of nesting and hatching include: beach erosion, armoring and nourishment; artificial lighting; beach cleaning; increased human presence; recreational beach equipment; beach driving; coastal construction and fishing piers; exotic dune and beach vegetation; and poaching. An increased human presence at some nesting beaches or close to nesting beaches has led to secondary threats such as the introduction of exotic fire ants, feral hogs, dogs, and an increased presence of native species (e.g., raccoons, armadillos, and opossums), which raid and feed on turtle eggs. Although sea turtle nesting beaches are protected along large expanses of the western North northwest Atlantic coast, other areas along these coasts have limited or no protection.

Loggerhead turtles are affected by a completely different set of anthropogenic threats in the marine environment. These include oil and gas exploration and transportation; marine pollution; underwater explosions; hopper dredging, offshore artificial lighting; power plant entrainment and/or impingement; entanglement in debris; ingestion of marine debris; marina and dock construction and operation; boat collisions; poaching, and fishery interactions. In the pelagic environment, loggerheads are exposed to a series of longline fisheries that include the U.S. Atlantic tuna and swordfish longline fisheries, an Azorean longline fleet, a Spanish longline fleet, and various fleets in the Mediterranean Sea (Aguilar *et al.*, 1995; Bolten *et al.*, 1994; Crouse, 1999). There is particular concern about the extensive incidental take of juvenile loggerheads in the eastern Atlantic by longline fishing vessels. In the benthic environment in waters off the coastal U.S., loggerheads are exposed to a suite of fisheries in federal and state waters including trawl, purse seine, hook and line, gillnet, pound net, longline, dredge, and trap fisheries

Green Sea Turtle

Total population estimates for the green turtle are unavailable, and trends based on nesting data are difficult to assess because of large annual fluctuations in numbers of nesting females. For instance, in Florida, where the majority of green turtle nesting in the southeastern U.S. occurs, estimates range from 150 to 2,750 females nesting annually (FWC, 2003). Populations in Surinam and Tortuguero, Costa Rica, may be stable, but there is insufficient data for other areas to confirm a trend.

A major factor contributing to the green turtle's decline worldwide is commercial harvest for eggs and food. Fibropapillomatosis, a disease of sea turtles characterized by the development of multiple tumors on the skin and internal organs, is also a mortality factor and has seriously impacted green turtle populations in Florida, Hawaii, and other parts of the world. The tumors interfere with swimming, eating, breathing, vision, and reproduction, and turtles with heavy tumor burdens may die. Other threats include loss or degradation of nesting habitat from coastal development and beach armoring; disorientation of hatchlings by beachfront lighting; excessive nest predation by native and non-native predators; degradation of foraging habitat; marine pollution and debris; watercraft strikes; and incidental take from channel dredging and commercial fishing operations.

Leatherback Sea Turtle

Declines in leatherback nesting have occurred over the last two decades along the Pacific coasts of Mexico and Costa Rica. The Mexican leatherback nesting population, once considered to be the world's largest leatherback nesting population (65 percent of worldwide population), is now less than one percent of its estimated size in 1980. Spotila *et al.* (1996) recently estimated the number of leatherback sea turtles nesting on 28 beaches throughout the world from the literature and from communications with investigators studying those beaches. The estimated worldwide population of leatherbacks in 1995 was about 34,500 females on these beaches with a lower limit of about 26,200 and an upper limit of about 42,900. This is less than one third the 1980 estimate of 115,000. Leatherbacks are rare in the Indian Ocean and in very low numbers in the western Pacific Ocean. The largest population is in the western Atlantic. Using an age-based demographic model, Spotila *et al.* (1996) determined that leatherback populations in the Indian Ocean and western Pacific Ocean cannot withstand even moderate levels of adult mortality and that even the Atlantic populations are being exploited at a rate that cannot be sustained. They concluded that leatherbacks are on the road to extinction and further population declines can be expected unless action is taken to reduce adult mortality and increase survival of eggs and hatchlings.

The crash of the Pacific leatherback population is believed primarily to be the result of exploitation by humans for the eggs and meat, as well as incidental take in numerous commercial fisheries of the Pacific. Other factors threatening leatherbacks globally include loss or degradation of nesting habitat from coastal development; disorientation of hatchlings by beachfront lighting; excessive nest predation by native and non-native predators; degradation of foraging habitat; marine pollution and debris; and watercraft strikes.

Common threats to all sea turtles in South Carolina

Coastal development, light pollution, and unsuitable material deposited on beaches has increasingly modified sea turtle nesting habitat in South Carolina over the years.

Analysis of the species/critical habitat likely to be affected

The proposed action may adversely affect nesting females, nests, and hatchlings within the proposed project area. The effects of the proposed action on sea turtles will be considered further in the remaining sections of this biological opinion. Potential effects include destruction of nests deposited within the boundaries of the proposed project, harassment in the form of disturbing or interfering with female turtles attempting to nest within the construction area or on adjacent beaches as a result of construction activities, disorientation of hatchling turtles on beaches adjacent to the construction area as they emerge from the nest and crawl to the water as a result of project lighting, behavior modification of nesting females due to escarpment formation within the project area during a nesting season resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs. The quality of the placed sand could affect the ability of female turtles to nest, the suitability of the nest incubation environment, and the ability of hatchlings to emerge from the nest.

Critical habitat has not been designated in the continental United States; therefore, the proposed action would not result in an adverse modification.

ENVIRONMENTAL BASELINE

Status of the species within the Action Area

Loggerhead Sea Turtle

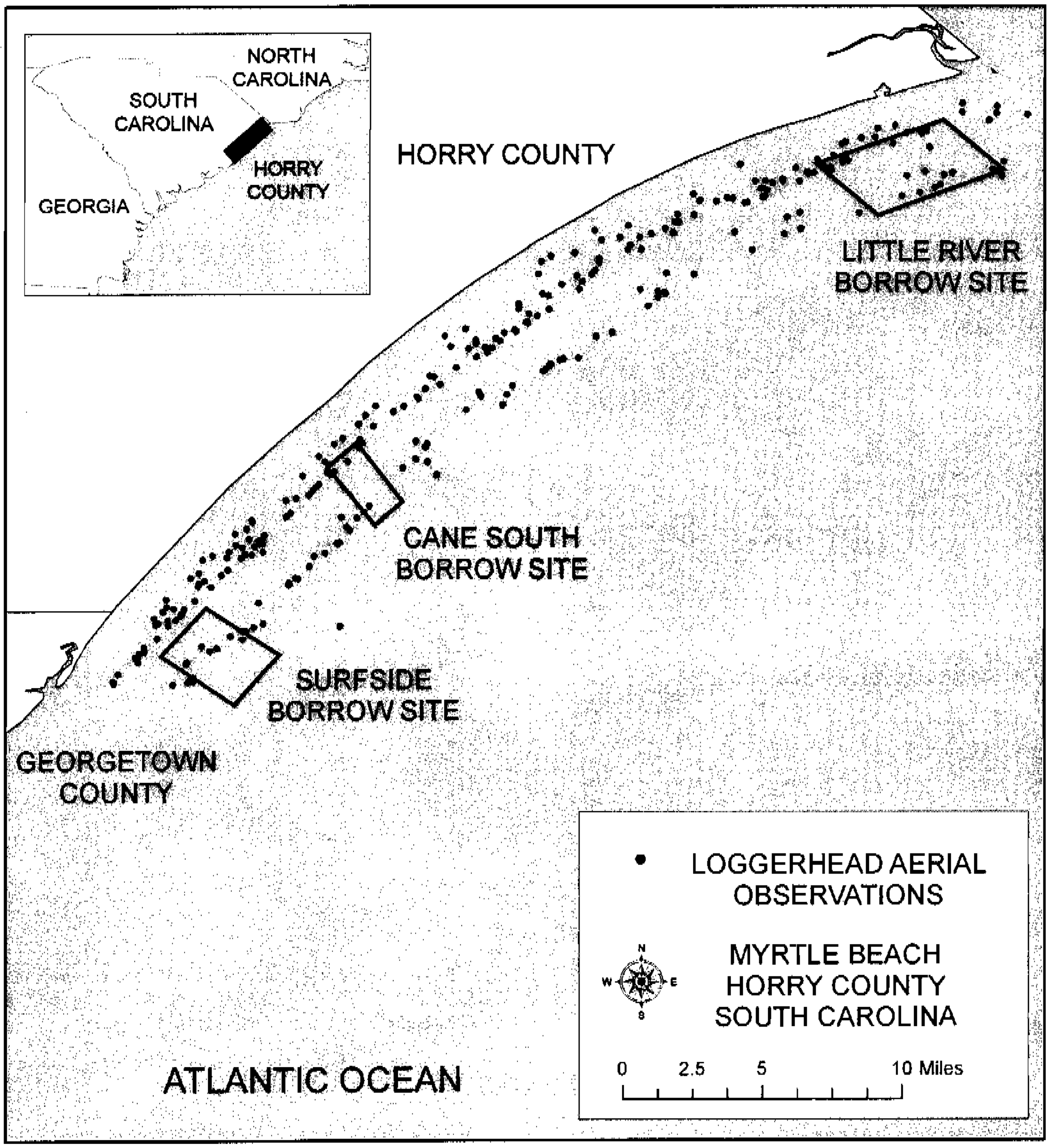
The loggerhead sea turtle nesting and hatching season for South Carolina extends from May 1 through October 31. Incubation ranges from about 45 to 60 days.

Loggerhead sea turtle nesting within the project area averages 12.94 nests per year based on a seventeen year average (SCDNR).

Table 3. Loggerhead Nesting History in Action Area of the Grand Strand Renourishment Project

YEAR	NUMBER OF NESTS
1990	11
1991	5
1992	23
1993	3
1994	19
1995	32
1996	16
1997	5
1998	18
1999	23
2000	10
2001	1
2002	5
2003	23
2004	2
2005	16
2006	8

Figure 4. Loggerhead Aerial Observations from 2001 Through 2006 in the Action Area (SCDNR unpublished data)



Green Sea Turtle

The green sea turtle nesting and hatching season for South Carolina extends from May 15 through October 31. Incubation ranges from about 45 to 75 days.

Green sea turtle nesting within the project area averages 0.29 nests per year based on a seventeen year average (SCDNR).

Table 4. Green Nesting History in Action Area of the Grand Strand Renourishment Project

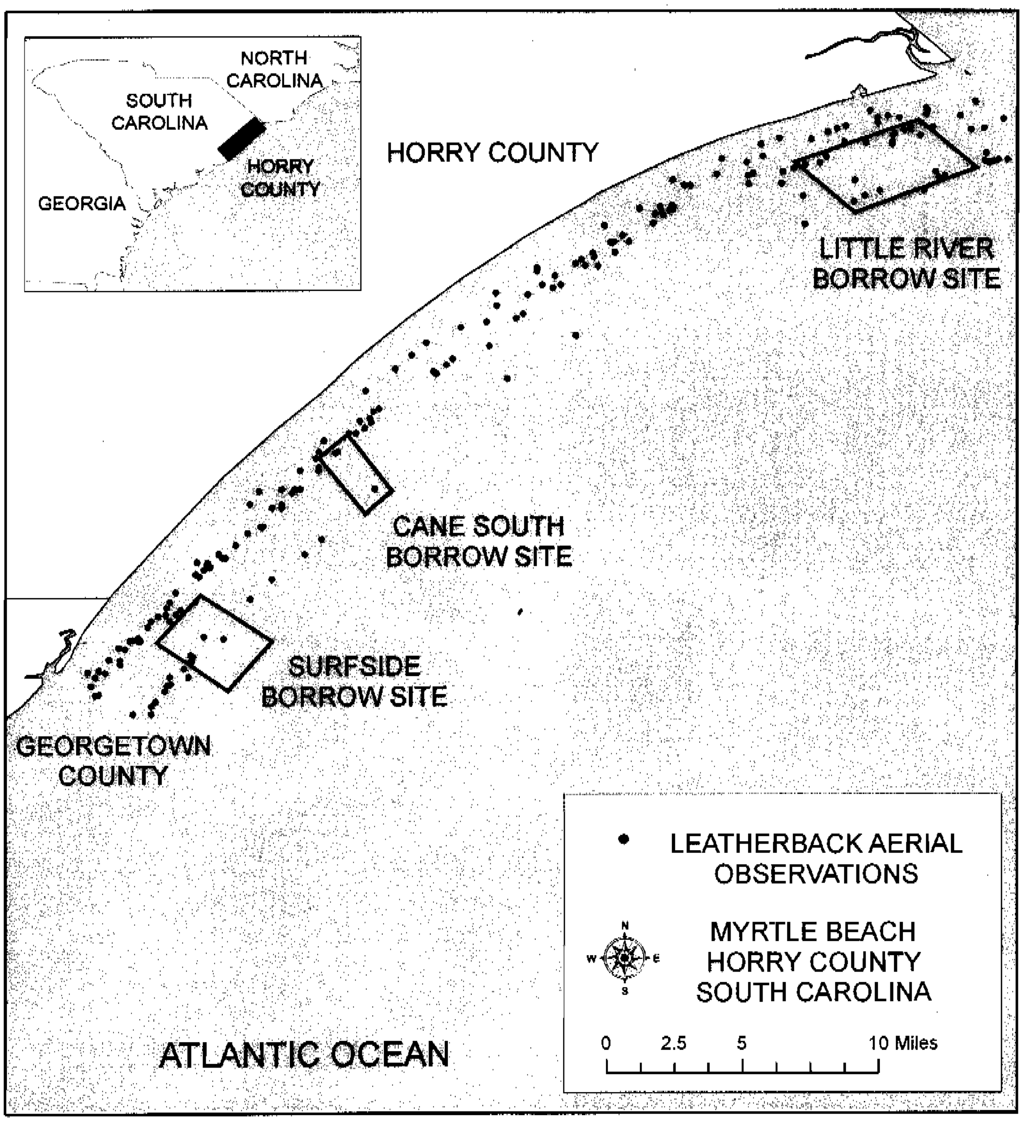
YEAR	NUMBER OF NESTS
1990	0
1991	0
1992	0
1993	0
1994	0
1995	0
1996	1
1997	0
1998	2
1999	0
2000	0
2001	0
2002	0
2003	0
2004	1
2005	0
2006	1

Leatherback Sea Turtle

The leatherback sea turtle nesting and hatching season for South Carolina extends from April 15 through August 30. Incubation ranges from about 55 to 75 days.

No Leatherback sea turtle nests have been recorded in the action area.

Figure 5. Leatherback Aerial Observations from 1993 Through 2006 in the Action Area (SCDNR unpublished data)



Factors affecting the species environment within the action area

Coastal development, light pollution, and beach raking affect sea turtles' nesting environment within the action area. There have been 333 sea turtle strandings within the action area from 1980 through 2006.

EFFECTS OF THE ACTION

This section is an analysis of the beneficial, direct and indirect effects of the proposed action on nesting sea turtles, nests, eggs, and hatchling sea turtles within the Action Area. The analysis includes effects interrelated and interdependent of the project activities. An interrelated activity is an activity that is part of a proposed action and depends on the proposed activity. An interdependent activity is an activity that has no independent utility apart from the action.

Factors to be considered

Proximity of the action

The proposed project is in the immediate vicinity of habitats important to nesting sea turtles.

Distribution

Disturbance activities that will impact sea turtles will primarily occur on the Atlantic shoreline in Georgetown and Horry Counties. As mobile species, sea turtles may also be affected in nearby waterways and on adjacent islands by intraspecific competition, excessive energy expenditure, and marginally suitable habitat selection.

Timing

The timing of the proposed project will result in direct impacts occurring during sea turtle nesting seasons.

Nature of the Effect

The effects of the action may destroy habitat and alter, or diminish the nesting success of sea turtles. Any reduction in productivity and/or survival rates will contribute to a vulnerability to extinction in sea turtles.

Duration

The duration of the direct impacts resulting from construction operations may continue through two sea turtle nesting seasons. Indirect impacts can last several years depending on sand compaction and escarpments.

Analyses for effects of the action

Beneficial Effects

The placement of sand on a beach with reduced dry fore-dune habitat may increase sea turtle nesting habitat if the placed sand is highly compatible (i.e., grain size, shape, color, etc.) with naturally occurring beach sediments in the area, and compaction and escarpment remediation measures are incorporated into the project. In addition, a nourished beach that is designed and constructed to mimic a natural beach system may be more stable than the eroding one it replaces, thereby benefiting sea turtles.

Direct Effects

Direct effects are those direct or immediate effects of a project on the species or its habitat. Placement of sand on a beach in and of itself may not provide suitable nesting habitat for sea turtles. Although beach nourishment may increase the potential nesting area, significant negative impacts to sea turtles may result if protective measures are not incorporated during project construction. Nourishment during the nesting season, particularly on or near high density nesting beaches, can cause increased loss of eggs and hatchlings and, along with other mortality sources, may significantly impact the long-term survival of the species. For instance, projects conducted during the nesting and hatching season could result in the loss of sea turtles through disruption of adult nesting activity and by burial or crushing of nests or hatchlings. While a nest monitoring and egg relocation program would reduce these impacts, nests may be inadvertently missed (when crawls are obscured by rainfall, wind, and/or tides) or misidentified as false crawls during daily patrols. In addition, nests may be destroyed by operations at night prior to beach patrols being performed. Even under the best of conditions, about 7 percent of the nests can be misidentified as false crawls by experienced sea turtle nest surveyors (Schroeder, 1994).

1. *Nest relocation*
Besides the potential for missing nests during a nest relocation program, there is a potential for eggs to be damaged by nest movement or relocation, particularly if eggs are not relocated within 12 hours of deposition (Limpus *et al.*, 1979). Nest relocation can have adverse impacts on incubation temperature (and hence sex ratios), gas exchange parameters, hydric environment of nests, hatching success, and hatchling emergence (Limpus *et al.*, 1979; Ackerman, 1980; Parmenter, 1980; Spotila *et al.*, 1983; McGehee, 1990). Relocating nests into sands deficient in oxygen or moisture can result in mortality, morbidity, and reduced

behavioral competence of hatchlings. Water availability is known to influence the incubation environment of the embryos and hatchlings of turtles with flexible-shelled eggs, which has been shown to affect nitrogen excretion (Packard *et al.*, 1984), mobilization of calcium (Packard and Packard, 1986), mobilization of yolk nutrients (Packard *et al.*, 1985), hatchling size (Packard *et al.*, 1981; McGehee, 1990), energy reserves in the yolk at hatching (Packard *et al.*, 1988), and locomotory ability of hatchlings (Miller *et al.*, 1987).

In a 1994 Florida study comparing loggerhead hatching and emergence success of relocated nests with *in situ* nests, Moody (1998) found that hatching success was lower in relocated nests at 9 of 12 beaches evaluated. She also found emergence success was lower in relocated nests at 10 of 12 beaches surveyed in 1993 and 1994.

2. *Equipment*

The placement of pipelines and the use of heavy machinery on the beach during a construction project may also have adverse effects on sea turtles. They can create barriers to nesting females emerging from the surf and crawling up the beach, causing a higher incidence of false crawls and unnecessary energy expenditure.

3. *Artificial lighting*

Visual cues are the primary sea-finding mechanism for hatchling sea turtles (Mrosovsky and Carr, 1967; Mrosovsky and Shettleworth, 1968; Dickerson and Nelson, 1989; Witherington and Bjorndal, 1991). When artificial lighting is present on or near the beach, it can misdirect hatchlings once they emerge from their nests and prevent them from reaching the ocean (Philibosian, 1976; Mann, 1977; FWC sea turtle disorientation database). In addition, a significant reduction in sea turtle nesting activity has been documented on beaches illuminated with artificial lights (Witherington, 1992). Therefore, construction lights along a project beach and on the dredging vessel may deter females from coming ashore to nest, misdirect females trying to return to the surf after a nesting event, and misdirect emergent hatchlings from adjacent non-project beaches. Any source of bright lighting can profoundly affect the orientation of hatchlings, both during the crawl from the beach to the ocean and once they begin swimming offshore. Hatchlings attracted to light sources on dredging barges may not only suffer from interference in migration, but may also experience higher probabilities of predation to predatory fishes that are also attracted to the barge lights. This impact could be reduced by using the minimum amount of light necessary (may require shielding) or low pressure sodium lighting during project construction.

Beach nourishment projects create a wider and higher beach. The newly created beach berm also exposes sea turtles and their nests to lights that were less visible, or not at all visible, from nesting areas before the beach nourishment. Following a beach nourishment project in Brevard County, Florida, completed in the spring of 2001, up to 70 percent of the nests hatching from the restored beach were disoriented. Reducing beachfront lighting is the most effective method to decrease the number of disorientations on a restored beach. Changing to sea turtle compatible lighting can be easily accomplished at the local level through voluntary compliance or by adopting appropriate regulations. Of the 64 coastal counties in Florida, 17 have passed beachfront lighting ordinances in addition to 47 municipalities.

Indirect Effects

Indirect effects are those effects that are caused by or result from the proposed action, are later in time, and are reasonably certain to occur. Effects from the proposed project may continue to affect sea turtle nesting on the project beach and adjacent beaches in future years.

Many of the direct effects of beach nourishment may persist over time and become indirect impacts. These indirect effects include increased susceptibility of relocated nests to catastrophic events, the consequences of potential increased beachfront development, changes in the physical characteristics of the beach, the formation of escarpments, and future sand migration.

1. *Increased susceptibility to catastrophic events*
Nest relocation may concentrate eggs in an area making them more susceptible to catastrophic events. Hatchlings released from concentrated areas also may be subject to greater predation rates from both land and marine predators, because the predators learn where to concentrate their efforts (Glenn, 1998; Wyneken *et al.*, 1998).

2. *Increased beachfront development*
Pilkey and Dixon (1996) state that beach replenishment frequently leads to more development in greater density within shorefront communities that are then left with a future of further replenishment or more drastic stabilization measures. Dean (1999) also notes that the very existence of a beach nourishment project can encourage more development in coastal areas. Following completion of a beach nourishment project in Miami during 1982, investment in new and updated facilities substantially increased tourism there (National Research Council, 1995). Increased building density immediately adjacent to the beach often resulted as older buildings were replaced by much larger ones that accommodated more beach users. Overall, shoreline management creates an upward spiral of initial protective measures resulting in more expensive development which leads to the need for more and larger protective measures. Increased shoreline development may adversely affect sea turtle nesting success. Greater development may support larger populations of mammalian predators, such as foxes and raccoons, than undeveloped areas (National Research Council, 1990a), and can also result in greater adverse effects due to artificial lighting, as discussed above.

3. *Changes in the physical environment*
Beach nourishment may result in changes in sand density (compaction), beach shear resistance (hardness), beach moisture content, beach slope, sand color, sand grain size, sand grain shape, and sand grain mineral content if the placed sand is dissimilar from the original beach sand (Nelson and Dickerson, 1988a). These changes could result in adverse impacts

on nest site selection, digging behavior, clutch viability, and emergence by hatchlings (Nelson and Dickerson, 1987; Nelson, 1988).

Beach compaction and unnatural beach profiles that may result from beach nourishment activities could negatively impact sea turtles regardless of the timing of projects. Very fine sand and/or the use of heavy machinery can cause sand compaction on nourished beaches (Nelson *et al.*, 1987; Nelson and Dickerson, 1988a). Significant reductions in nesting success (i.e., false crawls occurred more frequently) have been documented on severely compacted nourished beaches (Fletemeyer, 1980; Raymond, 1984; Nelson and Dickerson, 1987; Nelson *et al.*, 1987), and increased false crawls may result in increased physiological stress to nesting females. Sand compaction may increase the length of time required for female sea turtles to excavate nests and also cause increased physiological stress to the animals (Nelson and Dickerson, 1988b). Nelson and Dickerson (1988c) concluded that, in general, beaches nourished from offshore borrow sites are harder than natural beaches, and while some may soften over time through erosion and accretion of sand, others may remain hard for 10 years or more.

These impacts can be minimized by using suitable sand and by tilling compacted sand after project completion. The level of compaction of a beach can be assessed by measuring sand compaction using a cone penetrometer (Nelson, 1987). Tilling of a nourished beach with a root rake may reduce the sand compaction to levels comparable to unnourished beaches. However, a pilot study by Nelson and Dickerson (1988c) showed that a tilled nourished beach will remain uncompacted for up to 1 year. Multi-year beach compaction monitoring and, if necessary, tilling, would ensure that project impacts on sea turtles are minimized.

A change in sediment color on a beach could change the natural incubation temperatures of nests in an area, which, in turn, could alter natural sex ratios. To provide the most suitable sediment for nesting sea turtles, the color of the nourished sediments must resemble the natural beach sand in the area. Natural reworking of sediments and bleaching from exposure to the sun would help to lighten dark nourishment sediments; however, the timeframe for sediment mixing and bleaching to occur could be critical to a successful sea turtle nesting season.

4. *Escarpment formation*

On nourished beaches, steep escarpments may develop along their water line interface as they adjust from an unnatural construction profile to a more natural beach profile (Coastal Engineering Research Center, 1984; Nelson *et al.*, 1987). These escarpments can hamper or prevent access to nesting sites (Nelson and Blihovde, 1998). Researchers have shown that female turtles coming ashore to nest can be discouraged by the formation of an escarpment, leading to situations where they choose marginal or unsuitable nesting areas to deposit eggs (e.g., in front of the escarpments, which often results in failure of nests due to prolonged tidal inundation). This impact can be minimized by leveling any escarpments prior to the nesting season.

5. *Erosion*
Future sand displacement on nesting beaches is a potential effect of the nourishment project. Dredging of sand offshore from a project area has the potential to cause erosion of the newly created beach or other areas on the same or adjacent beaches by creating a sand sink. The remainder of the system responds to this sand sink by providing sand from the beach to attempt to reestablish equilibrium (National Research Council, 1990b).

Species' response to a proposed action

Ernest and Martin (1999) conducted a comprehensive study to assess the effects of beach nourishment on loggerhead sea turtle nesting and reproductive success. The following findings illustrate sea turtle responses to and recovery from a nourishment project. A significantly larger proportion of turtles emerging on nourished beaches abandoned their nesting attempts than turtles emerging on Control or pre-nourished beaches. This reduction in nesting success was most pronounced during the first year following project construction and is most likely the result of changes in physical beach characteristics associated with the nourishment project (e.g., beach profile, sediment grain size, beach compaction, frequenCY and extent of escarpments). During the first post-construction year, the time required for turtles to excavate an egg chamber on the untilled, hard-packed sands of one treatment area increased significantly relative to Control and background conditions. However, in another treatment area, tilling was effective in reducing sediment compaction to levels that did not significantly prolong digging times. As natural processes reduced compaction levels on nourished beaches during the second post-construction year, digging times returned to background levels.

During the first post-construction year, nests on the nourished beaches were deposited significantly seaward of the toe of the dune and significantly landward of the tide line than nests on Control beaches. This indicates that the nests were laid in the middle of the beach and not clustered near the dune as they were in the Control. As the width of nourished beaches decreased during the second year, among-treatment differences in nest placement diminished. More nests were washed out on the wide, flat beaches of the nourished treatments than on the narrower steeply sloped beaches of the Control. This phenomenon persisted through the second post-construction year monitoring and resulted from the placement of nests near the seaward edge of the beach berm where dramatic profile changes, caused by erosion and scarping, occurred as the beach equilibrated to a more natural contour.

Ernest and Martin (1999), as with other beach nourishment projects, found that the principal effect of nourishment on sea turtle reproduction was a reduction in nesting success during the first year following project construction. Although most studies have attributed this phenomenon to an increase in beach compaction and escarpment formation, Ernest and Martin indicate that changes in beach profile may be more important. Regardless, as a nourished beach is reworked by natural processes in subsequent years and adjusts from an unnatural construction profile to a more natural beach profile, beach compaction and the frequency of escarpment formation decline, and nesting and nesting success return to levels found on natural beaches.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. The Service is not aware of any cumulative effects in the project area.

CONCLUSION

After reviewing the current status of the loggerhead sea turtle, the green sea turtle, and the leatherback sea turtle, the environmental baseline for the action area, the effects of the proposed beach nourishment, and the cumulative effects, it is the Service's biological opinion that the beach nourishment project, as proposed, is not likely to jeopardize the continued existence of the loggerhead sea turtle, the green sea turtle, and the leatherback sea turtle and is not likely to destroy or adversely modify designated critical habitat. No critical habitat has been designated for the loggerhead sea turtle, the green sea turtle, and the leatherback sea turtle in the continental United States; therefore, none will be affected.

The proposed project will affect 25.4 miles of the about 1,400 miles of available sea turtle nesting habitat in the southeastern U.S. Research has shown that the principal effect of beach nourishment on sea turtle reproduction is a reduction in nesting success, and this reduction is most often limited to the first year following project construction. Research has also shown that the impacts of a nourishment project on sea turtle nesting habitat are typically short-term because a nourished beach will be reworked by natural processes in subsequent years, and beach compaction and the frequenCY of escarpment formation will decline. Although a variety of factors, including some that cannot be controlled, can influence how a nourishment project will perform from an engineering perspective, measures can be implemented to minimize impacts to sea turtles.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered or threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agenCY action is not considered to be prohibited under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be implemented by the Corps so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impacts on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

The Service anticipates 25.4 miles of nesting beach habitat could be taken as a result of this proposed action; however, incidental take of sea turtles will be difficult to detect for the following reasons:

(1) the turtles nest primarily at night and all nests are not found because
[a] natural factors, such as rainfall, wind, and tides may obscure crawls and
[b] human-caused factors, such as pedestrian and vehicular traffic, may obscure crawls, and result in nests being destroyed because they were missed during a nesting survey and egg relocation program;
(2) the total number of hatchlings per undiscovered nest is unknown;
(3) the reduction in percent hatching and emerging success per relocated nest over the natural nest site is unknown;
(4) an unknown number of females may avoid the project beach and be forced to nest in a less than optimal area;
(5) lights may misdirect an unknown number of hatchlings and cause death; and
(6) escarpments may form and cause an unknown number of females from accessing a suitable nesting site.

However, the level of take of these species can be anticipated by the disturbance and nourishment of suitable turtle nesting beach habitat because: (1) turtles nest within the project site; (2) beach nourishment will likely occur during a portion of the nesting season; (3) the nourishment project will modify the incubation substrate, beach slope, and sand compaction; and (4) artificial lighting will deter and/or misdirect nesting females and hatchlings.

The take is expected to be in the form of: (1) destruction of some nests and eggs that may be constructed and eggs that may be missed by a nest survey and egg relocation program within the boundaries of the proposed project; (2) destruction of some nests deposited after the nest survey and relocation program is completed within the boundaries of the proposed project; (3) reduced hatching success due to egg mortality during relocation and adverse conditions at the relocation site; (4) harassment in the form of disturbing or interfering with female turtles attempting to nest within the construction area or on adjacent beaches as a result of construction activities; (5) misdirection of hatchling turtles on beaches adjacent to the construction area as they emerge from the nest and crawl to the water as a result of project lighting; (6) behavior modification of nesting females due to escarpment formation within the project area during a nesting season, resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs; and (7) destruction of nests from escarpment leveling within a nesting season when such leveling has been approved by the Service.

Table 5 below represents the level of take that could occur if the reasonable and prudent measures were not implemented. According to Schroeder (1994), there is an average survey error of seven percent; therefore, there is the possibility that some nests in the project area may be missed. However, due to implementation of the sea turtle protection measures, we anticipate that the take will not exceed seven percent of the nesting average in the project area. This number is not the level of take exempted because the exact number cannot be predicted nor can the level of incidental take be monitored.

Table 5. The average number of sea turtle nests that will be taken, based on the best available commercial and scientific information.

SPECIES	NESTS*	TAKE TYPE	CRITICAL HABITAT AFFECTED
loggerhead sea turtle	12.94	harm/harassment	none
green sea turtle	0.29	harm/harassment	none
leatherback sea turtle	0	none	none

Table 6 represents the amount of turtle nesting habitat that will be affected by the project.

Table 6. Monitoring the incidental take for the proposed project will be done by amount of habitat affected

SPECIES	CRITICAL HABITAT AFFECTED	HABITAT AFFECTED
loggerhead sea turtle	none	25.4 miles of nesting
green sea turtle	none	25.4 miles of nesting
leatherback sea turtle	none	25.4 miles of potential nesting

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species. Critical habitat has not been designated in the project area; therefore, the project will not result in destruction or adverse modification of critical habitat.

Incidental take of nesting and hatchling sea turtles is anticipated to occur during the project construction and during the life of the project. The take will occur on nesting habitat consisting of the length of the beach where the restoration material will be placed.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize take of loggerhead, green, and leatherback sea turtles in the proposed beach restoration Action Area.

1. Beach quality sand suitable for sea turtle nesting, successful incubation, and hatchling emergence must be used for the beach nourishment project. Any unsuitable material placed in the project area will be removed (rock, silts, and fines).

2. If the beach nourishment project will be conducted during the sea turtle nesting season, surveys for nesting sea turtles must be conducted daily before work is conducted. If nests are constructed in the area of beach nourishment, the eggs must be relocated to minimize of sea turtle nest burial, crushing of eggs, or nest excavation.

3. Immediately after completion of the beach nourishment project and prior to the next three nesting seasons, beach compaction must be monitored and tilling must be conducted as required to reduce the likelihood of impacting sea turtle nesting and hatching activities.

4. Immediately after completion of the beach nourishment project and prior to the next three nesting seasons, monitoring must be conducted to determine if escarpments are present and escarpments must be leveled as required to reduce the likelihood of impacting sea turtle nesting and hatching activities.

5. The applicant must ensure that contractors doing the beach nourishment work fully understand the sea turtle protection measures detailed in this incidental take statement.

6. During the sea turtle nesting season, construction equipment and materials must be stored in a manner that will minimize impacts to sea turtles to the maximum extent practicable.

7. During the sea turtle nesting season, lighting associated with the project must be minimized to reduce the possibility of disrupting and disorienting nesting and/or hatchling sea turtles.

8. All dune restoration and planting must be designed and conducted to minimize impacts to sea turtles.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

Protection of sea turtles

1. Daily early morning surveys for sea turtle nests will be required if any portion of the beach nourishment project occurs during the period from May 1 to September 30. Nesting surveys must be initiated 75 days prior to nourishment activities or by May 1, whichever is later. Nesting surveys must continue through the end of the project or through September 30, whichever is earlier. If nests are constructed in areas where they may be affected by construction activities, eggs must be relocated per the following requirements.

   1a. Nesting surveys and egg relocations will only be conducted by personnel with prior experience and training in nesting survey and egg relocation procedures. Surveyors must be trained by qualified personnel have a valid SCDNR permit. Nesting surveys must be conducted daily between sunrise and 9 a.m (this is for all time zones). The contractor must not initiate work until daily notice has been received from the sea turtle permit holder that the morning survey has been completed. Surveys must be performed in such a manner so as to ensure that construction activity does not occur in any location prior to completion of the necessary sea turtle protection measures.

1b. Only those nests that may be affected by construction activities will be relocated. Nests requiring relocation must be moved no later than 9 a.m. the morning following deposition to a nearby self-release beach site in a secure setting where artificial lighting will not interfere with hatchling orientation. Nest relocations in association with construction activities must cease when construction activities no longer threaten nests. Nests deposited within areas where construction activities have ceased or will not occur for 75 days must be marked and left in place unless other factors threaten the success of the nest. Any nests left in the active construction zone must be clearly marked, and all mechanical equipment must avoid nests by at least 10 feet.

1c. Nests deposited within areas where restoration activities have ceased or will not occur for 75 days must be marked and left *in situ* unless other factors threaten the success of the nest. The turtle permit holder must install an on-beach marker at the nest site and a secondary marker at a point landward as possible to assure that future location of the nest will be possible should the on-beach marker be lost. A series of stakes and highly visible survey ribbon or string must be installed to establish an area of 10 feet radius surrounding the nest. No activity will occur within this area nor will any activity occur which could result in impacts to the nest. Nest sites must be inspected daily to assure nest markers remain in place and the nest has not been disturbed by the restoration activity.

2. Immediately after completion of the beach nourishment project and prior to May 1 for 3 subsequent years, sand compaction must be monitored in the area of restoration in accordance with a protocol agreed to by the Service, the State regulatory agency, and the applicant. At a minimum, the protocol provided under 2a and 2b below must be followed. If required, the area must be tilled to a depth of 36 inches. All tilling activity must be completed prior to May 1. Each pass of the tilling equipment must be overlapped to allow more thorough and even tilling. If the project is completed during the nesting season, tilling will not be performed in areas where nests have been left in place or relocated. A report on the results of the compaction monitoring shall be submitted to the Service prior to any tilling actions being taken. (NOTE: The requirement for compaction monitoring can be eliminated if the decision is made to till regardless of post-construction compaction levels. Additionally, out-year compaction monitoring and remediation are not required if placed material no longer remains on the dry beach.)

2a. Compaction sampling stations must be located at 500-foot intervals along the project area. One station must be at the seaward edge of the dune/bulkhead line (when material is placed in this area), and one station must be midway between the dune line and the high water line (normal wrack line).

At each station, the cone penetrometer will be pushed to a depth of 6, 12, and 18 inches three times (three replicates). Material may be removed from the hole if necessary to ensure accurate readings of successive levels of sediment. The penetrometer may need to be reset between pushes, especially if sediment layering exists. Layers of highly compact material may lay over less compact layers. Replicates will be located as close to each other as possible, without interacting with the previous hole and/or disturbed sediments. The three replicate compaction values for each depth will be averaged to produce final values for each depth at each station. Reports will include all 18 values for each transect line, and the final 6 averaged compaction values.

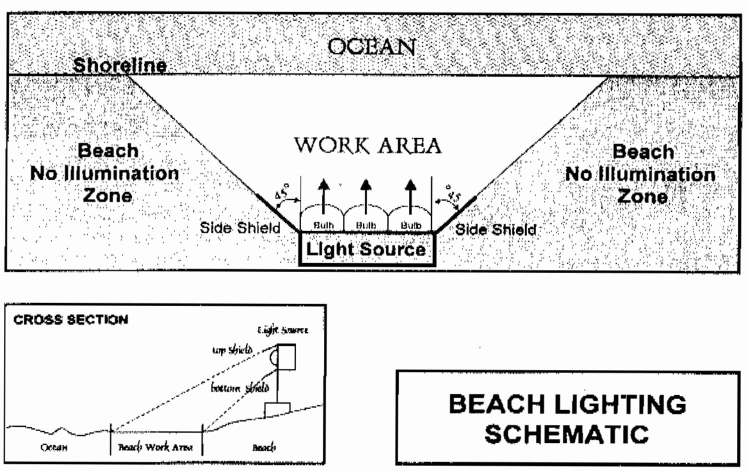
2b. If the average value for any depth exceeds 500 pounds per square inch (psi) for any two or more adjacent stations, then that area must be tilled immediately prior to May 1. If values exceeding 500 psi are distributed throughout the project area but in no case do those values exist at two adjacent stations at the same depth, then consultation with the Service will be required to determine if tilling is required. If a few values exceeding 500 psi are present randomly within the project area, tilling will not be required.

3. Visual surveys for escarpments along the project area must be made immediately after completion of the beach nourishment project and prior to May 1 for 3 subsequent years. Escarpments that interfere with sea turtle nesting or that exceed 18 inches in height for a distance of 100 feet must be leveled to the natural beach contour by May 1. If the project is completed during the sea turtle nesting and hatching season, escarpments may be required to be leveled immediately, while protecting nests that have been relocated or left in place. The Service must be contacted immediately if subsequent reformation of escarpments that interfere with sea turtle nesting or that exceed 18 inches in height for a distance of 100 feet occurs during the nesting and hatching season to determine the appropriate action to be taken. If it is determined that escarpment leveling is required during the nesting or hatching season, the Service will provide a brief written authorization that describes methods to be used to reduce the likelihood of impacting existing nests. An annual summary of escarpment surveys and actions taken must be submitted to the Service. To ensure compliance with this condition, turtle nesting surveys must be conducted for 3 years following beach restoration. (NOTE: Out-year escarpment monitoring and remediation are not required if placed material no longer remains on the beach.)

4. The applicant must arrange a meeting between representatives of the contractor, the Service, the SCDNR, and the permitted person responsible for egg relocation at least 30 days prior to the commencement of work on this project. At least 10 days advance notice must be provided prior to conducting this meeting. This will provide an opportunity for explanation and/or clarification of the sea turtle protection measures.

5. From May 1 to October 31, staging areas for construction equipment must be located off the beach to the maximum extent practicable. Nighttime storage of construction equipment not in use must be off the beach to minimize disturbance to sea turtle nesting and hatching activities. In addition, all construction pipes that are placed on the beach must be located as far landward as possible without compromising the integrity of the existing or reconstructed dune system. Temporary storage of pipes must be off the beach to the maximum extent possible. Temporary storage of pipes on the beach must be in such a manner so as to impact the least amount of nesting habitat and must likewise not compromise the integrity of the dune systems (placement of pipes perpendicular to the shoreline is recommended as the method of storage).

6. From May 1 to October 31, direct lighting of the beach and near shore waters must be limited to the immediate construction area and must comply with safety requirements. Lighting on offshore or onshore equipment must be minimized through reduction, shielding, lowering, and appropriate placement to avoid excessive illumination of the waters surface and nesting beach while meeting all Coast Guard, EM 385-1-1, and OSHA requirements. Light intensity of lighting plants must be reduced to the minimum standard required by OSHA for General Construction areas, in order not to misdirect sea turtles. Shields must be affixed to the light housing and be large enough to block light from all lamps from being transmitted outside the construction area (see below schematic).



BEACH LIGHTING SCHEMATIC

7. A 100 foot buffer must remain around any sea turtle attempting to nest in the action area and all construction equipment excluding the dredge must be shut down until the turtle returns to the ocean.

8. The Corps will hire nighttime monitors to patrol the beach adjacent to operating construction equipment looking for sea turtles attempting to nest. The monitors will coordinate with the S.C.U.T.E. volunteers and report any nests to them.

Reporting

1. A report describing the actions taken to implement the terms and conditions of this incidental take statement must be submitted to the Service within 60 days of completion of the proposed work for each year when the activity has occurred. This report will include the dates of actual construction activities, names and qualifications of personnel involved in nest surveys and relocation activities, descriptions and locations of self-release beach sites, nest survey and relocation results, and hatching success of nests.

2. In the event a sea turtle nest is excavated during construction activities, the permitted person responsible for egg relocation for the project must be notified so the eggs can be moved to a suitable relocation site.

3. Upon locating a sea turtle adult, hatchling, or egg harmed or destroyed as a direct or indirect result of the project, initial notification must be made to the Service Law Enforcement Office at (843) 727-4707 ext. 210 or 211 or (843) 514-3260 or (843) 297-9829. Additional notification must also be made to Melissa Bimbi of the Charleston Field Office at (843) 727-4707 ext. 228 and DuBose Griffin of the SCDNR at (843) 953-9016. Care should be taken in handling injured turtles or eggs to ensure effective treatment or disposition, and in handling dead specimens to preserve biological materials in the best possible state for later analysis.

The Service believes that incidental take will be limited to the 25.4 miles of beach that have been identified for sand placement. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. The Service believes that no more than the following types of incidental take will result from the proposed action: (1) destruction of all nests that may be constructed and eggs that may be deposited and missed by a nest survey and egg relocation program within the boundaries of the proposed project; (2) destruction of all nests deposited during the period when a nest survey and egg relocation program is not required to be in place within the boundaries of the proposed project; (3) reduced hatching success due to egg mortality during relocation and adverse conditions at the relocation site; (4) harassment in the form of disturbing or interfering with female turtles attempting to nest within the construction area or on adjacent beaches as a result of construction activities; (5)

disorientation of hatchling turtles on beaches adjacent to the construction area as they emerge from the nest and crawl to the water as a result of project lighting; (6) behavior modification of nesting females due to escarpment formation within the project area during a nesting season, resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs; and (7) destruction of nests from escarpment leveling within a nesting season when such leveling has been approved by the Service.

The amount or extent of incidental take for sea turtles will be considered exceeded if the project results in more than a one-time placement of sand on the 25.4 miles of beach that have been identified for sand placement. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Corps must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agenCY activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. Construction activities for this project and similar future projects should be planned to take place outside the main part of the sea turtle nesting and hatching season.

2. Appropriate native salt-resistant dune vegetation should be established on the restored dunes.

3. Surveys for nesting success of sea turtles should be continued for a minimum of 3 years following beach nourishment to determine whether sea turtle nesting success has been adversely impacted.

4. To increase public aware ness about sea turtles, informational signs should be placed at beach access points where appropriate. The signs should explain the importance of the beach to sea turtles and/or the life history of sea turtle species that nest in the area.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the action outlined in your request for formal consultation on the Grand Strand renourishment project. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

For this biological opinion, the incidental take will be exceeded when the renourishment of 25.4 miles of beach extends beyond the project's authorized boundaries. Incidental take of an undetermined number of young or eggs of sea turtles and piping plovers has been exempted from the prohibitions of section 9 by this opinion. The Service appreciates the cooperation of the Corps during this consultation. We would like to continue working with you and your staff regarding this project. For further coordination please contact Melissa Bimbi at (843) 727-4707, ext. 228. In future correspondence concerning the project, please reference FWS Log No. 2007-F-0041.

Sincerely,

Timothy N. Hall

Timothy N. Hall
Field Supervisor

TNH/MKB

cc: USFWS, Atlanta, GA (Joe Johnston) (via email)
USFWS, Jacksonville, FL (Nicole Adimey)
SCDNR, Charleston, SC (DuBose Griffin)
SCDNR, Charleston, SC (Susan Davis)
DHEC-OCRM, Charleston, SC (Bill Eiser)
NOAA-NMFS, St. Petersburg, FL (Eric Hawk)

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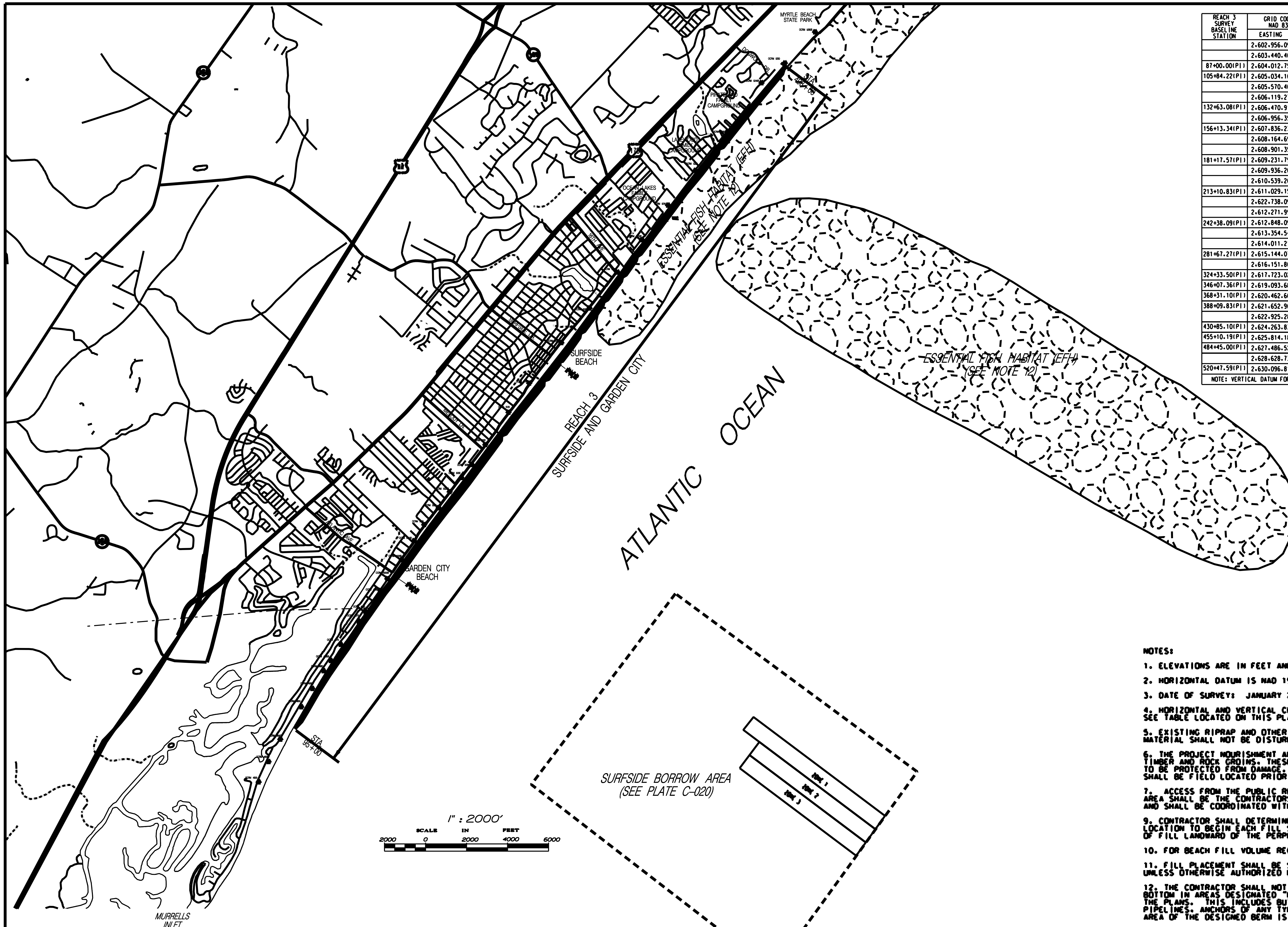
Appendix 3

Geo-technical Report & Design Drawings



REACH 3 SURVEY BASELINE STATION	GRID COORDINATES NAD 83 (2001)		ELEV. NAVD 88	DESCRIPTION
	EASTING	NORTHING		
	2,602,956.09	630,077.93	8.50	SCCC 4930 CONC. MONUMENT
	2,603,440.40	631,069.36	7.94	SCCC 4935 CONC. MONUMENT
87+00.00(PI)	2,604,012.75	632,161.72	7.71	SCCC 4940B CONC. MONUMENT
105+84.22(PI)	2,605,034.16	633,745.06	6.47	SCCC 4950 CONC. MONUMENT
	2,605,570.40	634,639.01	7.38	SCCC 4955B CONC. MONUMENT
	2,606,119.27	635,503.38	6.4	SCCC 4960 CONC. MONUMENT
132+63.08(PI)	2,606,470.91	636,006.05	8.65	SCCC 4965B CONC. MONUMENT
	2,606,956.35	636,790.85	7.44	SCCC 4970 CONC. MONUMENT
156+13.34(PI)	2,607,836.23	637,919.07	6.21	SCCC 4975 CONC. MONUMENT
	2,608,164.69	638,384.95	7.10	SCCC 4980 CONC. MONUMENT
	2,608,901.35	639,418.93	6.90	SCCC 4999B CONC. MONUMENT
181+17.57(PI)	2,609,231.79	639,998.39	5.17	SCCC 5000B CONC. MONUMENT
	2,609,936.26	640,920.52	5.18	SCCC 5005B CONC. MONUMENT
	2,610,539.26	641,851.79	4.8	SCCC 5010 CONC. MONUMENT
213+10.83(PI)	2,611,029.15	642,637.79	6.29	SCCC 5015 CONC. MONUMENT
	2,622,738.09	643,456.40	7.1	SCCC 5020 CONC. MONUMENT
	2,612,271.99	644,247.86	6.98	SCCC 5025B CONC. MONUMENT
242+38.09(PI)	2,612,848.09	644,931.32	7.87	SCCC 5030 CONC. MONUMENT
	2,613,354.54	645,567.20	9.86	SCCC 5035 CONC. MONUMENT
	2,614,011.21	646,541.14	9.59	SCCC 5100 CONC. MONUMENT
281+67.27(PI)	2,615,144.07	648,119.88	8.95	SCCC 5120 CONC. MONUMENT
	2,616,151.86	649,541.88	6.84	SCCC 5140 CONC. MONUMENT
324+33.50(PI)	2,617,723.02	651,518.38	7.06	SCCC 5130 CONC. MONUMENT
346+07.36(PI)	2,619,093.68	653,205.66	7.6	SCCC 5180 CONC. MONUMENT
368+31.10(PI)	2,620,462.60	654,958.11	9.89	SCCC 5195B CONC. MONUMENT
388+09.83(PI)	2,621,652.96	656,538.75	7.92	SCCC 5200B CONC. MONUMENT
	2,622,925.28	658,227.84	8.35	SCCC 5210B CONC. MONUMENT
430+85.10(PI)	2,624,263.83	659,924.20	9.10	SCCC 5220 CONC. MONUMENT
455+10.19(PI)	2,625,814.18	661,789.00	8.53	SCCC 5230B CONC. MONUMENT
484+45.00(PI)	2,627,486.52	664,200.72	6.25	SCCC 5240B CONC. MONUMENT
	2,628,628.73	665,165.37	7.8	SCCC 5250 CONC. MONUMENT
520+47.59(PI)	2,630,096.81	666,683.67	8.46	SCCC 5260B CONC. MONUMENT

NOTE: VERTICAL DATUM FOR MONUMENTS IS NAVD 88

NOTES:

1. ELEVATIONS ARE IN FEET AND REFER TO NAVD 88.

2. HORIZONTAL DATUM IS NAD 1983 STATE PLANE.

3. DATE OF SURVEY: JANUARY 2007

4. HORIZONTAL AND VERTICAL CONTROL REFERENCE: SEE TABLE LOCATED ON THIS PLATE.

5. EXISTING RIPRAP AND OTHER SLOPE PROTECTION MATERIAL SHALL NOT BE DISTURBED.

6. THE PROJECT NOURISHMENT AREA CONTAINS MANY TIMBER AND ROCK GROINS. THESE FEATURES ARE TO BE PROTECTED FROM DAMAGE. TIMBER AND ROCK GROINS SHALL BE FIELD LOCATED PRIOR TO CONSTRUCTION.

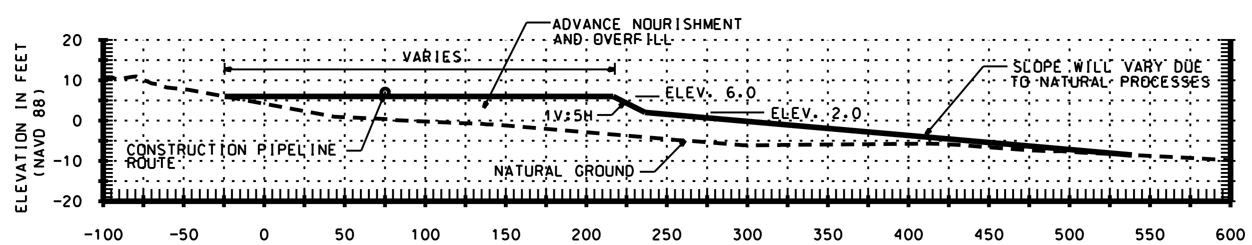
7. ACCESS FROM THE PUBLIC ROADS TO THE NOURISHMENT AREA SHALL BE THE CONTRACTORS RESPONSIBILITY TO BUILD AND SHALL BE COORDINATED WITH THE CONTRACTING OFFICER.

9. CONTRACTOR SHALL DETERMINE IN THE FIELD THE EXACT LOCATION TO BEGIN EACH FILL SECTION TO AVOID PLACEMENT OF FILL LANDWARD OF THE PERPETUAL EASEMENT.

10. FOR BEACH FILL VOLUME REQUIREMENTS, SEE THE SPECIFICATIONS.

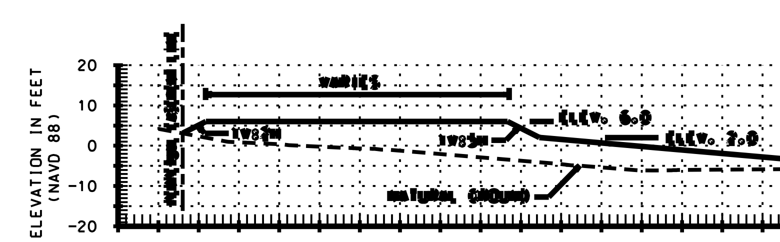
11. FILL PLACEMENT SHALL BE SEAWARD OF PERPETUAL EASEMENT LINE UNLESS OTHERWISE AUTHORIZED BY THE CONTRACTING OFFICER.

12. THE CONTRACTOR SHALL NOT IN ANY MANNER DISTURB THE OCEAN BOTTOM IN AREAS DESIGNATED "ESSENTIAL FISH HABITAT (EFH)" ON THE PLANS. THIS INCLUDES BUT IS NOT LIMITED TO SUBMERGED PIPELINES, ANCHORS OF ANY TYPE, SPUDS, ETC. BEACH FILL WITHIN THE AREA OF THE DESIGNED BERM IS ALLOWED.



TYPICAL STATION 100+00 TO STATION 493+00

SCALE: HOR. 1" = 50', VERT. 1" = 20'



FILL PLACEMENT NEAR PERPETUAL EASEMENT LINE (N.T.S.)

US Army Corps of Engineers
Charleston District

Designed by: DJW	Date: MAY 2007
Drawn by: DJW	Chk'd by: CSN
Reviewed by: X	Submitted by: CW

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
CHARLESTON, SOUTH CAROLINA

IFB NO. W912HN-0X-B-00XX
CONTRACT NO. W912HN-07-C-00XX

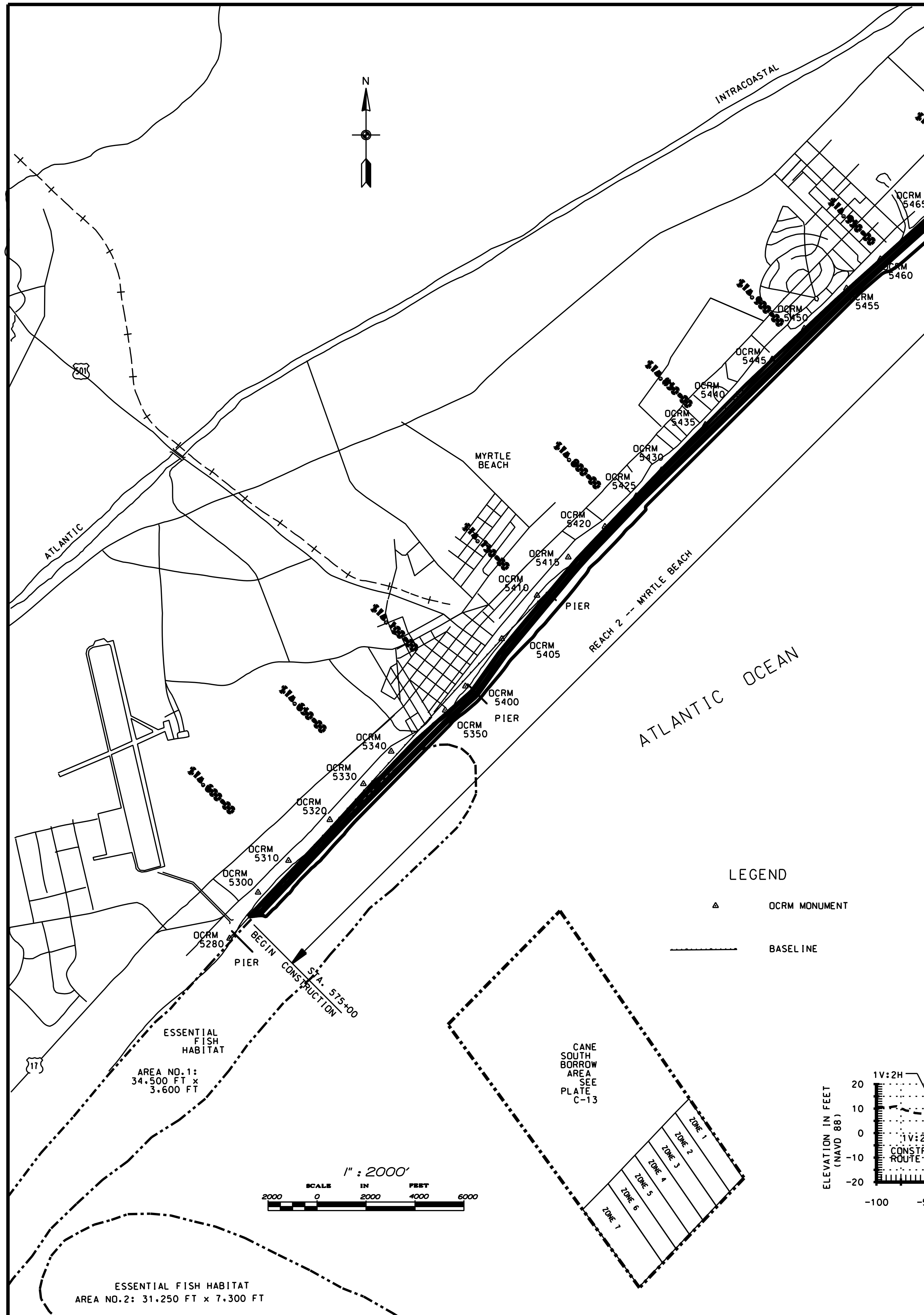
MYRTLE BEACH
SHORE PROTECTION PROJECT
REACH THREE

PLAN AND TYPICAL SECTIONS
CONSTRUCTION BERM – REACH 3

GEORGETOWN & HORRY COUNTIES SOUTH CAROLINA

SHEET REFERENCE NUMBER
C-014

BCOE REVIEW



REACH 2 BASELINE STATION	GRID COORDINATES NAD 83 (2001)		ELEV. NAVD 88	DESCRIPTION
	EASTING	NORTHING		
563+33.00	2,633,041.36	669,811.02	6.86	SCCC 5280B CONC. MONUMENT
	2,634,202.56	671,691.40	9.5	SCCC 5300 CONC. MONUMENT
	2,635,447.85	672,991.00	9.8	SCCC 5310 CONC. MONUMENT
	2,637,133.68	674,656.19	16.9	SCCC 5320 CONC. MONUMENT
	2,638,507.66	676,124.84	17.5	SCCC 5330 CONC. MONUMENT
	2,639,645.65	677,453.10	17.9	SCCC 5340 CONC. MONUMENT
	2,641,850.67	679,132.17	8.6	SCCC 5350 CONC. MONUMENT
	2,642,675.58	680,116.28	12.7	SCCC 5400 CONC. MONUMENT
728+67.97	2,644,159.65	682,049.85	16.6	SCCC 5405 CONC. MONUMENT
	2,645,603.16	683,821.13	17.0	SCCC 5410 CONC. MONUMENT
	2,646,880.15	685,386.97	17.95	SCCC 5415 CONC. MONUMENT
	2,648,376.88	686,635.00	10.69	SCCC 5420 CONC. MONUMENT
	2,649,652.67	687,883.14	12.7	SCCC 5425 CONC. MONUMENT
	2,650,686.81	688,944.21	10.05	SCCC 5430 CONC. MONUMENT
	2,652,478.96	690,800.32	11.5	SCCC 5435 CONC. MONUMENT
	2,653,780.81	692,031.05	11.5	SCCC 5440 CONC. MONUMENT
	2,655,210.24	693,474.38	11.9	SCCC 5445 CONC. MONUMENT
905+76.40	2,656,520.81	694,730.15	15.6	SCCC 5450 CONC. MONUMENT
	2,658,247.81	696,370.52	11.4	SCCC 5455 CONC. MONUMENT
	2,659,631.88	697,567.42	12.2	SCCC 5460 CONC. MONUMENT
	2,661,575.86	699,448.54	15.3	SCCC 5465 CONC. MONUMENT
	2,663,161.28	700,829.76	10.4	SCCC 5470 CONC. MONUMENT
	2,664,466.77	701,942.76	13.2	SCCC 5475 CONC. MONUMENT
	2,666,094.47	703,260.39	10.8	SCCC 5480 CONC. MONUMENT
1053+70.98	2,667,582.61	704,554.42	10.9	SCCC 5500 CONC. MONUMENT

NOTE: VERTICAL DATUM FOR MONUMENTS IS NAVD 88

NOTES:

1. ELEVATIONS ARE IN FEET AND REFER TO NAVD 88.

2. HORIZONTAL DATUM IS NAD 1983 STATE PLANE.

3. DATE OF SURVEY: JANUARY 2007.

4. HORIZONTAL AND VERTICAL CONTROL REFERENCE: SEE TABLE LOCATED ON THIS PLATE.

5. EXISTING RIPRAP AND OTHER SLOPE PROTECTION MATERIAL SHALL NOT BE DISTURBED.

6. THE CONTRACTOR SHALL NOT IN ANY MANNER DISTURB THE OCEAN BOTTOM IN AREAS DESIGNATED "ESSENTIAL FISH HABITAT (EFH)" ON THE PLANS. THIS INCLUDES BUT IS NOT LIMITED TO SUBMERGED PIPELINES, ANCHORS OF ANY TYPE, SPUDS, ETC. BEACH FILL WITHIN THE AREA OF THE DESIGNED BERM IS ALLOWED.

7. ACCESS FROM THE PUBLIC ROADS TO THE NOURISHMENT AREA SHALL BE THE CONTRACTORS RESPONSIBILITY TO BUILD, IF HE WISHES TO USE THE SITE.

9. CONTRACTOR SHALL DETERMINE IN THE FIELD THE EXACT LOCATION TO BEGIN EACH FILL SECTION TO AVOID PLACEMENT OF FILL LANDWARD OF THE PERPETUAL EASEMENT. ADDITIONAL DATA PERTAINING TO PERPETUAL EASEMENT TO BE PROVIDED BY THE GOVERNMENT AT THE PRECONSTRUCTION MEETING.

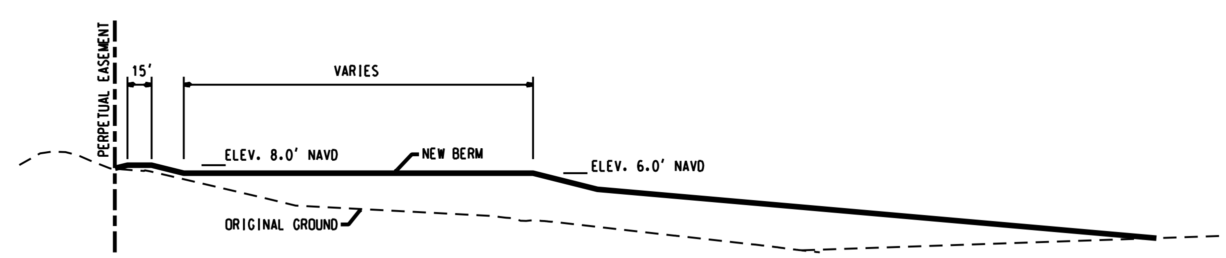
10. FOR BEACH FILL VOLUME REQUIREMENTS, SEE THE SPECIFICATIONS.

11. FILL PLACEMENT SHALL BE SEAWARD OF PERPETUAL EASEMENT LINE UNLESS OTHERWISE AUTHORIZED BY THE CONTRACTING OFFICER.

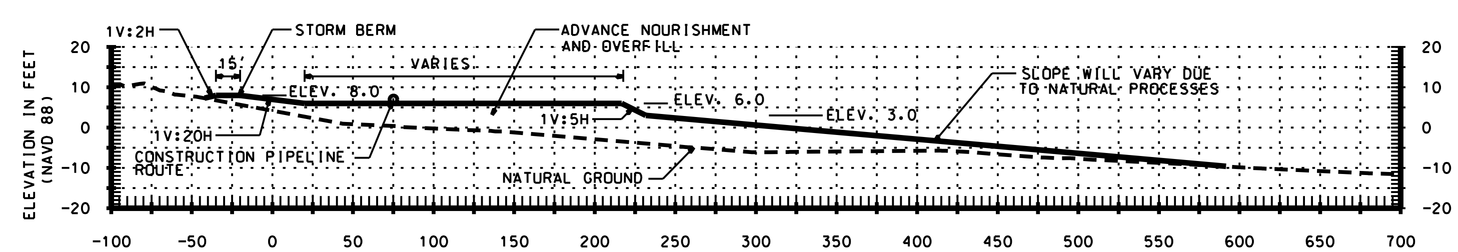
12. PIPELINE ACCESS FROM THE OCEAN SHALL BE BETWEEN STATIONS 681+00 AND 684+00. THE PIPELINE SHALL BE PERPENDICULAR TO THE SHORELINE BETWEEN THE ABOVE STATIONS AND SHALL EXTEND A MINIMUM OF 1,000 FEET SEAWARD FROM THE CONSTRUCTION LINE BEFORE CHANGING DIRECTION TO MINIMIZE POTENTIAL DAMAGE TO HARD BOTTOMS. NO OTHER PIPELINE ACCESS FROM THE OCEAN WILL BE ALLOWED EXCEPT AS SHOWN ON THE DRAWINGS.

13. OTHER PIPELINE ACCESS POINTS WHICH CAN BE UTILITIED DURING THE CONSTRUCTION OF THIS PROJECT ARE STATIONS 746+00 AND 749+00; 794+00 AND 797+00; 844+00 AND 849+00; 901+00 AND 907+00; 948+00 AND 953+00; 1000+00 AND 1005+00; OR 1047+00 AND 1052+00. IN ALL CASES THE PIPELINE SHALL BE PERPENDICULAR TO THE SHORELINE BETWEEN THE ABOVE STATIONS AND SHALL EXTEND A MINIMUM OF 1,000 FEET SEAWARD FROM THE CONSTRUCTION LINE BEFORE CHANGING DIRECTION TO MINIMIZE POTENTIAL DAMAGE TO HARD BOTTOMS. NO OTHER PIPELINE ACCESS FROM THE OCEAN WILL BE ALLOWED EXCEPT AS SHOWN ON THE DRAWINGS.

14. NUMEROUS EXISTING STRUCTURES ALONG THE BEACH INCLUDING SEAWALLS, DUNE WALKOVERS AND STORM DRAIN PIPES ARE PRESENT. THE CONTRACTOR SHALL TAKE PRECAUTION TO PROTECT THESE STRUCTURES FROM DAMAGE FROM HIS OPERATIONS. APPROXIMATELY 250 WALKOVERS AND 75 STORM DRAIN PIPES ARE LOCATED ON THE BEACH.



FILL PLACEMENT NEAR PERPETUAL EASEMENT LINE



TYPICAL STATION 580+00 TO 1045+00

SCALE: HOR. 1" = 50'
VERT. 1" = 20'

BCOE REVIEW

US Army Corps of Engineers
Charleston District

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
CHARLESTON, SOUTH CAROLINA

Designed by: VERNARD CLEVELAND | Date: MAY 2007
Drawn by: JVC | Ckd by: JVC
Reviewed by: JVC
Submitted by: CAROL WORKS

RFP NO. W912HN-07-R-0076
CONTRACT NO. W912HN-07-C-00XX

MYRTLE BEACH SHORE PROTECTION PROJECT REACH TWO

PLAN AND TYPICAL SECTIONS
CONSTRUCTION BERM – REACH 2

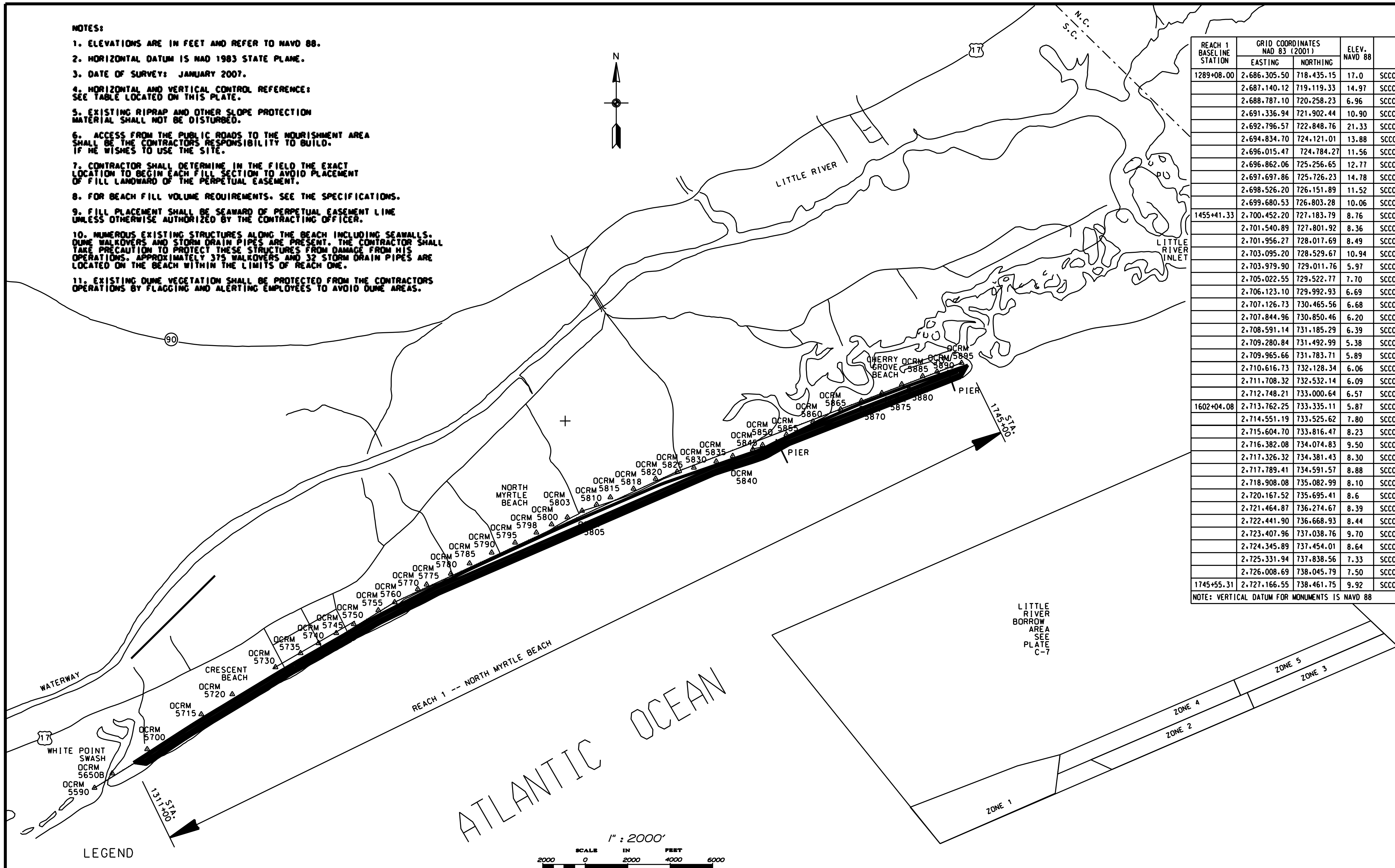
HORRY COUNTY SOUTH CAROLINA

SHEET REFERENCE NUMBER
C-008

SHEET 9 OF 21

NOTES:

1. ELEVATIONS ARE IN FEET AND REFER TO NAVD 88.
2. HORIZONTAL DATUM IS NAD 1983 STATE PLANE.
3. DATE OF SURVEY: JANUARY 2007.
4. HORIZONTAL AND VERTICAL CONTROL REFERENCE: SEE TABLE LOCATED ON THIS PLATE.
5. EXISTING RIPRAP AND OTHER SLOPE PROTECTION MATERIAL SHALL NOT BE DISTURBED.
6. ACCESS FROM THE PUBLIC ROADS TO THE NOURISHMENT AREA SHALL BE THE CONTRACTORS RESPONSIBILITY TO BUILD. IF HE WISHES TO USE THE SITE.
7. CONTRACTOR SHALL DETERMINE IN THE FIELD THE EXACT LOCATION TO BEGIN EACH FILL SECTION TO AVOID PLACEMENT OF FILL LANDWARD OF THE PERPETUAL EASEMENT.
8. FOR BEACH FILL VOLUME REQUIREMENTS, SEE THE SPECIFICATIONS.
9. FILL PLACEMENT SHALL BE SEAWARD OF PERPETUAL EASEMENT LINE UNLESS OTHERWISE AUTHORIZED BY THE CONTRACTING OFFICER.
10. NUMEROUS EXISTING STRUCTURES ALONG THE BEACH INCLUDING SEAWALLS, DUNE WALKOVERS AND STORM DRAIN PIPES ARE PRESENT. THE CONTRACTOR SHALL TAKE PRECAUTION TO PROTECT THESE STRUCTURES FROM DAMAGE FROM HIS OPERATIONS. APPROXIMATELY 375 WALKOVERS AND 32 STORM DRAIN PIPES ARE LOCATED ON THE BEACH WITHIN THE LIMITS OF REACH ONE.
11. EXISTING DUNE VEGETATION SHALL BE PROTECTED FROM THE CONTRACTORS OPERATIONS BY FLAGGING AND ALERTING EMPLOYEES TO AVOID DUNE AREAS.



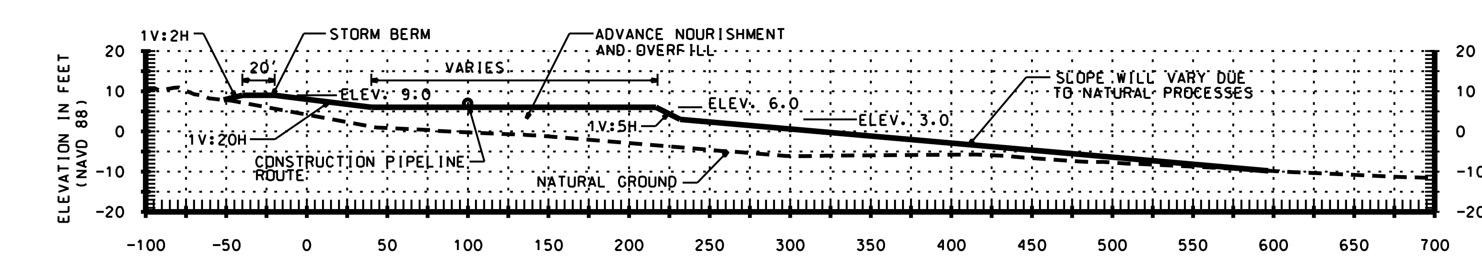
REACH 1 BASELINE STATION	GRID COORDINATES NAD 83 (2001)		ELEV. NAVD 88	DESCRIPTION
	EASTING	NORTHING		
1289+08.00	2,686,305.50	718,435.15	17.0	SCCC 5590 CONC. MONUMENT
	2,687,140.12	719,119.33	14.97	SCCC 5650B CONC. MONUMENT
	2,688,787.10	720,258.23	6.96	SCCC 5700 CONC. MONUMENT
	2,691,336.94	721,902.44	10.90	SCCC 5715 CONC. MONUMENT
	2,692,796.57	722,848.76	21.33	SCCC 5720 CONC. MONUMENT
	2,694,834.70	724,121.01	13.88	SCCC 5730 CONC. MONUMENT
	2,696,015.47	724,784.27	11.56	SCCC 5735 CONC. MONUMENT
	2,696,862.06	725,256.65	12.77	SCCC 5740 CONC. MONUMENT
	2,697,697.86	725,726.23	14.78	SCCC 5745 CONC. MONUMENT
	2,698,526.20	726,151.89	11.52	SCCC 5750 CONC. MONUMENT
	2,699,680.53	726,803.28	10.06	SCCC 5755 CONC. MONUMENT
1455+41.33	2,700,452.20	727,183.79	8.76	SCCC 5760 CONC. MONUMENT
	2,701,540.89	727,801.92	8.36	SCCC 5770 CONC. MONUMENT
	2,701,956.27	728,017.69	8.49	SCCC 5775 CONC. MONUMENT
	2,703,095.20	728,529.67	10.94	SCCC 5780 CONC. MONUMENT
	2,703,979.90	729,011.76	5.97	SCCC 5785 CONC. MONUMENT
	2,705,022.55	729,522.77	7.70	SCCC 5790 CONC. MONUMENT
	2,706,123.10	729,992.93	6.69	SCCC 5795 CONC. MONUMENT
	2,707,126.73	730,465.56	6.68	SCCC 5798 CONC. MONUMENT
	2,707,844.96	730,850.46	6.20	SCCC 5800 CONC. MONUMENT
	2,708,591.14	731,185.29	6.39	SCCC 5803 CONC. MONUMENT
	2,709,280.84	731,492.99	5.38	SCCC 5805 CONC. MONUMENT
	2,709,965.66	731,783.71	5.89	SCCC 5810 CONC. MONUMENT
	2,710,616.73	732,128.34	6.06	SCCC 5815 CONC. MONUMENT
	2,711,708.32	732,532.14	6.09	SCCC 5818 CONC. MONUMENT
	2,712,748.21	733,000.64	6.57	SCCC 5820 CONC. MONUMENT
1602+04.08	2,713,762.25	733,335.11	5.87	SCCC 5825 CONC. MONUMENT
	2,714,551.19	733,525.62	7.80	SCCC 5830 CONC. MONUMENT
	2,715,604.70	733,816.47	8.23	SCCC 5835 CONC. MONUMENT
	2,716,382.08	734,074.83	9.50	SCCC 5840 CONC. MONUMENT
	2,717,326.32	734,381.43	8.30	SCCC 5845 CONC. MONUMENT
	2,717,789.41	734,591.57	8.88	SCCC 5850 CONC. MONUMENT
	2,718,908.08	735,082.99	8.10	SCCC 5855 CONC. MONUMENT
	2,720,167.52	735,695.41	8.6	SCCC 5860 CONC. MONUMENT
	2,721,464.87	736,274.67	8.39	SCCC 5865 CONC. MONUMENT
	2,722,441.90	736,668.93	8.44	SCCC 5870 CONC. MONUMENT
	2,723,407.96	737,038.76	9.70	SCCC 5875 CONC. MONUMENT
	2,724,345.89	737,454.01	8.64	SCCC 5880 CONC. MONUMENT
	2,725,331.94	737,838.56	7.33	SCCC 5885 CONC. MONUMENT
	2,726,008.69	738,045.79	7.50	SCCC 5890 CONC. MONUMENT
1745+55.31	2,727,166.55	738,461.75	9.92	SCCC 5895 CONC. MONUMENT

NOTE: VERTICAL DATUM FOR MONUMENTS IS NAVD 88

LEGEND

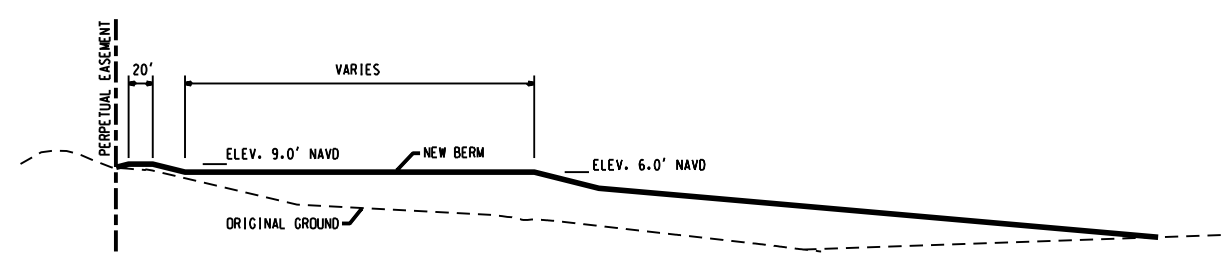
△ OCRM MONUMENT

- - - - BASELINE



TYPICAL STATION 1306+00 TO 1740+00

SCALE: HOR. 1" = 50'
VERT. 1" = 20'



FILL PLACEMENT NEAR
PERPETUAL EASEMENT LINE

BCOE REVIEW

US Army Corps of Engineers
Charleston District

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
CHARLESTON, SOUTH CAROLINA

RFP NO. W912HN-07-R-0076
CONTRACT NO. W912HN-07-C-00XX

Designed by: VERNARD CLEVELAND	Date: MAY 2007
Drawn by: JVC / Ckd by: JVC	Design file no.
Reviewed by: JVC	Drawing Code:
Submitted by: CAROL WORKS	File name: MBCRICI.DGN; Plot date: MAY 2007; Dwg scale: 1" = 2000'

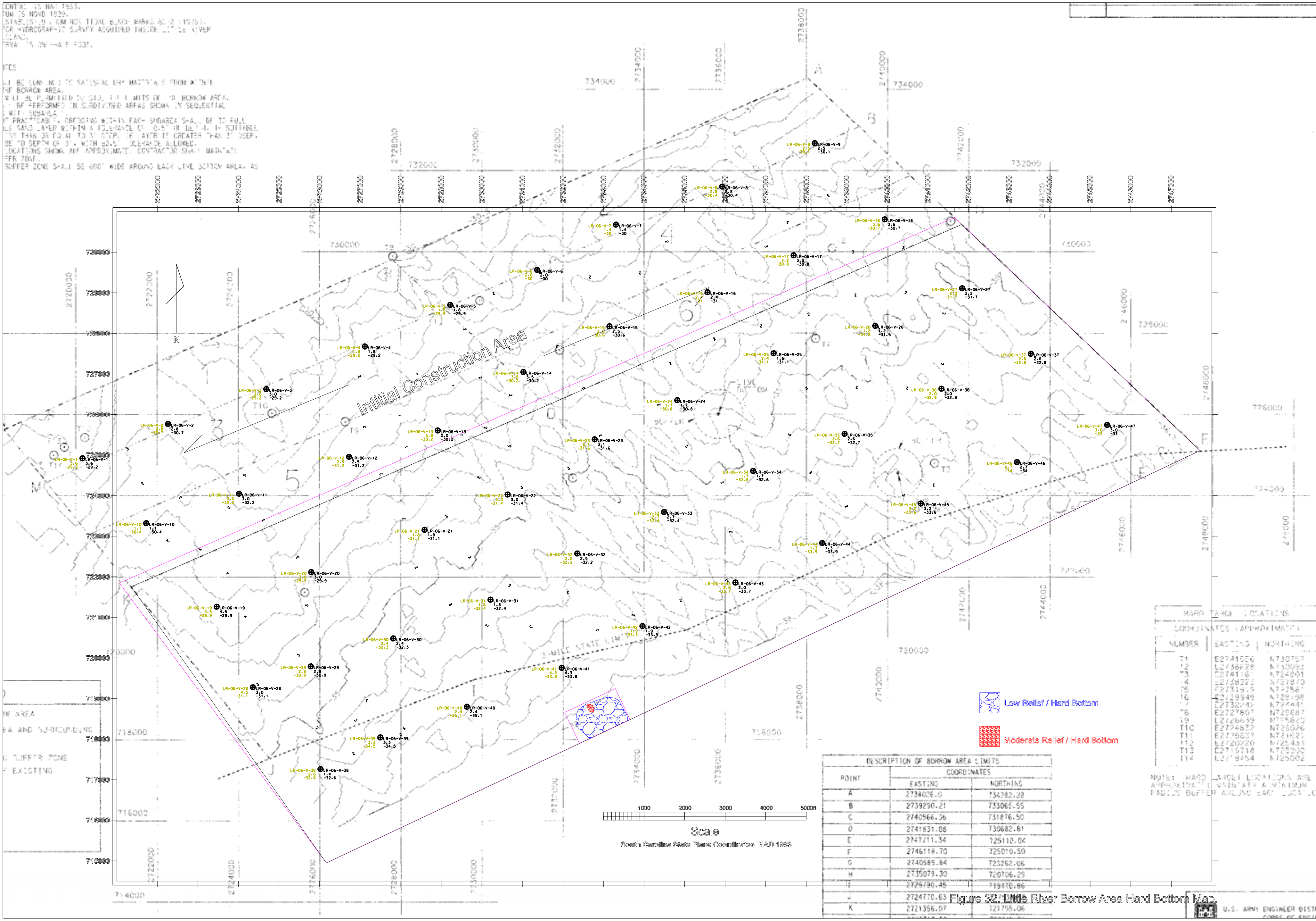
MYRTLE BEACH
SHORE PROTECTION PROJECT
REACH ONE

PLAN AND TYPICAL SECTIONS
CONSTRUCTION BERM – REACH 1

HORRY COUNTY SOUTH CAROLINA

SHEET REFERENCE NUMBER
C–001

SHEET 2 OF 21



POINT	COORDINATES EASTING	NORTHING
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B	2739290.21	733065.55
C	2740566.36	731876.50
D	2741831.88	730682.81
E	2747711.34	725110.04
F	2746118.70	725010.50
G	2740689.84	723262.06
H	2735079.30	720706.29
I	2729780.45	719470.86
J	2724770.63	[illegible]
K	2721356.07	721755.06

Figure 32. Little River Borrow Area Hard Bottom Map.

...\MBrch1LittleRiverBorrow.dgn 4/16/2007 3:37:37 PM

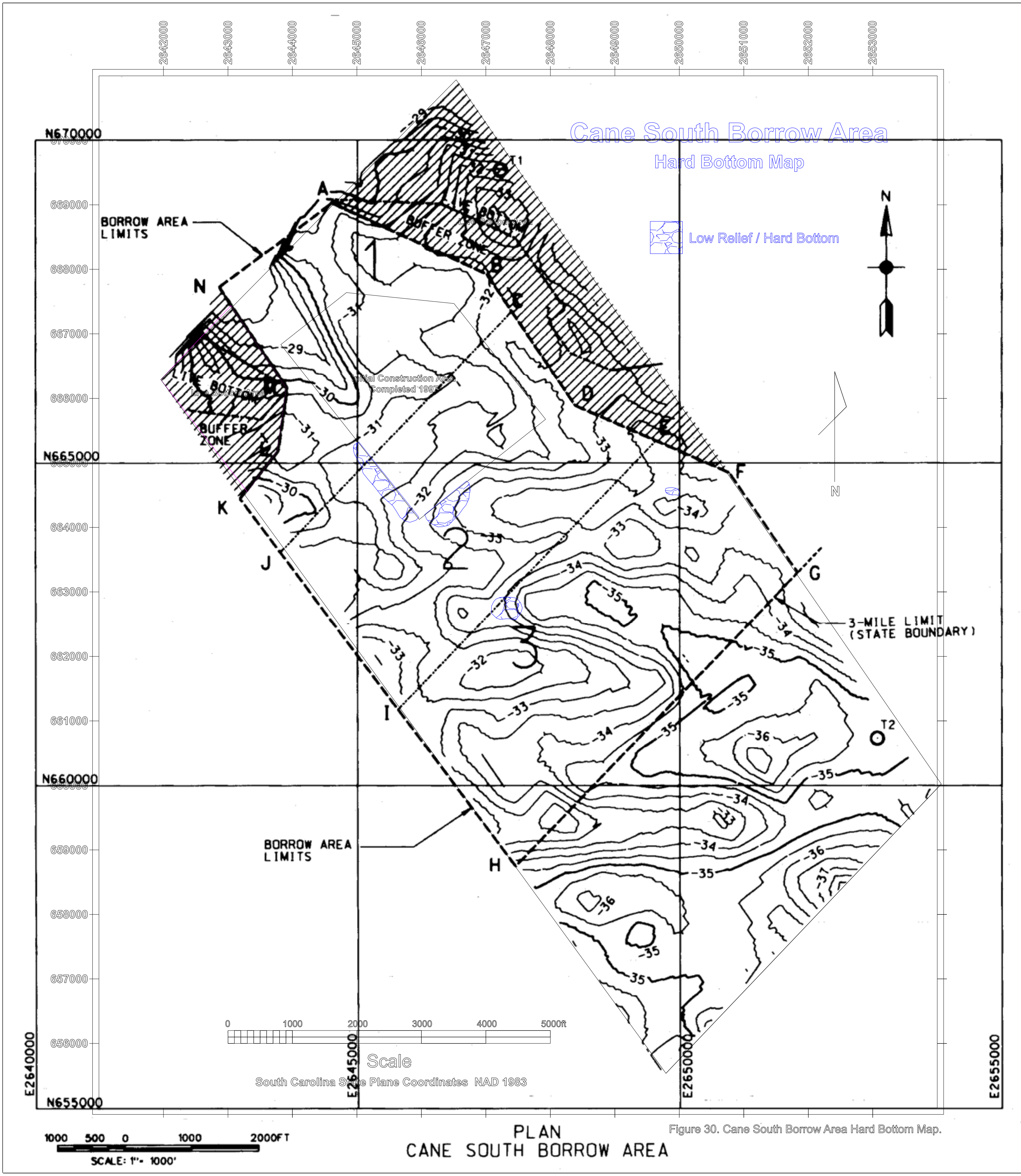


Figure 30. Cane South Borrow Area Hard Bottom Map.

...\Reach2\MBr2CaneSouthBorrow.dgn 4/16/2007 4:01:05 PM

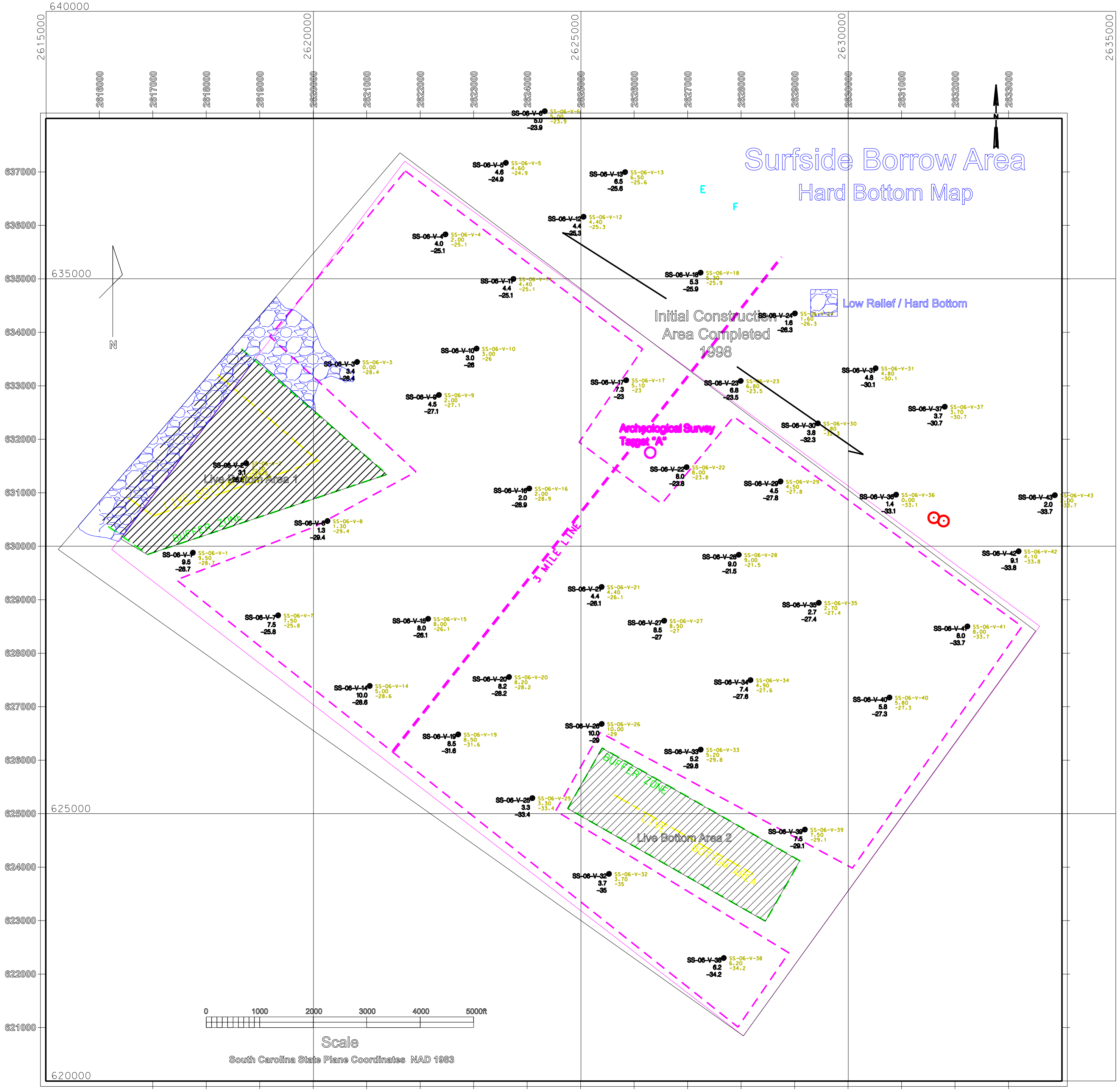


Figure 28. Surfside Borrow Area Hard Bottom Map.

Geo-technical Characterization of the Borrow Areas

Little River Borrow Area

Mean = 1.69 Φ
Std Deviation = 1.03 Φ
Passing #200 = 4.5%
Avg Usable Depth = 2.0'
Passing #10 = 97.0%

Cane South Borrow Area

Mean = 1.36 Φ
Std Deviation = 1.47 Φ
Passing #200 = 5.0%
Avg Usable Depth = 4.9'
Passing #10 = 88.4%

Surfside Borrow Area

Mean = 1.77 Φ
Std Deviation = 1.15 Φ
Passing #200 = 5.1%
Avg Usable Depth = 4.5'
Passing #10 = 93.3%

Appendix 4

Coastal Consistency Coordination

DHEC

PROMOTE PROTECT PROSPER

C. Earl Hunter, Commissioner

Promoting and protecting the health of the public and the environment.

April 24, 2006

Mr. Joseph A. Jones
Chief, Planning Branch
Charleston District, Corps of Engineers
69A Hagood Ave.
Charleston, SC 29403

2006 MAY -3 PM 2: 18

RE: Emergency Beach Renourishment, Myrtle Beach, SC

Dear Mr. Jones;

I am writing in response to your recent letter to Carolyn Boltin, DHEC-OCRM Deputy Commissioner, regarding the proposed emergency beach renourishment along the "Grand Strand" in the vicinity of Myrtle Beach, under the authority of Public Law 84-99. My purpose in writing is to endorse the concept of additional beach renourishment in the Myrtle Beach area in response to the erosion caused by Hurricane Ophelia in September 2005.

It's my understanding that the same offshore borrow source used in the previous 1996-1998 renourishment project will again be used for this additional renourishment work, and that the project will be paid for entirely with federal funds. Based on this information I concur that the South Carolina Coastal Zone Management Act Consistency Certification issued on October 29, 1992, for the original renourishment project will also apply to the proposed emergency renourishment project to be conducted later this year. If the Charleston District elects to issue a new Public Notice for this work, DHEC-OCRM will issue a new federal consistency certification in response.

Please feel free to contact me if you require any additional information.

Sincerely,

William C. Eiser
Project Manager

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
Ocean and Coastal Resource Management
Charleston Office • 1362 McMillan Avenue • Suite 400 • Charleston, SC 29405
Phone: (843) 744-5838 • Fax: (843) 744-5847 • www.scdhec.gov

OCT 30 1992
Jim W.

October 29, 1992

SOUTH CAROLINA COASTAL COUNCIL

Ashley Corporate Center
4130 Faber Place
Suite 300
Charleston, S.C. 29405
(803) 744-5838
FAX 744-5847

William W. Jones, Jr.
Chairman

H. Wayne Beam, Ph.D.
Executive Director

LTC Mark E. Vincent
District Engineer
U. S. Army Corps of Engineers
Post Office Box 919
Charleston, SC 29402

Re: Department of the Army
Grand Strand Renourishment
(E.I.S. Draft)
Various Counties
Federal Consistency

Dear Colonel Vincent:

The staff of the S. C. Coastal Council has reviewed the above referenced public notice and certifies that the project will be consistent to the maximum extent practicable with the State's Coastal Zone Management Program. The Council supports the comments offered by the U. S. Fish & Wildlife Service, the National Marine Fisheries Service and the S. C. Wildlife & Marine Resources Department. It is recommended that the beach renourishment be monitored in the following format:

1. Eight sets of survey data from all Coastal Council monitoring stations within the construction limits and stations within 2,000 feet of each end of the project must be submitted to the Coastal Council.

2. Surveys for year one will be taken at three month intervals, beginning at the time of project construction completion.

3. Semi-annual surveys of the project beach during years two and three after project construction must be performed and submitted to the Coastal Council.

4. All surveys should be beach profiles which begin at the most landward of the following three locations: primary oceanfront sand dune, erosion controls device, or the landward limit

of the fill material; extend perpendicular to the shoreline; and terminate at low tide wading depth (approximately -5 ft. MSL).

Sincerely,

H. Stephen Snyder
Director of Planning
and Certification

DH AST:0264a

cc: Dr. H. Wayne Beam
Mr. Christopher L. Brooks
Ms. Debra Hernandez
U. S. Fish & Wildlife Service
S. C. Wildlife & Marine Resources Department
National Marine Fisheries Service
S. C. Department of Health & Environmental Control

Appendix 5

Essential Fish Habitat Assessment

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701-5511
(727) 824-5317; FAX (727) 824-5300
http://sero.nmfs.noaa.gov/

June 4, 2007 F/SER4:KD/pw

Lt. Colonel Edward R. Fleming
District Engineer
Department of the Army
Charleston District Corps of Engineers
69-A Hagood Avenue
Charleston, South Carolina 29403-5107

Dear Colonel Fleming:

NOAA's National Marine Fisheries Service (NMFS) has reviewed the two documents provided to us on April 17, 2007, in support of the continued nourishment of beaches in Georgetown and Horry Counties, South Carolina. The documents provided to NMFS were the draft *Essential Fish Habitat Assessment, Myrtle Beach and the Grand Strand Storm Damage Reduction Project, Horry County, South Carolina, (*December 2006) and the draft *2007 Myrtle Beach Renourishment Project: Beach, Nearshore Reef and Borrow Site Monitoring Scope of Work*. Additional information on the project is contained within *Myrtle Beach and Vicinity Shore Protection Project Environmental Impact Statement (EIS),* which was prepared in January 1993. The Myrtle Beach Storm Damage Reduction Project was authorized for construction by Section 101 of the Water Resources Development Act of 1990, Public Law 101-640. Section 934 of the Water Resources Development Act of 1986, Public Law 99-662, authorized the Corps of Engineers to continue periodic beach nourishment for 50 years after initiation of construction (in this case until 2046). The currently proposed beach nourishment would involve placing approximately 2.91 million cubic yards of beach quality sand along the shore. The total distance of the project is 25.4 miles and consists of three reaches: reach 1 begins at North Myrtle Beach; reach 2 at Myrtle Beach, and reach 3 extends to Garden City/Surfside Beach. The initial determination of the Charleston District is that the project will not have a significant adverse impact on essential fish habitat (EFH) or federally managed fishery species. As the nation's federal trustee for the conservation and management of marine, estuarine, and anadromous fishery resources, the following comments and recommendations are provided pursuant to authorities of the Fish and Wildlife Coordination Act and the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act).

Beaches and nearshore areas along the Grand Strand provide habitat for numerous species that serve as prey for finfish and crustaceans that have economic and recreational importance, such as southern flounder (*Paralichthys lethostigma*), Florida pompano (*Trachinotus carolinus*), summer flounder (*Paralichthys dentatus*), red drum (*Sciaenops ocellatus*), spot (*Leiostomus xanthurus*), bluefish (*Pomatomus saltatrix*), white shrimp (*Litopenaeus setiferus*), and blue crab (*Callinectes sapidus*). Sea turtles also are common in the nearshore coastal waters of the project area, and the beach is used by sea turtles, including the threatened loggerhead sea turtle (*Caretta caretta*), for nesting. The influx of transient fauna and heightened biological activity in the late spring and summer through late fall necessitates certain work limitations if significant harm to living marine resources is to be avoided. Ideally, beach nourishment should be restricted to winter months when possible.

The South Atlantic Fishery Management Council (SAFMC) provides detailed information on types and locations of EFH in a comprehensive amendment that applies to all fishery management plans prepared by the SAFMC. The amendment was prepared in 1998 as required by the Magnuson-Stevens Act. SAFMC has identified the surf zone of ocean beaches as EFH for sub adult and adult red drum. As juvenile red drum develop into sub adults and adults, they utilize and become concentrated in progressively higher salinity estuarine and beachfront surf zones where their prey is most abundant. Areas of hard bottom habitat also are present within the project area, and the SAFMC has designated hard bottom habitat at EFH for snapper-grouper species and coastal migratory pelagic species. The importance of hard bottom habitat is also addressed in the SAFMC's policy (dated March 2003) on protecting EFH from large-scale coastal engineering projects, which stresses the importance of examining cumulative impacts to this EFH.

In addition to being EFH, the SAFMC has designated a specific area of hard bottom habitat along the Grand Strand known as Hurl Rocks as a Habitat Area of Particular Concern (HAPC), which is a special category of EFH designed to protect habitats that are rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in environmentally stressed areas. The HAPC designation for Hurl Rocks applies to the area parallel to the shore for approximately 6 miles within reaches 2 and 3 of the project area, and also includes a separate area occurring perpendicular to reach 3 that extends out approximately 6 miles and is approximately 1 mile wide.

Hurl Rocks was originally identified by the COE in the *Myrtle Beach and Vicinity Shore Protection Project EIS*, which stated: "There are no wildlife preserves, important agricultural lands, wild and scenic rivers, natural landmarks, recognized scenic areas, or any other environments of special interest with the exception of Hurl Rock, located where it could be impacted by the proposed project. Hurl Rock, a limestone outcropping at the same elevation as the beach, will be covered over with sand." This statement was written before the area was designated as an EFH-HAPC by the SAFMC. Deposition of nourishment sand prior to 1998 and/or natural erosion of Hurl Rocks adjacent to the shore appear to have resulted in burial of this limestone outcropping.

During discussion of this project, the Charleston District has stated to NMFS that impacts to the surf and beach zone sections of the designated Hurl Rocks HAPC will be minimized by not placing dredge pipes over these areas. In addition, the Charleston District will minimize impacts to hard bottom within the borrow areas by placing a 600-foot buffer around any hard bottom habitat that occurs within or adjacent to the borrow sites.

The Charleston District will work with the South Carolina Department of Natural Resources and Coastal Carolina University to monitor biota within the vicinity of the project. Specific objectives of the monitoring include: (1) Documenting changes in beach profile and determining the ecological impacts on and recovery rates of sediment characteristics and burrowing ghost crabs on nourished beaches; (2) Determining the impacts on nearshore hard-bottom habitats and biological recruitment to those habitats; and (3) Documenting the impacts on and recovery of native bathymetry, sediment characteristics, and benthic infaunal communities in sand borrow areas. If results of the monitoring show the nourishment activities have significantly impacted EFH, NMFS will work with the Charleston District to determine if mitigation is necessary.

Based on the information currently available concerning the impacts likely to result from the proposed nourishment project, NMFS concludes that potential adverse impacts to EFH and other living marine resources could occur as a result of the proposed work. Section 305(b)(4)(A) of the Magnuson-Stevens Act requires NMFS to provide EFH conservation recommendations when an activity is expected to adversely impact EFH. Based on this requirement, NMFS provides the following:

EFH Conservation Recommendations

1. To the extent practicable, work shall be limited to seasonal periods of low biological activity. For optimal minimization of impacts to intertidal organisms, deposition of beach fill should be limited to the months of December through April.

2. Buffers 600 feet wide shall be placed around all hard bottom areas located within and near the borrow areas and no excavation or mooring shall be allowed within these areas.

3. Dredging shall be confined to locations that are devoid of significant accumulations of clay, mud, or other materials that might substantially elevate turbidity and cause sedimentation over large areas.

4. In the event that significant impacts to EFH are identified through monitoring, the Charleston District shall consult with NMFS to determine if compensatory mitigation measures are appropriate.

In accordance with Section 305(b)(4)(B) of the Magnuson-Stevens Act and its implementing regulations at 50 CFR 600.920(k), your office is required to provide a written response to our EFH conservation recommendations within 30 days of receipt. Your response must include a description of measures to be required to avoid, mitigate, or offset the adverse impacts of the proposed activity. If your response is inconsistent with our EFH conservation recommendations, you must provide a substantive discussion justifying the reasons for not implementing the recommendations. If it is not possible to provide a substantive response within 30 days, the Corps of Engineers should provide an interim response to NMFS, to be followed by the detailed response. The detailed response should be provided in a manner to ensure that it is received by NMFS at least ten days prior to final approval of the action.

Finally, in accordance with the Endangered Species Act of 1973, as amended, it is the responsibility of the lead federal agency for an activity to review and identify any action that may affect endangered or threatened species and their habitat. Determinations involving species under NMFS jurisdiction should be reported to our Protected Resources Division at the letterhead address. If it is determined that the activities may adversely affect any species listed as endangered or threatened and under NMFS purview, then formal consultation must be initiated.

We appreciate the opportunity to provide these comments. Please direct related correspondence to the attention of Ms. Kay Davy at our Charleston Area Office. She may be reached at (843) 953-7202 or by e-mail at Kay.Davy@noaa.gov .

Sincerely,

/ for

Miles M. Croom
Assistant Regional Administrator
Habitat Conservation Division

cc: (via electronic mail)

OCRM, Charleston
SCDNR, Charleston
SAFMC, Charleston
EPA, Atlanta
FWS, Charleston
F/SER4
F/SER Ruebsamen
F/SER47 Davy

DEPARTMENT OF THE ARMY
CHARLESTON DISTRICT, CORPS OF ENGINEERS
69A HAGOOD AVENUE
CHARLESTON, SOUTH CAROLINA 29403-5107

REPLY TO
ATTENTION OF

July 12, 2007

Planning Branch

Mr. Miles M. Croom
Assistant Regional Administrator
NMFS Habitat Conservation Division
219 Fort Johnson Road
Charleston, South Carolina 29412-9110

Dear Mr. Croom:

This letter is in response to your letter dated June 4, 2007, addressed to Lt.Col. Edward Fleming of the Charleston District Corps of Engineers, which provides comments and EFH conservation recommendations for the Myrtle Beach and Grand Strand Storm Damage Reduction Project. This correspondence is intended to be the official response of the Charleston District in accordance with Section 305(b)(4)(B) of the Magnuson-Stevens Act and its implementing regulations at 50 CFR 600.920(k).

Measures to Avoid, Mitigate or Offset Adverse Impacts of the Proposed Activity

1. To the extent practicable, construction activities will take place in seasons of limited biological activity. Currently, the plan is to begin construction in the month of November, 2007. This date was chosen in an attempt to avoid seasonal activity of certain biological resources. Constraints associated with the cost and time of building this project make it impractical to perform construction only during the December to April window as recommended.

2. No-dredging buffers of at least 600 feet have been prescribed around all hard bottom areas within the defined borrow sites. This prohibition extends to mooring, anchoring, laying of submerged pipeline, and lowering of spuds within the exclusion zone. In addition, all areas of the defined Essential Fish Habitat-Habitat Area of Particular Concern known as Hurl Rocks have been given the same protections.

3. The Charleston District has gone to great lengths to identify suitable borrow material that is compatible with the existing beach material. Methods employed to identify compatible sands include side scan sonar and vibra-core borings. In addition, it has been stipulated that unsuitable material (clay, mud and debris) that is inadvertently dredged will be removed from the disposal area and disposed of in an approved land fill.

4. As your review has affirmed, the Charleston District has gone to significant lengths and expense to identify and document impacts to EFH before, during, and after the nourishment cycle. After the final report by the South Carolina Department of Natural

Resources, if it is determined that significant impacts to EFH have occurred as a result of this project, the Charleston District will consult with NMFS to determine the appropriate action.

Finally, the Charleston District will comply fully with the terms and conditions set forth in the 1997 Regional Biological Opinion for Corps' dredging activities in the South Atlantic region. Reporting and coordination will be addressed to the NMFS Protected Resources Division as indicated.

Thank you for your comments and your efforts concerning the Grand Strand Storm Damage Reduction Re-nourishment. If there are any questions or additional comments that require our attention, please contact Mr. Shawn Boone by phone at (843) 329-8158 or by email at shawn.a.boone@usace.army.mil.

Respectfully,

Joseph A. Jones
Chief, Planning Branch

Essential Fish Habitat Assessment

Myrtle Beach and the Grand Strand
Storm Damage Reduction Project

Horry County, South Carolina

December 2006

Table of Contents

<u>Essential Fish Habitat Assessment</u>

Myrtle Beach and the Grand Strand Storm Damage Reduction Project

1.0 INTRODUCTION

The purpose of this document is to present and record the findings of the Essential Fish Habitat (EFH) Assessment conducted for the Myrtle Beach and the Grand Strand Storm Damage Reduction Project as required by the Magnuson-Stevens Fishery Conservation and Management Act of 1976, as amended through 1996 (Magnuson-Stevens Act). The objectives of this EFH Assessment are to describe how the actions of the U.S. Army Corps of Engineers (USACE), their non-Federal sponsors and the Minerals Management Service (Department of Interior) potentially influence the quality of habitat designated by the National Marine Fisheries Service and the South Atlantic Fisheries Management Council.

Adjacent to the project area, there is a designated Habitat Area of Particular Concern (HAPC) – Essential Fish Habitat labeled Hurl Rocks. Hurl Rocks was designated as an HAPC after the initial construction of the Grand Strand Project. This area has been defined and its relationship to the project area has been displayed in Figure 1.

2.0 PROJECT DESCRIPTION

The Myrtle Beach Storm Damage Reduction Project was authorized for construction by Section 101 of the Water Resources Development Act of 1990, Public Law 101-640. Section 934 of the Water Resources Development Act of 1986 (WRDA86), Public Law 99-662, authorized the Government to extend the Federal participation in periodic beach nourishment until 2046. The final Environmental Impact Statement (EIS) was completed in January 1993 with the Record of Decision (ROD) being signed on 1 November 1993.

The authorized project calls for construction of a protective beach in three separable reaches, North Myrtle Beach (Reach 1), Myrtle Beach (Reach 2), and Garden City/Surfside Beach (Reach 3). The total project reach is 25.4 miles. Initial construction, as identified in the October 1987 Feasibility Report, consisted of constructing a protective berm to an elevation of between 7 and 11 feet above the National Geodetic Vertical Datum (NGVD) and a top width of 15 feet for all three project reaches. These project dimensions were later modified with the completion of a General Design Memorandum (GDM) in March 1993. In addition to being separable reaches, each reach also has differing non-federal sponsors.

The authorized project recommended utilization of borrow material obtained from inland sites, and that additional offshore investigation be performed during preconstruction studies. The offshore borrow sites eventually chosen to be mined for the initial nourishment of all three reaches are outlined in Figure 1 and exist both within and beyond the three-mile State jurisdictional limit onto the outer continental shelf. .

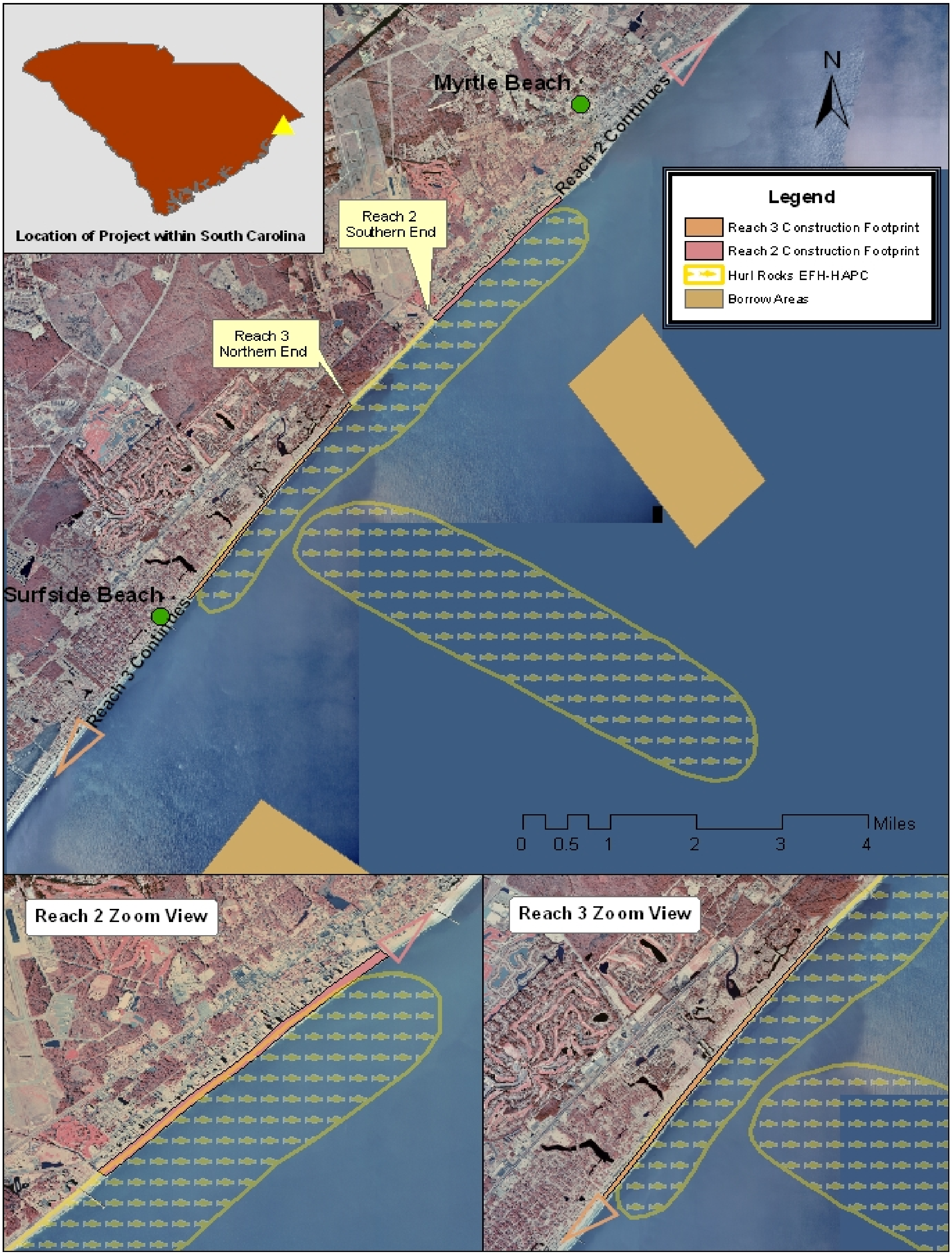


Figure 1 – Project Location and Relation to Hurl Rocks EFH-HAPC

This re-nourishment cycle is anticipated to be constructed with either a cutter-head dredge or a hopper dredge, booster pump, and land based heavy equipment (i.e. bulldozers and front-end loaders). The borrow area will be subdivided into separate, smaller zones. The dredge will remove the sand to a depth not to exceed ten feet within the borrow areas. The contract specifications will require the contractor remove material completely from one borrow zone prior to moving to another borrow zone. Hardbottom structures and archeological artifacts will be avoided and have a buffer placed around them to exclude the area from dredging. In addition to borrow area requirements, the contract specifications will require that the contractor control his beach placement techniques. The beach renourishment is anticipated to continue 24 hours per day, 7 days per week for a period of approximately 15 months including mobilization. Noise pollution and construction activities will be monitored to ensure minimum disturbance to the surrounding community.

Initial construction of Reach 1 of the project was completed in May 1997. Initial placement consisted of 57.7 cubic yards per linear foot of beach. This quantity includes material for the protective berm, advanced nourishment and overfill ratio, for a total placement of 2,622,900 cubic yards. Future renourishment of 490,000 cubic yards was planned for every ten years. According to this plan, North Myrtle Beach (Reach 1) would be due its first renourishment in 2007. Based on current conditions Reach 1 is in need of 702,600 cubic yards to restore the project to full dimension.

The first nourishment cycle of Reach 2 was completed in December 1997. Initial placement consisted of 47.1 cubic yards per linear foot of beach. This quantity includes material for the protective berm, advanced nourishment and overfill ratio, for a total placement of 2,250,000 cubic yards. Future renourishment of 440,000 cubic yards was planned for every eight years with the final nourishment being 550,000 cubic yards for the last ten years of project life. According to this plan, Myrtle Beach (Reach 2) was due its first renourishment in 2005. Due to the lack of available funds, the first renourishment was rescheduled for 2008. The current effort would require a volume of 1,442,500 cubic yards of material to return the beach to the full design template.

Reach 3 of the Myrtle Beach, South Carolina Shore Protection Project would provide restoration of approximately 7.7 linear miles of beach in Horry and Georgetown Counties extending from 1.2 miles south of the Horry/Georgetown County line to Myrtle Beach State Park in Horry County. Initial project construction was completed in November 1998 with placement of 1,517,494 cubic yards. Full project restoration provides for restoration of the advance nourishment over the entire 7.7-mile project length with a volume of 773,000 cubic yards.

3.0 ESSENTIAL FISH HABITAT (EFH)

This section describes the Essential Fish Habitat (EFH) located in the project area and describes their general character. NOAA Fisheries' authority to manage EFH is directly related to those species covered under fisheries management plans (FMP) in the United States. EFH sections of FMPs include detailed life history and habitat information used to describe and identify EFH for each plan's federally managed species. EFH information can also be found via the internet at each of the NOAA Fisheries Regional websites or on the NOAA Fisheries Headquarters website.

Essential Fish Habitat (EFH) can consist of both the water column and the underlying surface (e.g. seafloor) of a particular area. Areas designated as EFH contain habitat essential to the long-term survival and health of our nation's fisheries. Certain properties of the water column such as temperature, nutrients, or salinity are essential to various species. Some species may require certain bottom types such as sandy or rocky bottoms, vegetation such as seagrasses or kelp, or structurally complex coral or oyster reefs.

EFH includes those habitats that support the different life stages of each managed species. A single species may use many different habitats throughout its life to support breeding, spawning, nursery, feeding, and protection functions. EFH encompasses those habitats necessary to ensure healthy fisheries now and in the future.

3.1 Water Column

The water column serves as EFH for all managed species and their prey, at various life stages, by providing habitat for spawning, breeding, feeding and growth. Species (and life stages) for which the column of seawater has been designated as EFH are discussed in the following section, Managed Fish Species (Section 4.0).

3.2 Live/Hard Bottom & Hurl Rocks Habitat

Hard bottom constitutes a group of communities characterized by a thin veneer of live corals and other biota overlying assorted sediment types. Hard bottom are usually of low relief and on the continental shelf; many are associated with relic reefs where the coral veneer is supported by dead corals.

Ecologically and geologically, hard bottom and hard banks are diverse categories. Both habitats include corals but typically not the carbonate structure of a patch or outer bank coral reef nor the lithified rock of lithoherms, a type of deepwater bank. Diverse biotic patterns have evolved in many of these communities because of their geologic structure and geographic location. Hard bottom is common on rocky ledges, overlying relic reefs, or on a variety of sediment types. In each case, species compositions may vary dependent upon water depth and associated parameters (light, temperature, etc.).

The Hurl Rocks Essential Fish Habitat – Habitat Area of Particular Concern, located in the project footprint and adjacent to the project, is an area of sporadic hardbottom structures. There are no formal descriptions of the area with regard to structural or biological composition. The criteria for designating the habitat is based on the knowledge of the existence of low-relief hardbottom structures in the designated area, the fact that this type of habitat is sufficiently rare and the assumption that such habitat is used by species that require such structural conditions.

Essential Fish Habitat	Presence In / Near Project	Potential Impacts Dredge	Potential Impacts Beach Renourishment
Marine Areas			
Live / Hard Bottoms	yes	yes	yes
Coral & Coral Reefs	offshore	no	no
Artificial / Manmade Reefs	offshore	no	no
Sargassum	offshore	no	no
Water Column	yes	yes	yes
Area - Wide			
Council-designated Artificial Reef Special Management Zones	no	no	no
Hermatypic (reef-forming) Coral Habitat & Reefs	offshore	no	no
Hard Bottoms	yes	yes	yes
Hoyt Hills	distant offshore	no	no
Sargassum Habitat	offshore	no	no
State-designated Areas of Importance for Managed Species (PNAs)	no	no	no
Submerged Aquatic Vegetation (SAV)	no	no	no
South Carolina			
Charleston Bump	distant offshore	no	no
Hurl Rock	yes	yes	yes
Broad River	distant offshore	no	no

Table 1: Essential Fish Habitat Impacts

4.0 MANAGED FISH SPECIES

This section is intended to give a brief description of the fish species and groups of species that potentially occur in the project area and are managed under the Magnuson-Stevens Act. The majority of the information has been taken from the respective Fishery Management Plan for the specific group.

4.1 Shrimp

The proposed project is located in an area identified as EFH for the commercially and recreationally valuable penaeid shrimp (Shrimp Fishery Management Plan, SAFMC 1998). For these species, all inshore nursery areas, brackish and salt marshes (especially the edges), unvegetated, unconsolidated bottoms, and inter-tidal flats are the affected EFH for post larval and juvenile shrimp. While they spend their fastest growth phase in estuarine waters, the large adults migrate to coastal and offshore waters to spawn and grow. Adults are least common, therefore, in the fall and early winter after this migration occurs.

Brown, white and pink shrimp species eat a variety of other invertebrates, decaying plant matter, and other types of organic debris. No Habitat Areas of Particular Concern have been identified for shrimp in the proposed project area.

4.2 Snapper Grouper

The fish community referred to as the snapper-grouper fishery consists of demersal tropical and subtropical species which generally occupy the same type of habitat and are caught by common fishing methods on the Continental Shelf off the southeastern United States. This fishery includes the families of snappers (Lutjanidae), sea basses and groupers (Serranidae), porgies (Sparidae), tilefishes (Malacanthidae), grunts (Pomadasyidae), triggerfishes (Balistidae), wrasses (Labridae), and jacks (Carangidae)

- Snappers

Mutton, gray, red, and yellowtail snapper and schoolmaster have been recorded from New England to southeastern Brazil, including the Gulf of Mexico. Red snapper occur only as far south as Yucatan. All are rare north of Cape Hatteras.

Lane, mahogany, silk, blackfin, and vermilion snapper have been recorded from the Carolinas to at least the northern coast of South America. Blackfin snapper reportedly occur only as far south as the Lesser Antilles.

Cubera snapper have been recorded from South Florida to Brazil, including the Central American Coast. Black snapper have been reported from the Florida Keys, Cuba, and various West Indies Islands, and Queen snapper from deep tropical waters off southernmost Florida and the Bahaman Banks.

- Sea Basses and Groupers

Black sea bass are the most widely distributed of the listed sea basses, occurring from Maine to Florida and the eastern Gulf of Mexico with the greatest numbers between Cape Cod and Cape Canaveral. Two distinct populations of black sea bass have been identified, one north of Cape Hatteras and one between Cape Hatteras and Cape Canaveral.

Red, snowy, Warsaw, and black grouper, as well as gag and rock hind have been reported from New England to southeastern Brazil, including Bermuda and the Gulf of Mexico. Gag reportedly do not occur in the West Indies. These species are not common north of Cape Hatteras.

Scamp have been recorded from Massachusetts to Yucatan. However, it may be easily confused with yellowmouth grouper which appear to be common in the southern part of this range through Central America.

Speckled hind occur 'from North Carolina through Florida. Nassau grouper and red hind extend southward to Brazil. Other tropical groupers in the complex include jewfish, misty grouper, Coney, yellowedge grouper, graysby, yellowfin grouper and tiger grouper, all of which have been reported from Bermuda and Florida to southeastern Brazil.

- Porgies

Porgies are more temperate than other families of the snapper-grouper fishery. They are also well represented in the tropics. Red porgy have been reported from New York to Argentina, including the Gulf of Mexico. They are quite common in the South Atlantic Bight. Whitebone and longspine porgy have also been reported from this South Atlantic region. Scup reportedly occur from Nova Scotia to Florida. Sheepshead are also limited to near-shore waters, occurring from New England to Brazil, including the Gulf of Mexico. Jolthead porgy occur in this range and around Bermuda. Saucereye porgy have a similar range except they occur northward only to North Carolina. Knobbed porgy occur from North Carolina to Yucatan.

- Grunts

The majority of grunts listed in the management unit are tropical species, ranging from southern Florida to Brazil, as well as Bermuda. These include margate, cottonwick, Spanish grunt, and sailor's choice. Smallmouth grunt, porkfish and black margate are similarly distributed except they occur further north on the Florida coast. French and blue striped grunts occur as far north as South Carolina. White grunt and tomtate range northward to Virginia and New England respectively.

- Tile fishes

Golden tilefish occur from Nova Scotia to Key West and throughout the Gulf of Mexico. Blueline tilefish, also a continental species, have been reported from Virginia to Florida and in the eastern Gulf of Mexico. Sand tilefish are most abundant in subtropical and tropical waters, but range from Cape Lookout, North Carolina southward throughout the Gulf of Mexico and Caribbean.

- Triggerfishes

Gray triggerfish occur from Nova Scotia to Argentina and the Gulf of Mexico. Queen triggerfish have been recorded from New England to southeastern Brazil, including the Gulf of Mexico. These two species occur on both sides of the Atlantic. Ocean triggerfish are distributed from New England to the Lesser Antilles and the Gulf of Mexico. They also occur in Bermuda.

- Wrasses

Puddingwife range from North Carolina to Brazil, and also occurs in Bermuda. Hogfish are known from North Carolina to the northern coast of South America, including Bermuda, the Gulf of Mexico, and the coast of Central America.

- Jacks

Greater amberjack are known from New England to Brazil, including the Gulf of Mexico. Almaco jack are similarly distributed, ranging north to New Jersey and south to Buenos Aires, Argentina. These two species occur on both sides of the Atlantic. Blue runner occur from Nova Scotia to southeastern Brazil, barjack from New Jersey to the

Lesser Antilles. Crevalle jack have been recorded from Nova Scotia to Uruguay, and yellowjack from New England to Brazil. These four species also inhabit the Gulf of Mexico.

The information above has been taken from the Fishery Management Plan for the Snapper-Grouper Fishery of the South Atlantic Region.

4.3 Sharks

Shark habitat can be described in four broad categories: (1) coastal, (2) pelagic, (3) coastal - pelagic, and (4) deep-dwelling. Coastal species inhabit estuaries, the nearshore and waters of the continental shelves, *e.g*., blacktip (*Carcharhinus limbatus*), finetooth, bull, lemon, and sharpnose sharks (*Rhizoprinondon terraenaovae*). Pelagic species, on the other hand, range widely in the upper zones of the oceans, often traveling over entire ocean basins. Examples include shortfin mako (*Isurus oxyrinchus*), blue (*Prionace glauca*), and oceanic whitetip (*Carcharhinus longimanus*) sharks. Coastalpelagic species are intermediate in that they occur both inshore and beyond the continental shelves, but have not demonstrated mid-ocean or transoceanic movements. Sandbar, scalloped hammerhead (*Sphyrna lewini*), and dusky sharks (*Carcharhinus obscurus*) are examples of coastal-pelagic species. Deep-dwelling species, *e.g*., most cat sharks (*Apristurus spp*.) and gulper sharks (*Centrophorus spp*.), inhabit the dark, cold waters of the continental slopes and deeper waters of the ocean basins.

Seventy-three species of sharks are known to inhabit the waters along the U.S. Atlantic coast, including the Gulf of Mexico and the waters around Puerto Rico and the U.S. Virgin Islands. HMS manages seventy-two species; spiny dogfish also occur along the U.S. coast, however management for this species is under the authority of the Atlantic States Marine Fisheries Commission as well as the New England and Mid-Atlantic Fishery Management Councils. Based on a combination of ecology and fishery dynamics the sharks in the management unit have been divided into four species groups for management: (1) large coastal species, (2) small coastal species, (3) pelagic species, and (4) prohibited species.

Management Unit Shark Species Included

- Large Coastal Sharks (11): Sandbar, silky, tiger, blacktip, bull, spinner, lemon, nurse, smooth hammerhead, scalloped hammerhead, and great hammerhead sharks
- Small Coastal Sharks (4): Atlantic sharpnose, blacknose, finetooth, and bonnethead sharks
- Pelagic Sharks (5): Shortfin mako, thresher, oceanic whitetip, porbeagle, and blue sharks
- Prohibited Species (19): Whale, basking, sandtiger, bigeye sandtiger, white, dusky, night, bignose, Galapagos, Caribbean reef, narrowtooth, longfin mako, bigeye thresher, sevengill, sixgill, bigeye sixgill, Caribbean sharpnose, smalltail, and Atlantic angel sharks

This information was taken from the 2005 Draft Consolidated Atlantic HMS FMP.

4.4 Coastal Migratory Pelagics

The Coastal Pelagic Species Fishery Management Plan for the south Atlantic and Gulf of Mexico fishery management regions covers the following seven species: Spanish mackerel (Scomberomorus maculatus), king mackerel (Scomberomorus cavalla), cero mackerel (Scomberomorus reqalis), bluefish (Pomatomus saltatrix) , cobia (Rachycentron canadum), Little tunny (Ethynnus alletteratus), and the common dolphin-fish (Coryphaena hippurus). Following are summaries of the information on the distribution and biology of each species. Additional and more detailed information may be obtained in a resource document available through the Gulf of Mexico Fishery Management Council. All of the information in this section was taken directly from the Fishery Management Plan for Coastal Migratory Pelagic Resources.

- King Mackerel

The King Mackerel inhabits waters of the western Atlantic from the Gulf of Maine to Rio de Janiero, Brazil, including the Gulf of Mexico and the Caribbean. The species occurs regularly as far north as Virginia and North Carolina. It is a coastal species which is not normally found beyond the continental shelf.

Seasonal movement along the Gulf of Mexico and Atlantic coastlines of the United States is apparent; and. the species is more abundant in the northern part of its range during the summer and in south Florida during the winter. The movements are probably related to water temperature, annual or long term changes in temperature may affect seasonal migration patterns or their timing.

- Spanish Mackerel

The species S. maculatus, as redefined by Collette and Russo (1979), is restricted to the western Atlantic coast of the U.S. and the Gulf of Mexico. The southward extent of its range is the Florida Keys and the northward extent in the Atlantic is normally New York or southern New England, although occasional strays are found to the Gulf of Maine (Berrien and Finan, 1977).

Spanish mackerel make seasonal migrations along the Atlantic and eastern and northern Gulf coasts and appears to be much more abundant in Florida during the winter. They move northward each spring to occur off the Carolinas by April, off Chesapeake Bay by May, and, in some years, as far north as Narragansett Bay by July (Berrien and Finan, 1977).

- Cobia

Cobia has a circum-tropical distribution (Briggs, 1960). The species is found in the northern part of its range in summer and it winters in south Florida (Austin, et a1., 1978) and the West Indies (Richards, 1967). Charter boat fishermen in the area from Mexico Beach, Florida, t o Mobile, Alabama, report that their catch of cobia is heaviest during the spring, from l a t e March t o the f i r s t of May, when the species passes very close to the beach on a westward migration (Austin, e t al., 1978). This latter observation is somewhat at variance with the statement by Reid (1954) that May t o August is the season of occurrence of the species around Cedar Key, Florida. In the Bahamas, cobias are principally known from the Bimini area or the Grand Bahama Bank (Bohlke and Chaplin, 1968).

According t o Bohlke and Chaplin (19681, cobia are found in open water, in inlets, in bays, and in mangroves. Briggs (1960) describes cobia as a “shore species." In the Florida Keys it is often caught by sports fishermen in waters only 20 feet (6 m) deep (Austin, e t a1 ., 1978).

- Cero Mackerel

This species is not normally found in abundance north of Dade County Florida.

- Little Tunny

The little tunny is one of the most common scombrids in the western Atlantic (Rivas, 1951) accounting for 40 percent of the fishes taken in a trolling survey off the southeastern U.S. coast (Anderson, 1954). This species also is abundant In the Gulf of Mexico. In collections of young-fishes in the Gulf of Mexico, this was the species that was the best represented (Kiawe and Shimada, 1959).

The little tunny is found & both sides of the Atlantic throughout tropical and subtropical areas including the Mediterranean. It is a coastal species (de Sylva and Rathjen, 1961; Mardal, 1963; Postel, 1950; Whiteleather and Brown, 1945; and Zhudova, 1969) which may be found in open ocean waters in small numbers.

The available literature indicates that the majority of the stock or stocks of little tunny found in U.S. waters remains within U.S. jurisdiction throughout spring, summer, and fall and may remain in U.S. waters during winter (Davis, 1979). Little tunny migrate seasonally, moving south and offshore during fa1l and winter, then returning northward in the spring (de Sylva and Rathjen, 1962). In summer, little tunny is abundant in the Gulf of Mexico and Atlantic at least as far north as Cape Hatteras. In winter, large numbers of little tunny are found off south Florida, primarily in the Gulf, south and west of Naples**,** and in the Tortugas (de Sylva and Rathjen, 1962). At the same time, some are found offshore in more northern regions such as off Georgia (Carlson, 1952). Some fraction of the stock(s) may extend into the Caribbean in winter; however, there is no available data to document such an extension (Davis, 1979).

- Dolphin Fish

The dolphin is the larger of two open-ocean pelagic congenetors that are cosmopolitan in distribution in tropical and subtropical waters (Bohlke and Chaplin, 1968). It is a valuable commercial species in Japan, China, and Hawaii and is an important source of food in many islands of the Pacific and Caribbean (Beardsley, 1967): in Florida the dolphin is an important sport fish and is taken on more trips and in greater numbers by Florida east coast charter boats than any other species (Ellis, 1967). I t is also an Important sport fish in North Carolina (Rose and Hassler, 1969).

According t o Shcherbachev (19731)**,** *C. hippurus* penetrates temperature latitudes to range above 40°N in the summer. Gibbs and Collette (1959) give the latitudinal limit of the species in the Atlantic as the 45° line, which corresponds to the poleward 1imits of the 15°C (5g°F) isotherm. Rose and Hassler (1968) give Prlnce Edward Island, Nova Scotia, and the southern tip of Africa as the range limits of the dolphin in the Atlantic. Sightings in the extreme limits of the range reportedly are rare, and the general range of this species probably is best described by the 20°C (68OF) isotherm (Gibbs and Collette, 1959). Hochachka (1974) alludes t o the common dolphin as a tropical eurythermal species." *C. hippurus* is common in the Caribbean, the Gulf Stream, and the Gulf of Mexico. The occurrence of this species in large numbers off the Texas coast has been reported (Baughman, 1941).

This species comes close to shore where blue waters are found near the shore, notably southeastern Florida, Cape Hatteras, and Ocean City, Maryland (Gibbs and Collette, 1959). Schuck (1951) found that the best fishing for dolphin off North Carolina was by trolling in areas where bottom depths were between 21 and 100 fathoms, Gibbs and Collette (1959) cited by de Sylva as saying that in south Florida *C. hippurus* adults are caught both in the Gulf Stream and at its junction with coastal waters. This species occasionally enters inshore waters of somewhat high turbidity (Gibbs and Collette, 1959)

- Bluefish

The bluefish generally occurs in temperate and warm temperate continental shelf waters (Briggs, 1960). In the eastern side of the New World, bluefish have been reported from Nova Scotia t o Texas, Brazil t o Uruguay, in Bermuda, Cuba, and Venezuela. They also are reported from Portugal to Senegal, Angola t o South Africa, in the Azores, the Mediterranean, the Black Sea, the Indian Ocean, the east coast of southern Africa, Madagascar, the Mayala peninsula, Tasmania, and Australia. On our Atlantic coast, the bluefish aggregations migrate seasonally - northward in spring and summer and southward in fall and early winter. In winter much of the population remains offshore (Lund and Maltezos, 1970). Groups of larger fish not only travel farther and faster but tend t o congregate in the northern part of their range.

Bluefish in the Gulf of Mexico appear to be a different stock from those in the Atlantic. Extensive tagging in the Atlantic has been done, and no returns have been recorded from the Gulf. On the west coast of Florida commercial fishermen catch bluefish year around at different locations, but the fish are less abundant than on the east side of the peninsula. In addition, It is cannon knowledge among fishermen that the bluefish caught in the Gulf of Mexico are smaller than those caught in the Atlantic and at Key West.

4.5 Coral

Coral reefs and associated habitats are complex systems that are culturally, economically, and scientifically significant in the South Atlantic. Coral reefs are composed of a diverse assemblage of sessile and mobile benthic animals, as well as free-swimming organisms that interact among them and with their physical environment. In addition to biological reefs, which are formed by corals, submerged rock formations (hardbottoms) are often colonized by reef species.

Corals can be characterized using the following terms: deepwater species, shallow water species, stony corals, octocorals, hermatypic, and ahermatypic. The Fishery Management Plan for Coral, Coral Reefs and Live/Hard Bottom Habitat of the South Atlantic Region (Coral FMP) defines coral reefs as hardbottoms, nearshore hardbottoms, deepwater hardbottoms (including deepwater banks), patch reefs, and outer bank reefs.

Although attempts have been made to generalize discussion of the different types of habitats managed under the Coral FMP into definable types, it must be noted that the continuum of habitats includes many more than the distinct categories listed below:

Hardbottoms are found on wide bathymetric and geographic scales. These formations are present in nearshore, mid- and outer-shelf areas. Hardbottoms are also called hard banks, organic banks or simply banks. Hardbottoms can support coral communities; however, they generally lack the coral diversity, density, and reef development of patch and outer bank reefs. Hardbottom may include some hermatypic corals and are widely distributed in the management area. Biota usually include a thin veneer of live corals, often covering a rock outcrop or a relic reef, and associated benthos (e.g., sponges, tunicates, holothurians) in an assemblage with low relief. Hardbottoms are also called live bottom, hard grounds, or pinnacles (when found in a non-bank setting).

4.6 Red Drum

The red drum is one of twenty-two members of the drum family (Sciaenidae) that includes many of the southeast coast's most important inshore commercial and recreational species. Species in this family are typically known as the drums, and other common drum species landed in the region include weakfish, Atlantic croaker, spot, spotted sea trout, kingfishes (sea mullet), and black drum. Red drum and many others in this family produce drumming sounds by vibrating their swim bladders with special muscles. Other common names for red drum include channel bass, redfish, spot tail bass, and puppy drum. Red drum are common along the Atlantic coast over a wide range of habitats from Chesapeake Bay to Key West, Florida. Historically, landings reached as far north as Massachusetts and there was a moderate commercial fishery off the coast of New Jersey in the 1930's. There are few reports of landings from areas north of Chesapeake Bay since the 1950's, which suggests a decline in red drum distribution along the Atlantic coast. (This information was taken from the March 2001 North Carolina Fisheries Management Plan for Red Drum.)

4.7 Summer Flounder

The summer flounder or fluke, *Paralichthys dentatus*, is a demersal flatfish distributed from the southern Gulf of Maine to South Carolina. Important commercial and recreational fisheries exist from Cape Cod to Cape Hatteras. The resource is managed as a unit stock from North Carolina to Maine. Summer flounder are concentrated in bays and estuaries from late spring through early autumn, when an offshore migration to the outer continental shelf is undertaken. Spawning occurs during autumn and early winter, and the larvae are transported toward coastal areas by prevailing water currents. Development of post larvae and juveniles occurs primarily within bays and estuarine areas, notably Pamlico Sound and Chesapeake Bay (Packer et al. 1999). Most fish are sexually mature by age 2 (O'Brien et al. 1993). Female summer flounder may live up to 20 years, but males rarely live for more than 10 years (Bolz et al. 2000).

Growth rates differ appreciably between the sexes with females attaining weights up to 11.8 kg (26 lb).

U.S. commercial and recreational fisheries for summer flounder are managed under the Summer Flounder, Scup and Black Sea Bass Fishery Management Plan (FMP) administered jointly by the Atlantic States Marine Fisheries Commission (ASMFC) and the Mid-Atlantic Fishery Management Council (MAFMC).

(This information taken from http://www.nefsc.noaa.gov/sos/spsyn/fldrs/summer/, March 2007)

4.8 Anadromous Fish Species

This group of fish relies on annual adult migrations from the sea to the specific freshwater rivers and habitats of origins to spawn, and includes American shad (*Alosa sapidissima*), hickory shad (*Alosa mediocris*), alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), striped bass (*Morone saxatilis*), and Atlantic sturgeon (*Acipenser oxyrhynchus*). The river herring, which include blueback herring and alewife, have experienced a dramatic decline in abundance since the 1960s and they are still being exploited above optimum levels. Restoration efforts are being implemented in many areas to reclaim important spawning habitat currently unavailable because of migration impediments, and by-catch is managed under the squid-mackerel-butterfish FMP to improve survival. Striped bass have made a spectacular recovery from the species' previous very depressed condition. Limited commercial harvest is currently allowed, but striped bass commercial landings will remain at a lower level for the near future, since the stock is still in management under the Striped Bass Recovery Act. It should be noted that the striped bass was declared fully recovered in January 1995. Commercial fishing for this group of fish uses a variety of gear types, including haul seine, trawl, pound and gill net, and hook and line. Commercial fisheries continue on American shad stocks, although most are in depressed condition. Management recommendations are currently being developed to assist in recovery of the stocks. There is no FMP for anadromous fish. (Taken from http://training.fws.gov/library/pubs5/web_link/text/int_fish.htm, March 2007)

Managed Species for Coastal South Carolina					
MANAGEMENT PLAN AGENCY[2]	MANAGEMENT PLAN SPECIES GROUP	COMMON NAME OF SPECIES	SCIENTIFIC NAME OF SPECIES	LIFE STAGES BY ECOSYSTEM[3] Marine	NOTES
SAFMC	Coastal Migratory Pelagics	Spanish mackerel	*Scomberomorous maculatus*	J A	
SAFMC	Coastal Migratory Pelagics	Cobia	*Rachycentron canadum*	E L P J A	
SAFMC	Red Drum	Red drum	*Sciaenops ocellatus*	E L P J S A	
SAFMC	Shrimp	White shrimp	*Lilopenaeus setiferus*	L A	
SAFMC	Shrimp	Brown shrimp	*Farfantepenaeus aztecus*	E L A	
SAFMC	Snapper Grouper	Sheepshead	*Archosargus probatocephalus*		
SAFMC	Snapper Grouper	Crevalle Jack	*Caranx hippos*		
SAFMC	Snapper Grouper	Gray snapper	*Lutjanus griseus*	L A	
SAFMC	Snapper Grouper	Gag grouper	*Mycteroperca microlepis*	A	
SAFMC	Snapper Grouper	Lane snapper	*Lutjanus synagris*	A	
SAFMC	Snapper Grouper	Black Sea Bass	*Centropristis striata*		also managed under the MAFMC Black Sea Bass FMP
MAFMC	Bluefish	Bluefish	*Pomatomus saltatrix*	L J A	
MAFMC	Summer Flounder	Summer flounder	*Paralichthys dentatus*	L J A	
SAFMC		American Shad	*Alosa sapidissima*	A	anadromous species do not have a FMP
SAFMC		Hickory Shad	*Alosa mediocris*	A	anadromous species do not have a FMP
SAFMC		Blueback Herring	*Alosa aertivalis*	A	anadromous species do not have a FMP
SAFMC		Striped Bass	*Morone saxatilis*	A	anadromous species do not have a FMP
SAFMC		Shortnose Sturgeon	*Acipenser brevirostrum*	A	anadromous species do not have a FMP
SAFMC		Atlantic Sturgeon	*Acipenser oxyrinchus*	A	anadromous species do not have a FMP
NMFS	Sharks	Atlantic sharpnose shark	*Rhizoprionodon terraenovae*	J	
NMFS	Sharks	Blacknose shark	*Carcharhinus acronotus*	J	
NMFS	Sharks	Bonnethread shark	*Sphyrna tiburo*	J A	
NMFS	Sharks	Bull shark	*Carcharhinus leucas*	J	
NMFS	Sharks	Dusky shark	*Carcharhinus obscurus*	J	
NMFS	Sharks	Finetooth shark	*Carcharhinus isodon*	E L P J S A	
NMFS	Sharks	Lemon shark	*Negaprion brevirostris*	J	
NMFS	Sharks	Sand tiger shark	*Odontaspis taurus*	J	
NMFS	Sharks	Sandbar shark	*Carcharhinus plumbeus*	J	
NMFS	Sharks	Scalloped hammerhead	*Sphyrna lewini*	J	

Table 2: Managed Species in the Project Area

Note: 1. These Essential Fish Habitat species were compiled from Essential Fish Habitat: A Marine Fish Habitat Conservation Mandate for Federal Agencies. February 1999 (Revised 10/2001)

2. Organizations responsible for Fishery Management Plans include: SAFMC = South Atlantic Fishery Management Council; MAFMC = Mid-Atlantic Fishery Management Council; NMFS = National Marine Fisheries Service.

3. Life stages include: E = Eggs, L = Larvae, P = Post-Larvae, J = Juveniles, S = Sub-Adults, A = Adults

5.0 ASSESSMENT OF IMPACTS, CONCLUSIONS AND RESEARCH MEASURES

Hurl Rocks EFH-HAPC (hereafter referred to as Hurl Rocks) has been designated in the vicinity of the Grand Strand Storm Damage Reduction Project. In fact, portions of both areas overlap. The initial construction of the berm of sand intended to protect structures along the project length was completed prior to the designation of Hurl Rocks.

While there is a designated area for Hurl Rocks, there is no formal description of the structural characteristics written by the South Atlantic Fisheries Management Council (SAFMC). Likewise, there are no formal biological surveys that iterate the species composition, age structure or distribution. Verbal communication with the SAFMC staff reveals that the area designated was chosen based on information obtained from the State of South Carolina Department of Natural Resources (SCDNR) and a survey of hard bottom structures performed jointly by the U.S. Geological Survey and the Minerals Management Service.

While the Hurl Rocks EFH-HAPC was designated after the first nourishment cycle of the 50 year Grand Strand project, knowledge of hardbottom structures in the vicinity is not new. Post nourishment sampling of the nearshore environment was performed jointly by the Corps of Engineers, SCDNR, and Coastal Carolina University. The resulting report, titled “Habitat Mapping and Sea Bottom Change Detection on the Shoreface and Inner Shelf Adjacent to the Grand Strand Beach Nourishment Project”, was submitted in September 2001. The title page and executive summary can be found in Appendix A.

Based on the report contained in Appendix A and the fact that the project was in existence prior to the designation of the habitat as an area of particular concern, the Corps of Engineers Charleston District does not believe that the Grand Strand project represents a significant threat to Essential Fish Habitat. The SAFMC has issued a policy paper on large-scale coastal engineering projects that is contained in Appendix B. While the Corps of Engineers Charleston District does not agree with all of the findings contained in the paper, the policy will be followed to the maximum extent practicable.

1. Initial planning for the Grand Strand project considered a number of alternatives. Criteria for the selection of the plan were based primarily on the efficiency of the design for the purpose of protecting the economic structure of the beach front. Eliminating portions of the protective berm in order to avoid specific habitat would severely endanger the structures in the modified area.
2. Hurl Rocks EFH-HAPC has been designated, in part, on top of the existing footprint of the civil works project and in some cases on top of existing structures which makes total avoidance impossible.
3. Past investigation have shown that the habitat was not significantly altered by the Grand Strand nourishment. Therefore, mitigation is not necessary.
4. Investigations and monitoring of the environment will be performed in partnership with the SCDNR and Coastal Carolina University. The scope of the monitoring is contained in Appendix C.

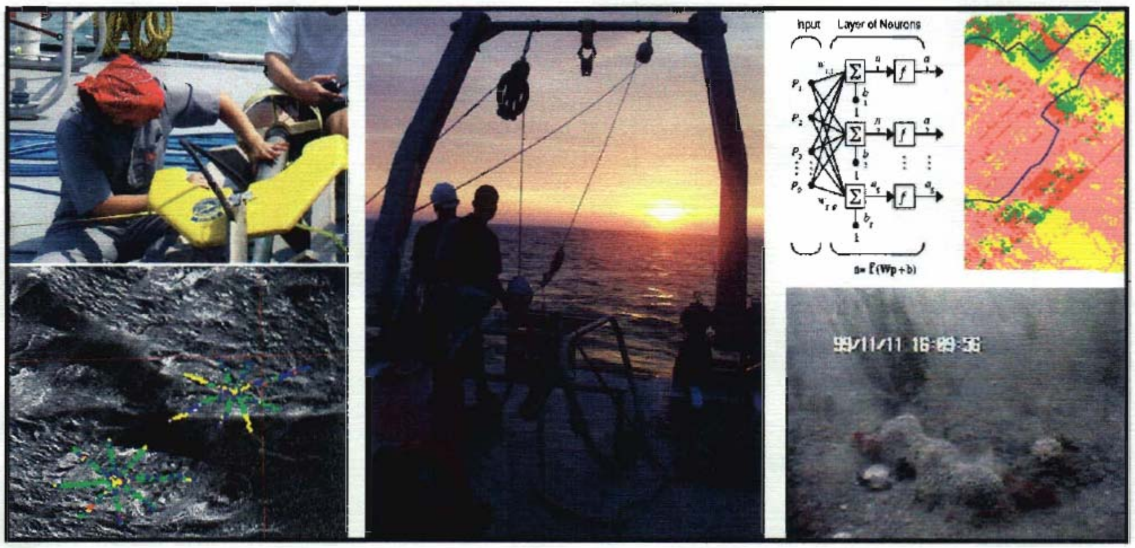
APPENDIX A

Grand Strand Beach Nourishment Project Study

Habitat Mapping and Sea Bottom Change Detection on the Shoreface and Inner Shelf Adjacent to the Grand Strand Beach Nourishment Project

(September 2001)

Habitat Mapping and Sea Bottom Change Detection on the Shoreface and Inner Shelf Adjacent to the Grand Strand Beach Nourishment Project



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September 2001

EXECUTIVE SUMMARY

To monitor and evaluate the success of Phases I, II and III of the Grand Strand Nourishment Project, the Center for Marine and Wetland Studies in collaboration with the South Carolina Department of Natural Resources and the US Army Corps of Engineers designed and implemented an integrated approach that included (1) documentation of behavior of the beach fill over time through collection of long beach profiles along the length of the constructed projects; (2) evaluation of the impact or changes that occurred in the beach and shoreface habitats associated with the influx of additional nourished sand into the system; and (3) evaluation of the effects of excavation and physical infilling of inner-shelf borrow sites on benthic habitats.

For purposes of evaluating the effect that redistribution of nourished sand might have exerted on offshore habitats, thirteen target sites were monitored during the last four years. Five sequential side scan sonar surveys and twenty-one submarine video-transects were acquired over these sites. The sonar surveys were classified by means of a quantitative approach that involved textural analysis of images, and training of a neural network classifier. The output of this technique was a set of maps that categorized the sonar images in terms of 'hard bottom' or 'sand'. This technique facilitated tracking of habitat changes on a pixel-by-pixel basis, and quantification of changes on each site on a percent area basis.

Results of this approach indicate that offshore habitats have not been significantly impacted by effect of redistribution of nourished sand. Although changes were detected in bottom-type over the years, these changes were mainly interpreted as natural shifting of sediment within hard bottom areas. Sediment deposition and burial of hard bottom habitats were largely balanced by erosion and exhumation of new hard bottom. Such variability is expected in shallow marine settings such as the inner shelf, and was documented in this study by observation of the most distal target site, which showed an initial rapid increase in hard bottom coverage followed by a slow decrease, on a percent basis. All data available for this study and analysis of beach profiles suggest that limited nearshore loss of hard bottom habitat observed on the shoreface, seaward of the constructed beach fill, was due to localized introduction of "new" sand into the system from the beach fill, but was only marginally above the inherent variability of the system.

APPENDIX B

South Atlantic Fishery Management Council

Policies for the Protection and Restoration of Essential Fish Habitats from Beach Dredging and Filling and Large-Scale Coastal Engineering

(March 2003)

SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL

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Gregg T. Waugh, Deputy Executive Director

(MARCH 2003)
POLICIES FOR THE PROTECTION AND RESTORATION OF ESSENTIAL FISH HABITATS FROM BEACH DREDGING AND FILLING AND LARGE-SCALE COASTAL ENGINEERING

Policy Context

This document establishes the policies of the South Atlantic Fishery Management Council (SAFMC) regarding protection of the essential fish habitats (EFH) and habitat areas of particular concern (EFH-HAPCs) impacted by beach dredge and fill activities, and related large-scale coastal engineering projects. The policies are designed to be consistent with the overall habitat protection policies of the SAFMC as formulated and adopted in the Habitat Plan (SAFMC, 1998a) and the Comprehensive EFH Amendment (SAFMC, 1998b).

The findings presented below assess the threats to EFH potentially posed by activities related to the large-scale dredging and disposal of sediments in the coastal ocean and adjacent habitats, and the processes whereby those resources are placed at risk. The policies established in this document are designed to avoid, minimize and offset damage caused by these activities, in accordance with the general habitat policies of the SAFMC as mandated by law.

EFH At Risk from Beach Dredge and Fill Activities

The SAFMC finds:

1) In general, the array of large-scale and long-term beach dredging projects and related disposal activities currently being considered for the United States southeast together constitute a real and significant threat to EFH under the jurisdiction of the SAFMC.

2) The cumulative effects of these projects have not been adequately assessed, including impacts on public trust marine and estuarine resources, use of public trust beaches, public access, state and federally protected species, state critical habitat, SAFMC-designated EFH and EFH-HAPCs.

3) Individual beach dredge and fill projects and related large-scale coastal engineering activities rarely provide adequate impact assessments or consideration of potential damage to fishery resources under state and federal management. Historically, emphasis has been placed on the logistics of dredging and economics, with environmental considerations dominated by compliance with the Endangered Species Act for sea turtles, piping plovers and other listed organisms. There has been little or no consideration of hundreds of other species affected, many with direct fishery value.

4) Opportunities to avoid or minimize impacts of beach dredge and fill activities on fishery resources, and offsets for unavoidable impacts have rarely been proposed or implemented. Monitoring is rarely adequate to develop statistically appropriate impact evaluations.

5) Large-scale beach dredge and fill activities have the potential to impact a variety of habitats across the shelf, including:

a) waters and benthic habitats near the dredging sites
b) waters between dredging and filling sites
c) waters and benthic habitats in or near the fill sites, and
d) waters and benthic habitats potentially affected as sediments move subsequent to deposition in fill areas.

6) Certain nearshore habitats are particularly important to the long-term viability of commercial and recreational fisheries under SAFMC management, and potentially threatened by large-scale, long-term or frequent disturbance by dredging and filling:

a) the swash and surf zones and beach-associated bars
b) underwater soft-sediment topographic features
c) onshore and offshore coral reefs, hardbottom and worm reefs
d) inlets

7) Large sections of South Atlantic waters potentially affected by these projects, both individually and collectively, have been identified as EFH or EFH-HAPC by the SAFMC, as well as the Mid-Atlantic Fishery Management Council (MAFMC) in the case of North Carolina. Potentially Affected species and their EFH under federal management include (SAFMC, 1998b):

a) summer flounder (various nearshore waters, including the surf zone and inlets; certain offshore waters)
b) bluefish (various nearshore waters, including the surf zone and inlets)
c) red drum (ocean high-salinity surf zones and unconsolidated bottoms nearshore waters)
d) many snapper and grouper species (live hardbottom from shore to 600 feet, and – for estuarine-dependent species [e.g., gag grouper and gray snapper] – unconsolidated bottoms and live hardbottoms to the 100 foot contour).

e) black sea bass (various nearshore waters, including unconsolidated bottom and live hardbottom to 100 feet, and hardbottoms to 600 feet)
f) penaeid shrimp (offshore habitats used for spawning and growth to maturity, and waters connecting to inshore nursery areas, including the surf zone and inlets)
g) coastal migratory pelagics [e.g., king mackerel, Spanish mackerel] (sandy shoals of capes and bars, barrier island ocean-side waters from the surf zone to the shelf break inshore of the Gulf Stream; all coastal inlets)
h) corals of various types (hard substrates and muddy, silt bottoms from the subtidal to the shelf break)
i) areas identified as EFH for Highly Migratory Species (HMS) managed by the Secretary of Commerce (e.g., sharks: inlets and nearshore waters, including pupping and nursery grounds)

In addition, hundreds of species of crustaceans, mollusks, and annelids that are not directly managed, but form the critical prey base for most managed species, are killed or directly affected by large dredge and fill projects.

8) Beach dredge and fill projects also potentially threaten important habitats for anadromous species under federal, interstate and state management (in particular, inlets and offshore overwintering grounds), as well as essential overwintering grounds and other critical habitats for weakfish and other species managed by the Atlantic States Marine Fisheries Commission (ASMFC) and the states. The SAFMC also identified essential habitats of anadromous and catadromous species in the region (inlets and nearshore waters).

9) Many of the habitats potentially affected by these projects have been identified as EFH-HAPCs by the SAFMC. The specific fishery management plan is provided in parentheses:

a) all nearshore hardbottom areas (SAFMC, snapper grouper).
b) all coastal inlets (SAFMC, penaeid shrimps, red drum, and snapper grouper).
c) near-shore spawning sites (SAFMC, penaeid shrimps, and red drum).
d) benthic *Sargassum* (SAFMC, snapper grouper).
e) from shore to the ends of the sandy shoals of Cape Lookout, Cape Fear, and Cape Hatteras, North Carolina; Hurl Rocks, South Carolina; *Phragmatopora* (worm reefs) reefs off the central coast of Florida and nearshore hardbottom south of Cape Canaveral (SAFMC, coastal migratory pelagics).
f) Atlantic coast estuaries with high numbers of Spanish mackerel and cobia from ELMR, to include Bogue Sound, New River, North Carolina; Broad River, South Carolina (SAFMC, coastal migratory pelagics).
g) Florida Bay, Biscayne Bay, Card Sound, and coral hardbottom habitat from Jupiter Inlet through the Dry Tortugas, Florida (SAFMC, Spiny Lobster)
h) Hurl Rocks (South Carolina), The *Phragmatopoma* (worm reefs) off central east coast of Florida, nearshore (0-4 meters; 0-12 feet) hardbottom off the east coast of Florida from Cape Canaveral to Broward County; offshore (5-30 meters; 15-90 feet) hardbottom off the east coast of Florida from Palm Beach County to Fowey

Rocks; Biscayne Bay, Florida; Biscayne National Park, Florida; and the Florida Keys National Marine Sanctuary (SAFMC, Coral, Coral Reefs and Live Hardbottom Habitat).

i) EFH-HAPCs designated for HMS species (e.g., sharks) in the South Atlantic region (NMFS, Highly Migratory Species).

10) Habitats likely to be affected by beach dredge and fill projects include many recognized in state-level fishery management plans. Examples of these habitats include Critical Habitat Areas established by the North Carolina Marine Fisheries Commission, either in FMPs or in Coastal Habitat Protection Plans (CHAs).

11) Recent work by scientists in east Florida has documented important habitat values for nearshore, hardbottom habitats often buried by beach dredging projects, is used by over 500 species of fishes and invertebrates, including juveniles of many reef fishes. Equivalent scientific work is just beginning in other South Atlantic states, but life histories suggest that similar habitat use patterns will be found.

Threats to Marine and Estuarine Resources from Beach Dredge and Fill Activities and Related Large Coastal Engineering Projects

The SAFMC finds that beach dredge and fill activities and related large-scale coastal engineering projects (including inlet alteration projects) and disposal of material for navigational maintenance, threaten or potentially threaten EFH through the following mechanisms:

1) Direct mortality and displacement of organisms at and near sediment dredging sites
2) Direct mortality and displacement of organisms at initial sediment fill sites
3) Elevated turbidity and deposition of fine sediments down-current from dredging sites
4) Alteration of seafloor topography and associated current and waves patterns and magnitudes at dredging areas
5) Alteration of seafloor sediment size-frequency distributions at dredging sites, with secondary effects on benthos at those sites
6) Elevated turbidity in and near initial fill sites, especially in the surf zone, and deposition of fine sediment down-current from initial fill sites (ASMFC, 2002)
7) Alteration of nearshore topography and current and wave patterns and magnitudes associated with fill
8) Movement of deposited sediment away from initial fill sites, especially onto hardbottoms
9) Alteration of large-scale sediment budgets, sediment movement patterns and feeding and other ecological relationships, including the potential for cascading disturbance effects
10) Alteration of large-scale movement patterns of water, with secondary effects on water quality and biota
11) Alteration of movement patterns and successful inlet passage for larvae, post-larvae, juveniles and adults of marine and estuarine organisms

12) Alteration of long-term shoreline migration patterns (inducing further ecological cascades with consequences that are difficult to predict)
13) Exacerbation of transport and/or biological uptake of toxicants and other pollutants released at either dredge or fill sites

In addition, the interactions between cumulative and direct (sub-lethal) effects among the above factors certainly triggers non-linear impacts that are completely unstudied.
<u>SAFMC Policies for Beach Dredge and Fill Projects and Related Large Coastal Engineering Projects</u>

The SAFMC establishes the following general policies related to large-scale beach dredge and fill and related projects, to clarify and augment the general policies already adopted in the Habitat Plan and Comprehensive Habitat Amendment (SAFMC 1998a; SAFMC 1998b):

1) Projects should avoid, minimize and where possible offset damage to EFH and EFH-HAPCs.

2) Projects requiring expanded EFH consultation should provide detailed analyses of possible impacts to each type of EFH, with careful and detailed analyses of possible impacts to EFH-HAPCs and state CHAs, including short and long-term, and population and ecosystem scale effects. Agencies with oversight authority should require expanded EFH consultation.

3) Projects requiring expanded EFH consultation should provide a full range of alternatives, along with assessments of the relative impacts of each on each type of EFH, HAPC and CHAs.

4) Projects should avoid impacts on EFH, HAPCs and CHAs that are shown to be avoidable through the alternatives analysis, and minimize impacts that are not.

5) Projects should include assessments of potential unavoidable damage to EFH and other marine resources, using conservative assumptions.

6) Projects should be conditioned on the avoidance of avoidable impacts, and should include compensatory mitigation for all reasonably predictable impacts to EFH, taking into account uncertainty about these effects. Mitigation should be local, up-front and in-kind, and should be adequately monitored, wherever possible.

7) Projects should include baseline and project-related monitoring adequate to document pre-project conditions and impacts of the projects on EFH.

8) All assessments should be based upon the best available science, and be appropriately conservative so follow and precautionary principles as developed for various federal and state policies.

9) All assessments should take into account the cumulative impacts associated with other beach dredge and fill projects in the region, and other large-scale coastal engineering projects that are geographically and ecologically related.

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Appendix 6

Archeological Survey & Coordination

THE
South
Carolina
Archives
& History
Center

HISTORY & HERITAGE
For All Generations

April 19, 2007

Mr. Richard H. Kimmel
Department of the Army
Wilmington District, Corps of Engineers
PO Box 1890
Wilmington, NC 28402-1890

RE: Draft Report, *Archaeological Remote Sensing Survey of Myrtle Beach Offshore Borrow Areas, Horry County, South Carolina*

Dear Mr. Kimmel:

We have reviewed the above referenced survey report, and find that the report meets both State and Federal standards for the identification, documentation, and assessment of cultural resources. We concur with the recommendations that the Surfside A target exhibits characteristics that may be associated with a significant submerged cultural resource and that this site should either be avoided or further investigated. Without additional information we assume that the proposed project would be an adverse effect on the resource.

If additional investigations to further evaluate the site are not an option, the we concur that the Surfside A target an avoidance buffer of at least 200 feet all around the target should be established prior to dredging activities. If additional investigations take place, we would expect that this target be given an official state site number. We would also look forward to receipt of a report on the investigations.

These comments are being provided to assist you with your responsibilities under Section 106 of the National Historic Preservation Act, as amended. I can be contacted at (803) 896-6173 if you have any questions or comments.

Sincerely,

Valerie Marcil
Staff Archaeologist
State Historic Preservation Office

cc: Keith Derting, SCIAA
Jim Spirek, SCIAA

UNIVERSITY OF SOUTH CAROLINA

SOUTH CAROLINA INSTITUTE OF ARCHAEOLOGY AND ANTHROPOLOGY

26 April 2007

Richard Kimmel
Wilmington District, Corps of Engineers
PO Box 1890
Wilmington, NC 28402-1890

Re: Myrtle Beach Offshore Borrow Areas, Horry County, South Carolina.

Dear Mr. Kimmel,

We have reviewed the report entitled "Archaeological Remote Sensing Survey of Myrtle Beach Offshore Borrow Areas, Horry County, South Carolina." This report was prepared to determine the presence or absence of submerged cultural resources in the proposed borrow areas. We find the report satisfactory in outlining the scope of work undertaken by the underwater archaeological contractor. We concur with the findings of the survey that anomaly Surfside A has potential cultural significance, and that the best course of action is avoidance of the anomaly, or if not feasible, that additional archaeological investigation occur to identify the source of the anomaly. If you have questions or comments please do not hesitate to call me or Christopher Amer.

Sincerely,

James D Spirek

James D. Spirek
Deputy State Underwater Archaeologist
Review & Compliance

c: Valerie Marcil, SCSHPO

DEPARTMENT OF THE ARMY
WILMINGTON DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1890
WILMINGTON, NORTH CAROLINA 28402-1890

IN REPLY REFER TO

March 14, 2007

Environmental Resources Section

Dr. Rodger E. Stroup, SHPO
Department of Archives and History
8301 Parklane Road
Columbia, South Carolina 29223-4905

Dear Dr. Stroup:

Enclosed for your review please find a copy of the Mid-Atlantic Technology and Environmental Research draft report, "Archaeological Remote Sensing Survey of Myrtle Beach Offshore Borrow Areas, Horry County, South Carolina." This report has been prepared per provisions of the National Historic Preservation Act of 1966, as amended, and the Abandoned Shipwreck Act.

If you have any questions about the report, please contact me at (910) 251-4994, fax (910) 251-4653, or e-mail richard.h.kimmel@usace.army.mil. I would like to receive any comments you may have by April 27, 2007.

Sincerely,

Richard H. Kimmel

Richard H. Kimmel, Archaeologist
Contracting Officer's Representative

Enclosure

Copy Furnished (w/enclosure):

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Deputy State Underwater Archaeologist
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Archaeological Remote Sensing Survey of Myrtle Beach Offshore Borrow Areas, Horry County, South Carolina

Contract Number: DACW54-03-D-0002 Del. Order: CV05

Submitted to:

Department of the Army
Wilmington District, Corps of Engineers
P.O. Box 1890
Wilmington, North Carolina 28429

Submitted By:

Mid-Atlantic Technology and Environmental Research, Inc.
441 Blossom Ferry Road
Castle Hayne, North Carolina 28429

Wes Hall
Principal Investigator

26 February 2007

Abstract

The U.S. Army Corps of Engineers Wilmington District in conjunction with Charleston District (USACE) is conducting preliminary investigations of three proposed sand borrow areas for beach re-nourishment projects at or near Myrtle Beach, in Horry County, South Carolina. As a part of these investigations, Mid-Atlantic Technology and Environmental Research, Inc. (M-AT/ER) of Castle Hayne, North Carolina, was contracted to conduct marine magnetometer, side-scan sonar and sub-bottom profiler surveys of the proposed borrow areas for the purpose of identifying any potential archaeological resources that might be impacted by the offshore dredging activities during the sand mining process. M-AT/ER conducted historical research and field investigations for the project between 10 November and 15 December 2007.

A total of five remote sensing targets were identified within the three borrow areas. One target - Surfside A exhibits characteristics that may be associated with a significant submerged cultural resource. Additional underwater investigations to identify and assess Surfside A's potential as an archaeological resource are recommended. If underwater archaeological investigations are not an option, an avoidance buffer of at least 200 feet (radius) around the target coordinates should be established prior to dredging activities.

The remainder of the remote sensing targets identified during the survey of the three borrow areas (Cane South A, and Little River A, B, C) appear to have little potential to be associated with significant cultural resources. No additional underwater investigation or mitigation is recommended.

Analysis of sub-bottom records provide no indication of stratification or protected deposition of surficial (Late Pleistocene or Holocene) sediments that would contain or support any remnant evidence of human occupation or usage. No additional underwater archaeological investigations are recommended related to sub-bottom investigations within the three borrow areas.

Minor hard bottom areas were identified within each of the three borrow areas.

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Introduction

The U.S. Army Corps of Engineers Wilmington District in conjunction with Charleston District (USACE) is conducting preliminary investigations of three proposed sand borrow areas for beach re-nourishment projects at or near Myrtle Beach, in Horry County, South Carolina. As a part of these investigations, Mid-Atlantic Technology and Environmental Research, Inc. (M-AT/ER) of Castle Hayne, North Carolina, was contracted to conduct marine magnetometer[1], side-scan sonar[2], and sub-bottom profiler[3] surveys of the proposed borrow areas for the purpose of identifying any potential archaeological resources that might be impacted by the offshore dredging activities during the sand mining process. This work was conducted pursuant to provisions of Section 106 of the National Preservation Act of 1966 (36 CFR 800, Protection of Historic Properties) and the Abandon Shipwreck Act of 1987 (Abandon Shipwreck Guidelines, National Park Service, Federal Register, Vol. 55, No. 3, 4 December 1990, pages 50116-50145)[4].

In addition to archaeological resources, M-AT/ER was required to search for and identify hard bottom/marine habitat areas using side-scan sonar record analysis as part of the remote sensing investigations. M-AT/ER conducted historical research and field investigations for the project between 10 November and 15 December 2007.

Project Location

The three survey areas were located between Murrells Inlet and Little River Inlet, in the Atlantic Ocean offshore of North Myrtle Beach, Myrtle Beach, Surfside Beach, and Garden City, South Carolina (Figure 1). The survey areas were positioned between 1.6 and 4.1 nautical miles offshore (Figure 2). Portions of the borrow areas have already been utilized for past beach re-nourishment project and portions are know to be hard bottom or live bottom areas. South Carolina State Plane coordinates (NAD 83) for the proposed borrow area are listed below:

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1. A magnetometer is an electronic instrument that measures localized changes in the earth's magnetic field. By using a magnetometer in a controlled survey, the presence of ferrous materials can be detected. Since most historically significant shipwrecks contain relatively large amounts of iron or steel in the form of fasteners, anchors, cannons, or engines, etc., their presence can frequently be detected by a magnetometer survey.

2. Side-scan sonar is an underwater acoustic instrument that by electronic means generates a graphic representation of the bottom surface. By interpretation of these graphic records, the user can identify geographic changes in the bottom or man-made objects protruding above the bottom surface.

3. A sub-bottom profiler is an acoustic instrument that typically utilizes low frequent sound pulses to to detect sedimentary and geological changes below the bottom surface.

4. A national policy for historic preservation has been established in accordance with authorization contained in Sections 106 and 110 (formerly E.O. 11593) of the National Historic Preservation Act of 1966, as amended following the Advisory Council on Historic Preservation Regulations (36 CFR 800). Executive Order 11593 and the Historic Preservation Act Amendments of 1980 specified that the Federal Government shall provide leadership in preserving, restoring, and maintaining the historic and cultural environment of the nation. In 1988, the Abandoned Shipwreck Act (Public Law 100-298) declared that the states (or territories of the U.S.) are to manage shipwrecks in state waters. As a result of these acts and other legislation, state and federal agencies are required to administer cultural properties under their control in a spirit of stewardship and trusteeship. Each agency is required to initiate such measures as are necessary to insure that policies, plans, and programs will preserve sites, structures, and objects of historical or archaeological significance that exist on properties owned by the Federal Government or that are subject to federal regulation.

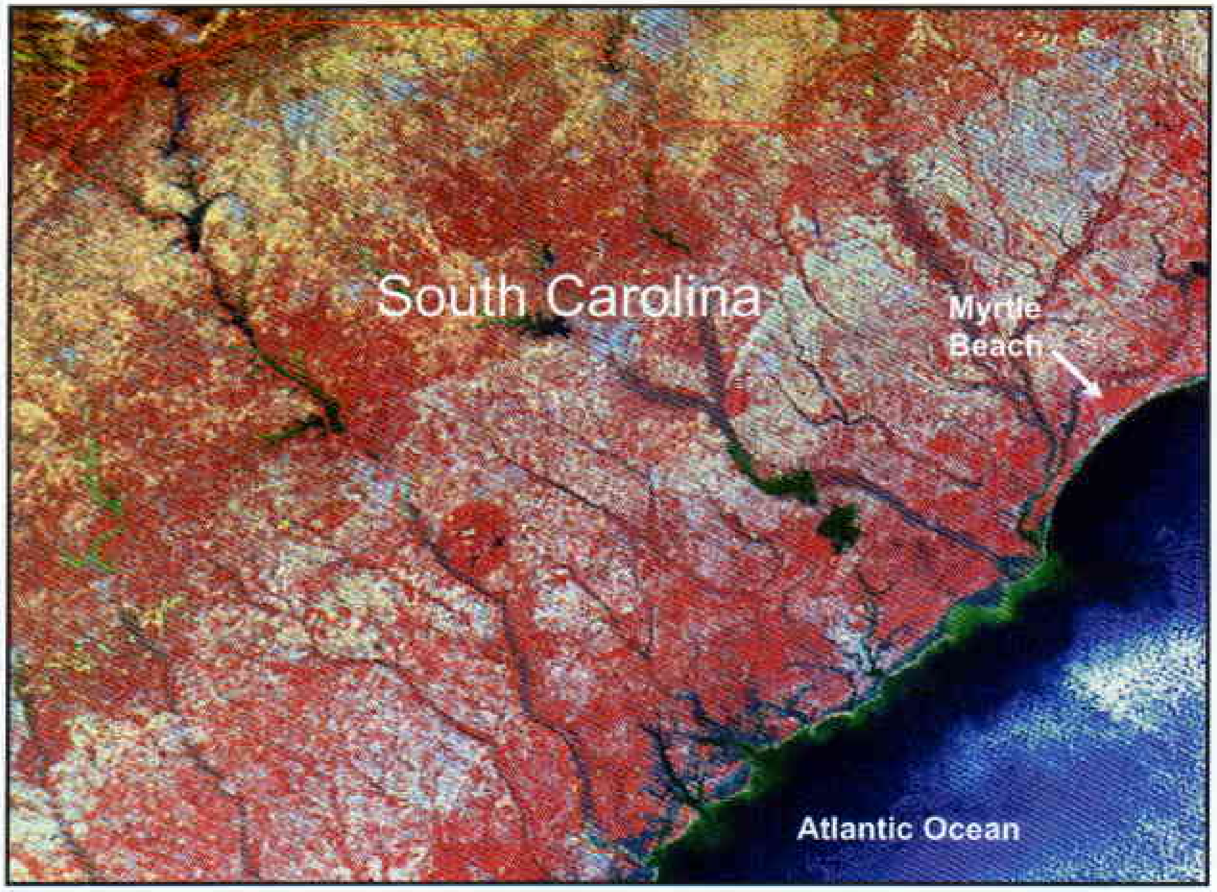

Figure 1. Project Location Map

Borrow Area Boundaries – South Carolina State Plane Coordinates NAD 1983

Surfside Borrow Area

A	x= 2616232.00	y= 629941.00
B	x= 2621710.00	y= 637200.00
C	x= 2633585.00	y= 628505.00
D	x= 2628043.00	y= 620845.00

Cane South Borrow Area

A	x= 2641959.00	y= 666291.00
B	x= 2643046.00	y= 667436.00
C	x= 2643904.00	y= 666161.00
D	x= 2643766.00	y= 665187.00
E	x= 2643300.00	y= 664552.00

Little River Borrow Area

A	x= 2721065.00	y= 721850.00
B	x= 2741655.00	y= 730855.00
C	x =2747711.00	y= 725110.00
D	x =2726165.00	y= 714950.00

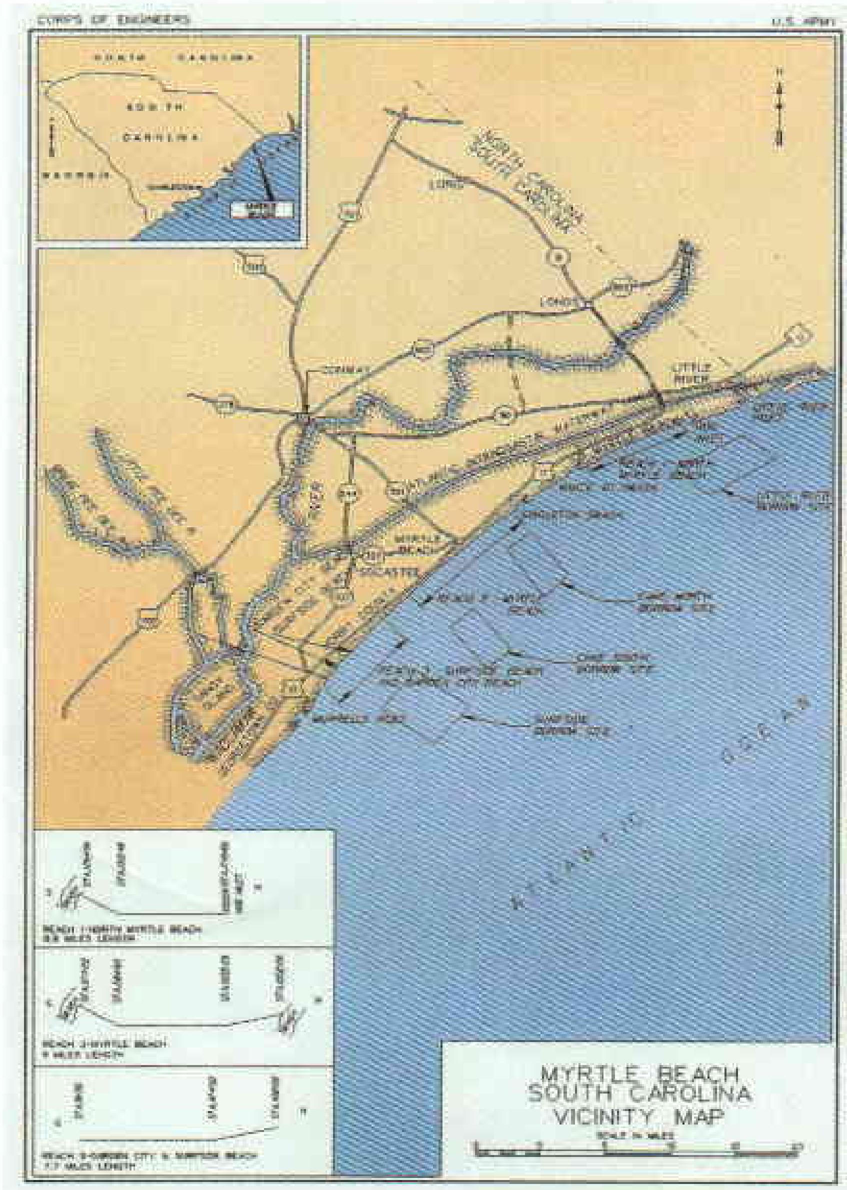

Figure 2. Project Area Location Map (US Army Corps of Engineers).

Myrtle Beach Vicinity Historical Background

Early Settlement and Colonial Periods. European colonization of South Carolina began with temporary Spanish and French settlements in the sixteenth century. These settlements were in the Beaufort area at the southern end of the coast. The English, however, were the first Europeans to establish permanent colonies. In 1663, King Charles II made a proprietary grant to a group of powerful English courtiers who had supported his return to the throne in 1660, and who sought to profit from the sale of the new lands. These Lords Proprietors, including Sir John Colleton, Sir William Berkeley, and Sir Anthony Ashley Cooper, provided the basic rules of governance for the new colony. They also sought to encourage settlers, many of whom came from the overcrowded island of Barbados in the early years. These Englishmen from Barbados first settled at Albemarle Point on the west bank of the Ashley River in 1670. By 1680, they moved their town down the river to Oyster Point, the present location of Charleston, and called it Charles Towne. These initial settlers, and more who followed them, quickly spread along the central South Carolina coast. By the second decade of the eighteenth century, they had established settlements from Port Royal Harbor in Beaufort County northward to the Santee River in Georgetown County.

The initial settlements in the region took advantage of the extensive woodlands of the region, harvesting the timber cleared from the land for the production of naval stores. Lumber, tar, turpentine, and resin all were produced from the forests cleared for agricultural lands (Gregorie 1961:20). Evidence of these harvesting activities includes many small circular tar kilns found throughout the region (Hart 1986), as well as site 38GE548 found on the Allston Bluffs tract (Baluha and Hendrix 2001). The lumber industry has continued to be very important in the economy of region.

The early economic development of the region also focused on the Native fur trade. However, agricultural industries soon replaced the fur trade. Trade with the Native Americans was pursued aggressively through the beginning of the eighteenth century, but by 1716, conflicts with the Europeans and disease had drastically reduced or displaced the local native population.

One of the important commercial ventures in the early settlements of the northeastern South Carolina was the raising of cattle. The climate in South Carolina permitted year-round grazing, and the many necks of land surrounded by rivers and creeks along the coast provided naturally bounded cowpens that allowed the cattle to range freely. Cattle ranching was a low-capital industry, with a natural market in the West Indies sugar plantations. Cattle ranching in South Carolina began in the late seventeenth century in the Charleston area, and by the early eighteenth century it had extended south into what is now Colleton County, between the Edisto and Combahee Rivers and north into Georgetown County (Rowland et al. 1997: 85-88).

While cattle ranching was an ideal frontier industry, it required great amounts of open land. Large purchases of land throughout the Lowcountry created problems between the white settlers and the Yamasee natives, whose lands were steadily and rapidly encroached upon. Angered by a combination of mistreatment from traders and encroachments on their land, the Native Americans attacked, resulting in the Yamasee War in 1715. While the Yamasee staged a number of successful raids throughout the 1720s, by 1728 the English had routed them and made the area more accessible for renewed English settlement (Covington 1978: 12).

Lowcountry colonists began to experiment with rice cultivation by the end of the seventeenth century. The regular flood conditions of the immediate tidal area proved valuable. Production for export increased rapidly, by 1715, Charles Towne exported more than 8,000 barrels of rice annually. This number increased to 40,000 by the 1730s. In the 1740s, residents in the Lowcountry also began to experiment with growing and processing indigo, a blue dye that was very popular in Europe and which became one of South Carolina's principal exports during the second half of the eighteenth century. Indigo and rice, both labor-intensive, laid the basis for South Carolina's dependence on African slave labor, much as tobacco had done in the Virginia colony (Coclanis 1989; Wood 1974). The British government, dependent on French colonies for this dye, heavily subsidized the crop in 1748. The Revolutionary War ended the bounty on indigo, making it unprofitable (Lawson 1975).

With the rapidly increasing wealth in the South Carolina Lowcounty, and with the Yamasee War largely behind them, the population began to swell. By 1730 the colony had 30,000 residents, at least half of whom were black slaves. A 1755 magazine, cited by Peter Wood, estimates that South Carolina residents had imported over 32,000 slaves by 1723 (Wood 1974:151). The growing population increased pressure for territorial expansion, which was compounded by the growing black majority in the Lowcountry. Fears of a slave rebellion, along with fears of attack from the Native Americans such as in the Yamasee War in 1715, led Charles Town residents to encourage settlement in the backcountry.

The capacity of the Lords Proprietors to govern the colony effectively declined in the early years of the eighteenth century. Governance under the Lords Proprietors became increasingly arbitrary, while wars with Native Americans rose and the colonial currency went into steep depreciation. According to a historian of colonial South Carolina, "proprietary attitudes and behavior. . .convinced many of the dissenters—who at one time had composed the most loyal faction—that the crown was a more reliable source of protection against arbitrary rule" (Weir 1983:94). South Carolina's legislature sent a petition to Parliament in 1719, requesting that royal rule supplant that of the Lords Proprietors. After several years in limbo, South Carolinians received a degree of certainty in 1729 when the crown purchased the Proprietors' interests, and in 1730 when the new royal governor, Robert Johnson, arrived in the colony.

Settlement in northeastern South Carolina proceeded slowly during the late seventeenth and early eighteenth centuries. Robert Johnson, South Carolina's first Royal Governor after the end of proprietary rule in 1719, directed the establishment of several townships in the interior of the state under his "Township Scheme." The purpose of these townships was to encourage settlement by white Europeans. These settlers would act as a buffer between the plantations around Charleston and the Native Americans and Spanish. Of equal if not greater concern to the Colonial Government was the dramatic rise in slave importation that accompanied the growth of rice agriculture. The settlement of free, white Europeans increased the tax base and strengthened the colony (Wallace 1951:154; Bedford 1989).

As settlement in the region grew, so did the need for the colony's civil and religious establishment. The Church Act of 1706 established the parish as the local unit of government. Counties or districts within Carolina were divided into parishes, with the local church serving as the administrative center. The project area was not within one of the original ten parishes; St. James Santee was the northernmost parish, and stopped at the Santee River. Between 1682 and 1721, the area above Winyah Bay represented the northern fringe of Craven County. The parish of Prince George Winyah was created in the early 1720s, and stretched from the Santee River to the Cape Fear River. There were several divisions of the original Prince George Winyah Parish from the 1730s to the 1750s, as the parishes of Prince Frederick, St. Mark's, and St. David's were created. In 1767 the Parish of All Saint's was created, which included the land between the Atlantic Ocean and the Waccamaw River, as far north as the boundary of North Carolina (Rogers 1970:3-4). The project area lies within All Saint's Parish.

As the delay in naming a parish suggests, the project area did not see early settlement. Indeed, during the seventeenth century settlement was discouraged above the Santee River. However, Native American traders, trappers, and particularly French Huguenots began to filter into this northeastern area of the colony. By 1705, a number of influential persons in Charleston received land grants in the area. European activities in the area during the late seventeenth and early eighteenth centuries focused on trade with the Native Americans. The Waccamaw and the Winyah represented the major aboriginal groups in the Winyah Bay area in the early eighteenth century, with a population estimated at 900. The Winyah had one village with a population of just over 100 people (Swanton 1946:207).

During the early 1700s, land grants were obtained and plantations were established in the area of present day Georgetown County. Along Winyah Bay and the Pee Dee and Black Rivers to the west, most of these landholdings were long and narrow. This configuration provided access to the river marshes, the interior uplands on the peninsulas between the rivers, and (to the east) the salt marshes and sea islands on the coast. Main plantation residences and facilities were established on the low bluffs of the Santee, Sampit, Waccamaw, Pee Dee, and Black Rivers; summer houses often were placed near the Atlantic shore. Though early experimentation occurred in the 1730s with using marshes for growing rice, by the 1760s planters were locating their fields in the river marshes. The central upland portions of most plantations were used for growing indigo, gardening and pasturage. Meanwhile communication with Charles Town to the south and other colonies to the north was established primarily by boat.

The South Carolina Commissioners of Trade established a post at Yauhannah on the Pee Dee River in 1716. This post served the Winyah who resided on the west bank of the Pee Dee River, the Waccamaw on the east bank of the river, and the Peedee who lived further upstream on the Pee Dee. At least one of the villages associated with the Waccamaw was located at the present-day Wachesaw Landing (Trinkley 1983). By the 1730s, however, much of the Native American population had been destroyed, enslaved, or driven from the region.

Myrtle Beach and Horry County

During the 18th century settlement came slowly into northeastern South Carolina. Most of the settlement occurred to the south along waterways with access to the ocean. A few fishermen settled along the coast of the Atlantic Ocean. The fur trade continued but declined through the century and farming became far more prevalent. Cattle and pigs free ranged in Horry County before the 1800s. The hides were more valuable than the meat which could not be preserved. Round-ups were not unusual during which time thousands of cows were regularly driven through forest and swamp to the slaughter houses in Charleston. The Horry County area could not have been founded, however, without its considerable naval stores. This seemingly inexhaustible supply of pitch, pine tar, turpentine, and a variety of other naval products supplied the average Horry County citizen with the majority of their income until the 1900s (Brosky 2007:1).

As the late 18th century approached, Horry County (then known as Kingston) residents separated into three political groups. The Patriots wanted to break all ties with England, the Tories remained loyal to England, and a third group comprised mostly of frontiersmen had no political preference.

The relatively isolated Horry County region experienced very little war related activity during the Revolutionary War. General Francis Marion, known as the "Swamp Fox" for his ability to disappear into the swamps, may have retreated into the area to avoid British troops. Brigadier General Peter Horry served under General Marion, and the two combined to help discourage British troops from gaining a foothold in the area.

Brigadier General Horry was born in South Carolina sometime around 1743. He started his military career in 1775 as one of 20 captains the Provincial Congress of South Carolina elected to serve the 1st and 2nd Regiments. In 1801 residents of Kingston County successfully petitioned the South Carolina Legislature to change the name of the county from Kingston to Horry (Brosky 2007:1).

The period between the Revolutionary War and Civil War were relatively uneventful in Horry County's History. Although the population of Horry County grew through this period most of the population was found along the Waccamaw River and in the vicinity of Conway. Coastal areas were sparsely populated (Figure 3).

In 1860, the southern states sent delegates to a convention to discuss the issue of Secession. South Carolina, always a staunch state's rights supporter, was first to adopt the Ordinance of Secession in December of that year. Horry County, not aggressively Secessionist, joined the "Cause" as soon as the War started, April 12, 1861, when the Confederate States of America fired on the Federals at Fort Sumter in Charleston harbor (Brosky 2007:2)

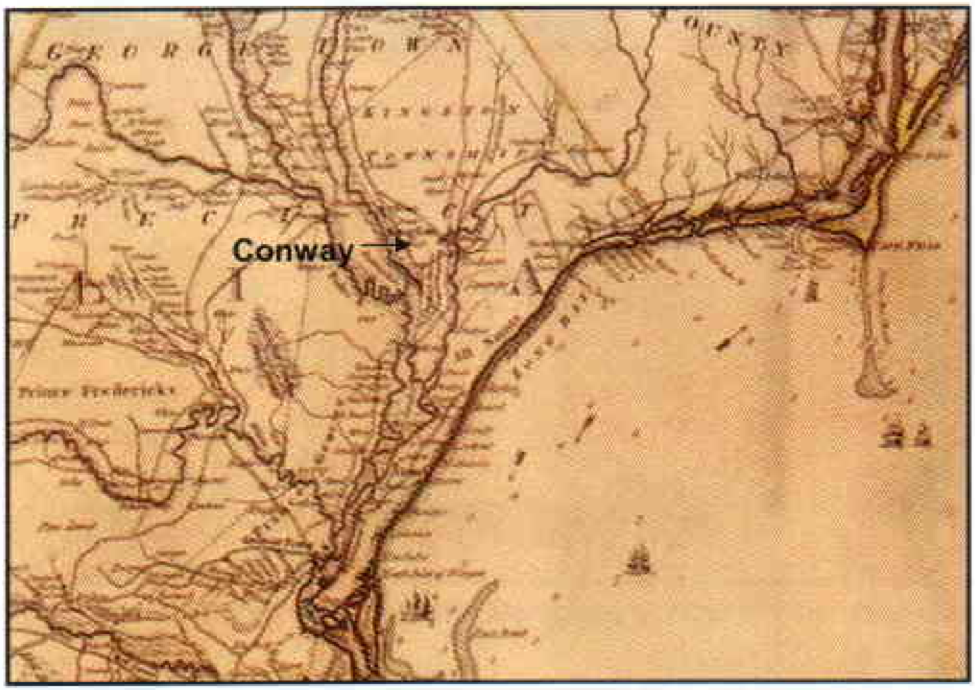

Figure 3. A portion of Mouzon's Map of North and South Carolina in 1775.

No major battles were fought in Horry County during the Civil War however the war had a major impact. It's reported that as much as 90 percent of the county's white male population were involved in the war. Horry soldiers saw fighting on battlefields such as Chickamauga, Kennesaw Mountain, and at the Battle of the Crater.

The county seat, Conwayborough, named after another Revolutionary War figure, Robert Conway, was occupied by Union force brought by gunboats on the Waccamaw River early in 1865. It was rumored that residents actually welcomed the Union forces as they represented the only real law in the county. Roving bands of deserters and outlaws frequently preyed upon the town during the later part of the War (Brosky 2007:2).

Southern economic progress was slow following the Civil War. The first real economic advancement within Horry County occurred when the railroad was built to Conway in mid-December of 1887 (Figure 4). Tobacco began to replace naval

However, no great fleet of barges or other shipping ever utilized the waterway to the degree that was originally anticipated (Brosky 2007:3).

Myrtle Beach continued to be popular destination and continued to grow. In early 1934 Myrtle Beach State Park was opened, thanks in part to the Civilian Conservation Corps. Roads and bridges were developed and the town was incorporated in 1938.

During World War Two, German submarines once again patrolled the South Carolina coast. The Intracoastal Waterway finally became an important means of marine transportation as it was too shallow and protected for submarines.

Myrtle Beach began to influence the region's economy as it developed into an increasingly popular summertime tourist destination during the late 1940s. Tobacco and tourism were the mainstays of Horry County's economy until the 1980s when the Tobacco market collapsed.

The tourism economy was stunted, at least temporarily, by Hurricane Hazel in October of 1954. The devastation of this Category 4 hurricane was compounded by its arrival during a high tide. Myrtle Beach was in ruin. However, Hurricane Hazel marked a new beginning for Myrtle Beach. Hazel helped to acquaint the beautiful beaches of Horry County to a larger audience. Capital investors rebuilt the "Grand Strand" establishing large resorts, hotels, and golf courses (Brosky 2007:4).

From the mid 1950s until present, Myrtle Beach has developed into one to the largest areas for tourism in the world. Today there are over 1,400 restaurants, 7,000 campsites, and over 50,000 hotel rooms. Myrtle Beach attracts over 13 million visitors annually and is ranked as one of the 20 fastest growing communities in the United States (Brosky 2007:4).

Description of Work

Historical Research

M-AT/ER conducted a literature search as part of the investigative effort for the Myrtle Beach Borrow Areas Survey. This research helped document man's activities in the vicinity, thereby providing an understanding of local resource use and human activities. This research focused on primary and secondary materials as compiled by environmental and archeological agencies responsible for managing the local cultural resources and depositories such as libraries and museums. In addition, research included interviews with local historians. Resources used are as follows:

- Charleston Public Library
- South Carolina Historical Society
- Institute of Archaeology and Anthropology, University of South Carolina
- Horry County Historical Society, Conway, South Carolina

Preliminary secondary sources reviewed are as follows:

- The Encyclopedia of American Shipwrecks
- Merchant Steam Vessels of the United States 1807 - 1868
- Shipwrecks of the Western Hemisphere
- Shipwrecks of the Civil War
- Official Records of the Union and Confederate Navies in the War of the Rebellion
- Automated Wreck and Obstruction Information System of the National Oceanic and Atmospheric Administration

Researchers reviewed source materials at each institution, and conducted interviews with librarians to determine the best potential sources for background information on the Myrtle Beach vicinity and potential shipwrecks in the region.

Remote Sensing Survey

M-AT/ER's underwater archaeology team conducted the survey from two equally equipped survey vessels. One vessel was 25-feet in length and the other was 36-feet in length. Three primary remote sensing devices were used: 1) a Geometrics 881 cesium marine magnetometer, 2) a Marine Sonic 600 kHz digital, side-scan sonar and 3) an Ocean Data Equipment Corporation 10 Hz Stratabox sub-bottom profiler system. Each instrument was interfaced with a Starlink Differential Global Positioning System.

Data was collected along parallel lines spaced at 95-foot intervals. Magnetic data, along with corresponding positioning data, was recorded at .5-second sample intervals (or approximately every 5 feet along a track line at 6 knots) using HYPACK™ data acquisition software. Acoustic data was recorded with Marine Sonic Sea Scan® acoustic data acquisition software using an onboard PC computer system. Sub-bottom data was recorded using Stratabox software and Chesapeake Technology, Inc. SonarWiz.Map for post processing. At the end of each day, all remote sensing data was backed up on 180 gigabyte external hard drives.

Data Analysis / Cultural Resources

During field investigations, data being produced by the magnetometer, side-scan sonar and sub-bottom profiler were closely monitored. Targets (magnetic or acoustic) were identified and recorded as they were generated. Also noted on field records was information about the local environment, which included man-made features such as pipelines, channel markers, crab traps, and conditions that could influence magnetic or acoustic data.

After a survey area had been completed, archaeologists edited the magnetic data for detailed analysis and comparison to acoustic data. Editing was performed in three phases. The initial phase consisted of using HYPACK's single-beam editing program to review raw data (of individual survey lines) and to delete any artificially induced noise or data spikes. While editing survey lines, a preliminary target table was developed that included individual target coordinates, signature characteristics, intensity, and duration. Once all survey lines for an area were edited, the edited data was converted to an XYZ file (Easting and Northing State Plane Coordinates, and magnetometer data – measured in gamma), also using HYPACK. Next, the XYZ files were imported into a Triangular Irregular Network (TIN) modeling program (HYPACK) that was used to contour the data in 10-gamma intervals. Once the data was contoured, the contour graphic was converted to a DXF file and imported into AutoCAD in order to clearly view individual magnetic anomalies and their association with acoustic target signatures. Once in AutoCAD, additional editing of the total magnetic intensity was performed without affecting individual magnetic anomalies. For example, dramatic or pronounced diurnal changes that frequently will create a "striped," "zigzag," or "herring bone" pattern in the contour lines can be edited out and averaged across a survey area to create a more realistic and accurate contour map.

A second major analytical technique employed included the subtraction of general background from each successive data sample to develop the actual field gradient. The gradient is the vertical difference (z) between samples. By subtracting successive data samples one from the other the effects of diurnal change is completely eliminated. The resulting data represents only the localized changes in the magnetic background created by ferrous object(s) (i.e. anomalies). When graphically represented by contouring (using the same method described above), only the intensity of variation is represented.

During the analysis process, magnetic anomalies were categorized using the anomaly intensity, duration and/or extent, and signature characteristics. In addition, the anomaly's geographic location was taken into consideration, as well as its association with acoustic target signatures.

After magnetic data was developed into a target list, acoustic data was examined using SeaScan™ acoustic data review software to identify any unnatural or man-made features in the records. Once identified, acoustic features were described using visible length, width, and height from the bottom surface. The coordinates of the acoustic features also were recorded.

Data Assessment (General)

Target signatures were evaluated using the National Register of Historic Places criteria[5] as a basis for the assessment. For example, although a historic object

5 To qualify for the National Register, a historic shipwreck must "meet one or more of the National Register criteria A, B, C, and D. Determining the significance of a historic vessel depends on establishing whether the vessel is 1) the sole, best, or a good representative of a specific vessel type; 2) is associated with a significant designer or builder; or 3) was involved in important maritime trade, naval, recreational, government, or commercial activities" The criteria is described thusly:

A. [B]e associated with events that have made a significant contribution to the broad patterns of our history; or

B. be associated with the lives of persons significant in our past;

C. embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D. have yielded, or may be likely to yield, information important in prehistory or history.

(National Register Bulletin, U.S. Department of the Interior, National Park Service, Interagency Resources Division) might produce a remote sensing target signature, it is unlikely that a single object (such as a cannon ball) has the potential to meet the criteria for nomination to the National Register of Historic Places.

Target assessment was based primarily on the nature and characteristics of the acoustic and magnetic signatures. Shipwrecks – large or small – often have distinctive acoustic signatures, which are characterized by geometrical features typically found only in a floating craft. Most geometrical features identified on the bottom (in open water) are manmade objects. Often an acoustic signature will have an associated magnetic signature. Generally, if the acoustic signature demonstrates geometric forms or intersecting lines with some relief above the bottom surface and have a magnetic signature of any sort; it can be categorized as a potentially significant target. Often, modern debris near docks, bridges, or an anchorage is easily identified solely based on the characteristics of its acoustic signature. However, it is more common to find material partially exposed. Frequently, these objects produce a record that obviously indicates a man-made object, but the object is impossible to identify or date. In making an archaeological assessment of any sonogram record, the history and modern use of the waterway must be taken into consideration. Naturally, historically active areas tend to have greater potential for submerged cultural resources. The assessment process prioritizes targets for further underwater archaeological investigations.

Magnetic target signatures alone are more difficult to assess. Without any supporting sonogram record, the nature of the bottom sediments and the water currents become more important to the assessment process. A small, single-source magnetic signature has the least potential to be a significant cultural resource. Although it might represent a cannon ball or historic anchor, this type of signature has little potential to meet National Register criteria.

A more complex magnetic anomaly, represented by a broad monopolar or dipolar type signature, has a greater potential to be a significant cultural resource, depending on bottom type. Shipwrecks that occur in regions with hard bottoms, with little migrating sand, tend to remain exposed and are often visible on sonogram records. A magnetic anomaly that is identified in a hard bottom area and has no associated acoustic signature frequently can be discounted as being a historic shipwreck. Most likely, such an anomaly is modern debris, such as wire rope, chain, or other ferrous material.

Soft migrating sand or mud can bury large wrecks, leaving little or no indication of their presence on the bottom surface. The types of magnetic signatures that a boat or ship might produce are infinite, because of the large number of variables including location, position, chemical environment, other metals, vessel type, cargo, sea state, etc. These variables are what determine the characteristics of every magnetic target signature. Since shipwrecks occur in a dynamic environment, many of the variables are subject to constant change. Thus, in making an assessment of a magnetic anomaly's potential to represent a significant cultural resource, investigators must be circumspect in their predictions.

Broad, multi-component signatures (again, depending on bottom characteristics and other factors) often have the greatest potential to represent a shipwreck. On the other hand, high-intensity, multi-component, magnetic signatures (without an accompanying acoustic signature) in areas of relatively high velocity currents can be discounted as a historic resource. Eddies created by the high-velocity currents almost always keep some portion of a wreck exposed. Generally, wire rope or some other low-profile ferrous debris produces this type of signature in these circumstances. Many types of magnetic anomalies display characteristics that are not easily interpreted. The only definitive method of determining the nature of the object creating these anomalies is by physical examination.

Description of Findings and Recommendations

Identification of Submerged Cultural Resources

A total of five targets were identified within the three areas. Only one (1) magnetometer anomaly with corresponding sonar target signature was found in the Surfside borrow area. One (1) magnetic anomaly was identified in the Cane South borrow area and two (2) magnetic anomalies were found in Little River borrow area. None of the magnetic anomalies in Cane South or Little River Borrow Area had corresponding sonar target signatures. There was one sonar target signature in Little River borrow area that had no associated magnetic signature (Figures 5, 6, and 7).

Surfside A

SC State Plane x=2626302 y=631752

Surfside A has a dipolar magnetic signature with an intensity of more than 120 nT. An acoustic target signature with three aligned objects protruding approximately 1-foot above the bottom over 27 feet in length was associated with the magnetic signature (Figures 8 and 9). Target Surfside A is recommended for additional underwater investigations to identify and assess its potential as an archaeological resource. If underwater archaeological investigations are not an option, an avoidance buffer of at least 200 feet (radius) around the target coordinates should be establish prior to dredging activities.

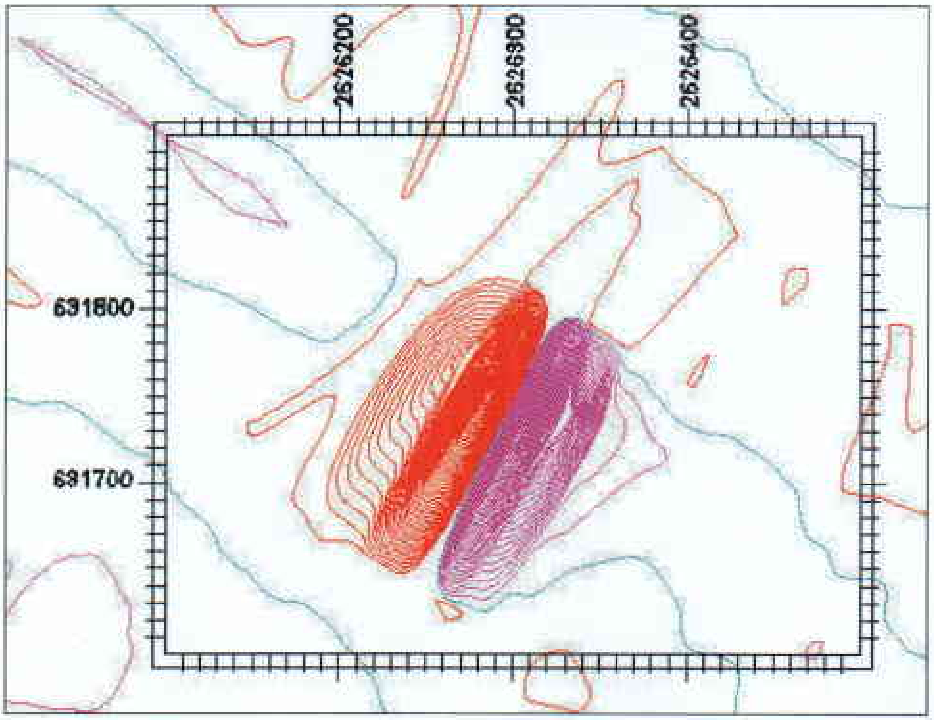

Figure 5. Target Surfside A Magnetic Signature

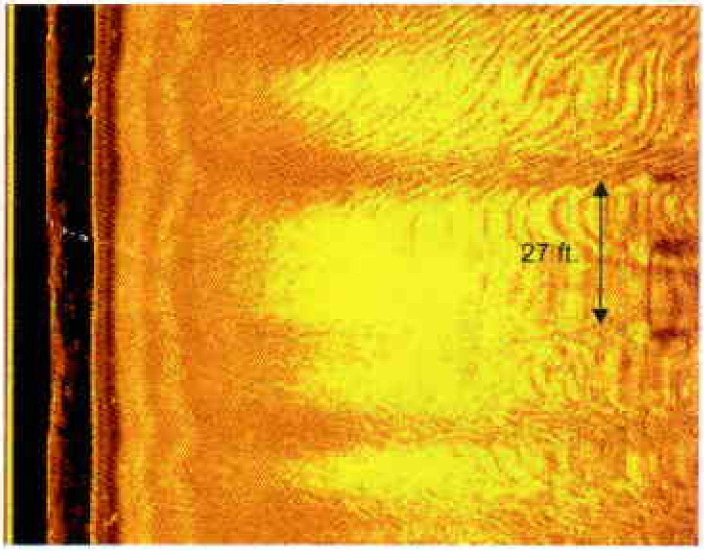

Figure 6.Target Surfside A Sonar Signature.

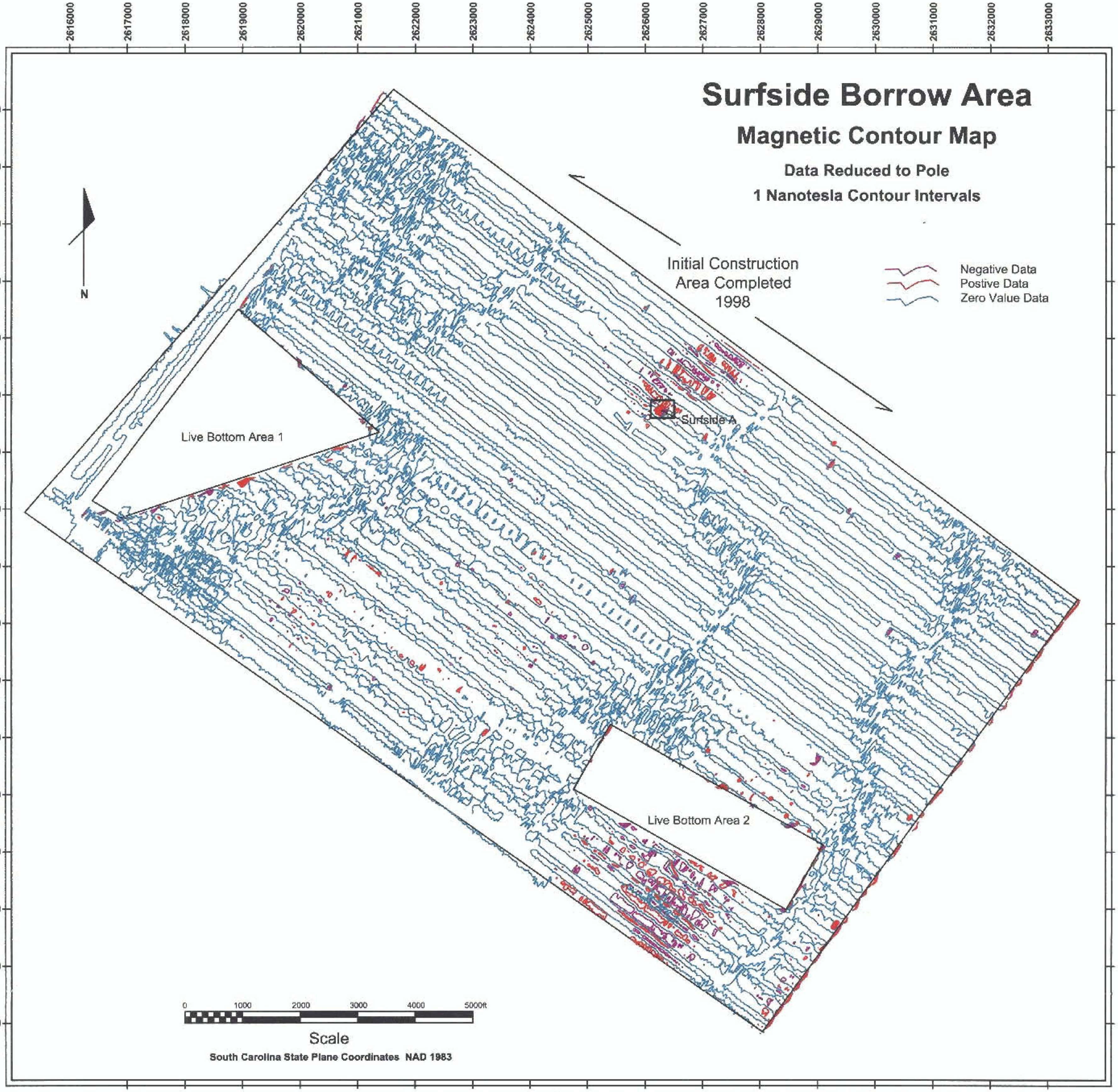

Figure 7. Surfside Borrow Area Magnetic Contour and Target Location Map.

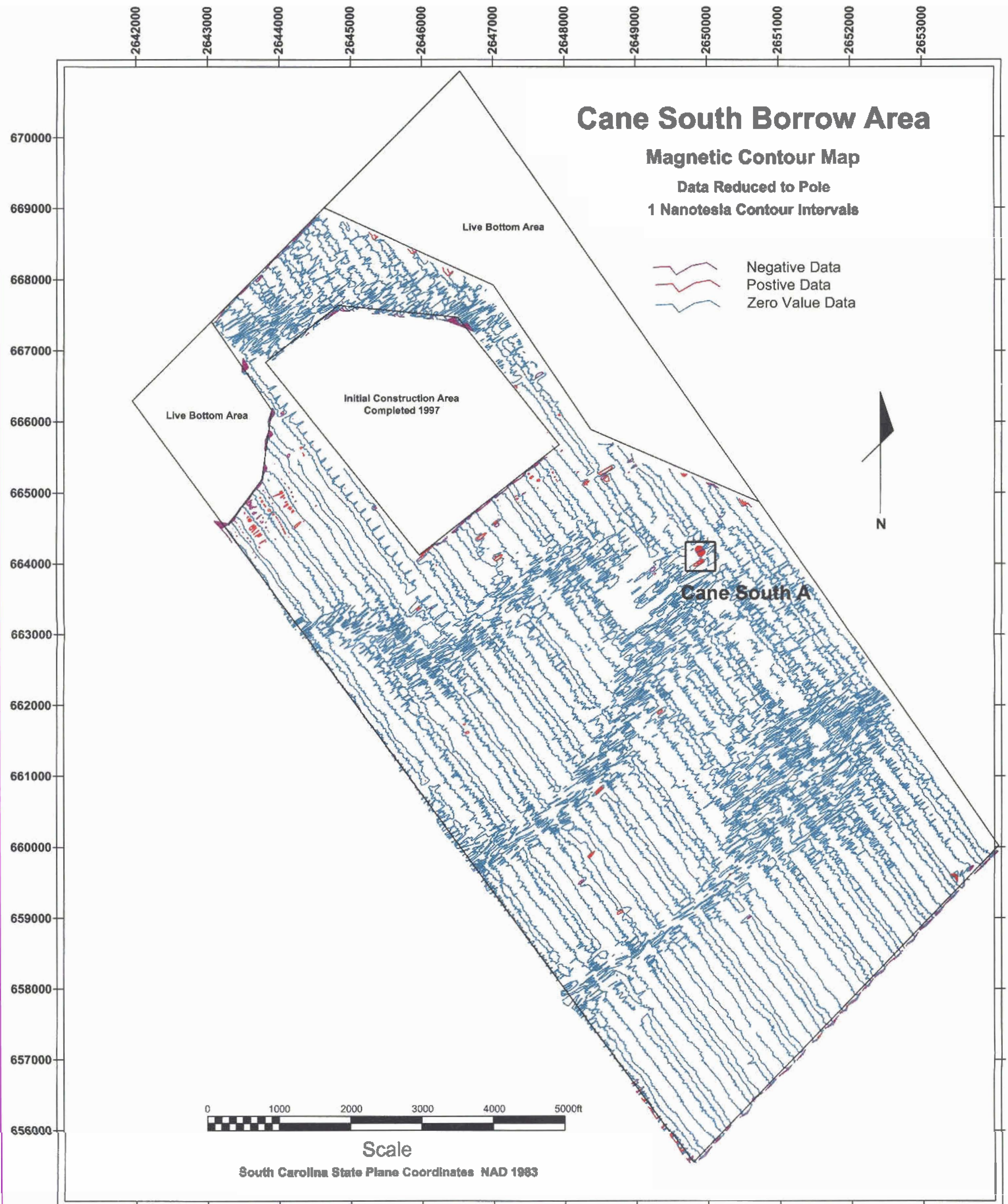

Figure 8. Cane South Borrow Area Magnetic Contour and Target Location Map.

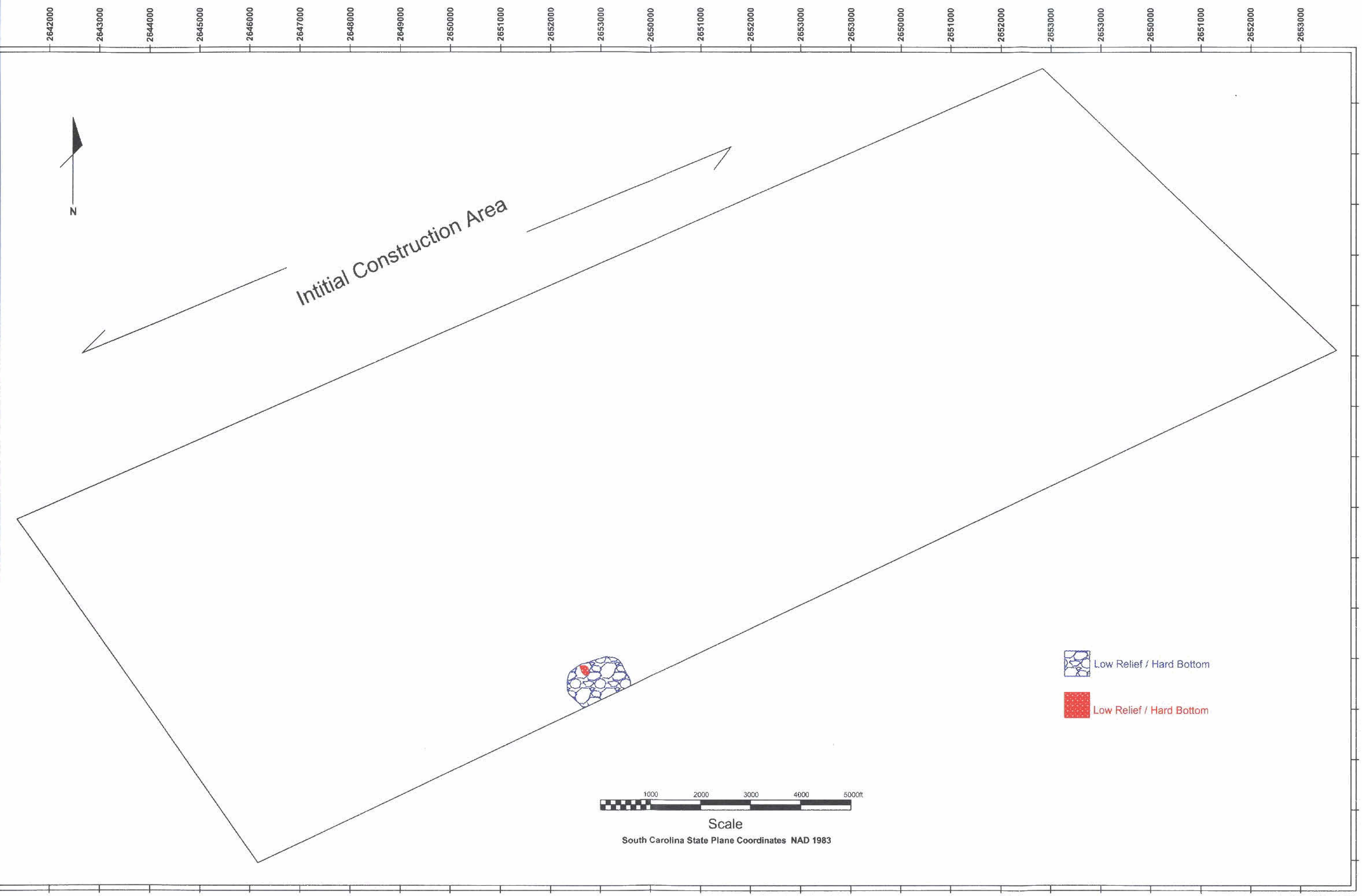

Figure 26. Little River Borrow Area Har Bottom Map.

Cane South A

SC State Plane x=2626302 y=631752

Cane South A has a multi-component magnetic signature with an intensity of more than 32 nT. No acoustic target signature found in association with the magnetic signature (Figure 10). Target Cane South A appears to be a small single source anomaly. The target has little potential to be associated with a significant cultural resource. No additional underwater archaeological investigations are recommended.

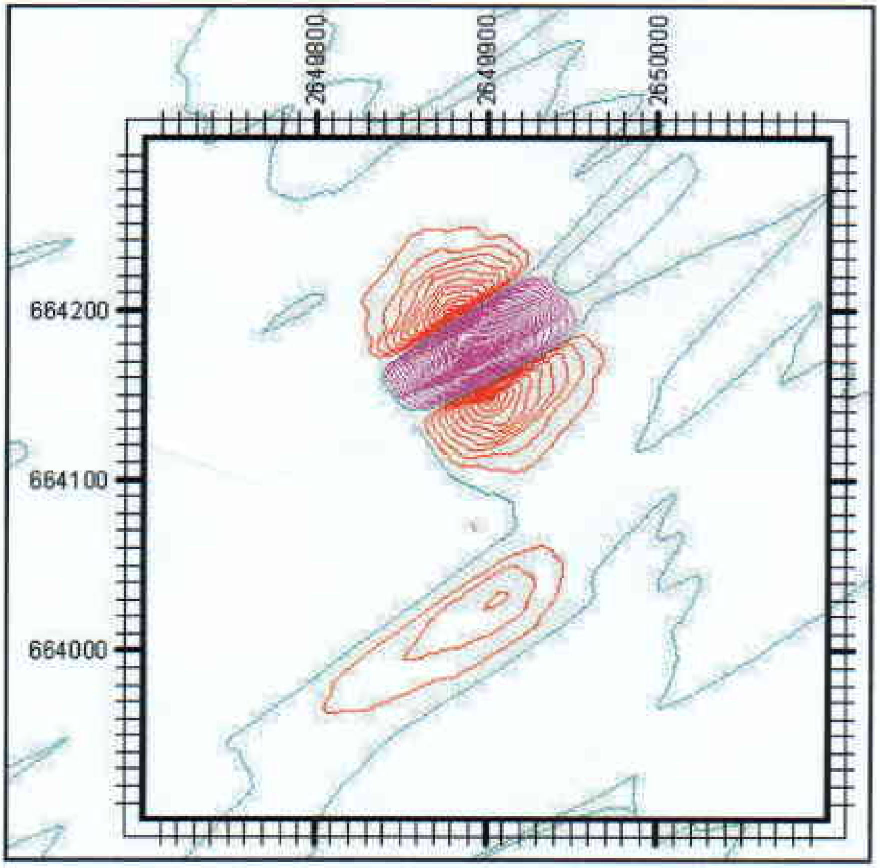

Figure 10. Target Cane South A Magnetic Signature

Little River A
SC State Plane x=2626302 y=631752
Little River A has a multi-component magnetic signature with an intensity of more than 21 nT. No acoustic target signature found in association with the magnetic signature (Figures 11). Target Little River A appears to be a small single source anomaly. The target has little potential to be associated with a significant cultural resource. No additional underwater archaeological investigations are recommended.

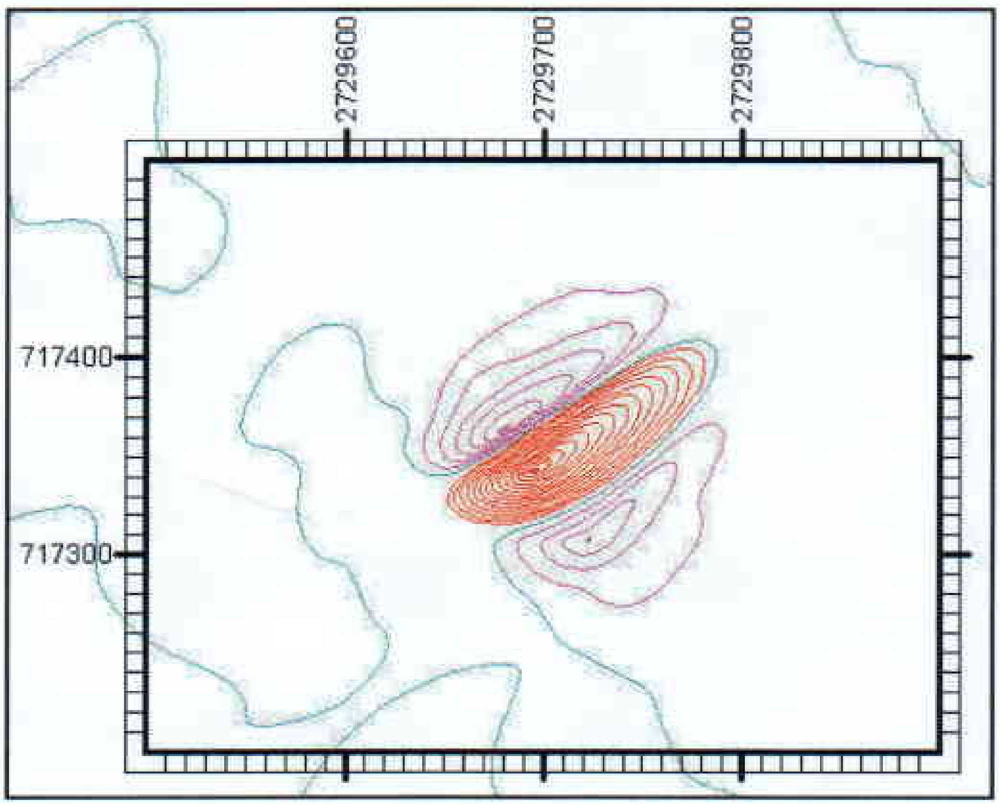

Figure 11. Little River A Magnetic Contour Signature

Little River B
SC State Plane x=2626302 y=631752
Little River B. No Magnetic signature was detected in association with Little River B Side scan records identified an 8-foot wide by 12- foot long rectangular object with other associated linear objects (Figures 12). Target Little River B does not exhibit characteristic associated with a shipwreck. It may be associated with modern fishing tackle or other miscellaneous debris. No additional underwater archaeological investigations are recommended.

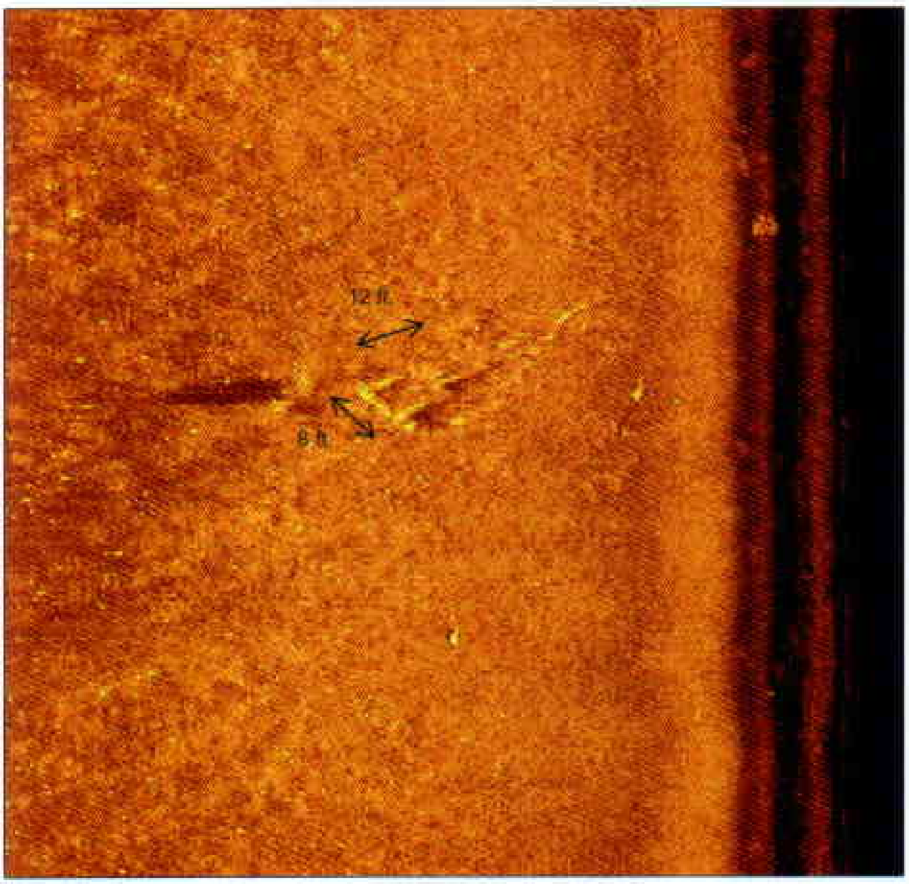

Figure 12. Little River B Acoustic Target Signature

Little River C
SC State Plane x=2626302 y=631752

Little River A has a multi-component magnetic signature with an intensity of more than 18 nT. No acoustic target signature found in association with the magnetic signature (Figure 13). Target Little River C appears to be a small single source anomaly. The target has little potential to be associated with a significant cultural resource. No additional underwater archaeological investigations are recommended.

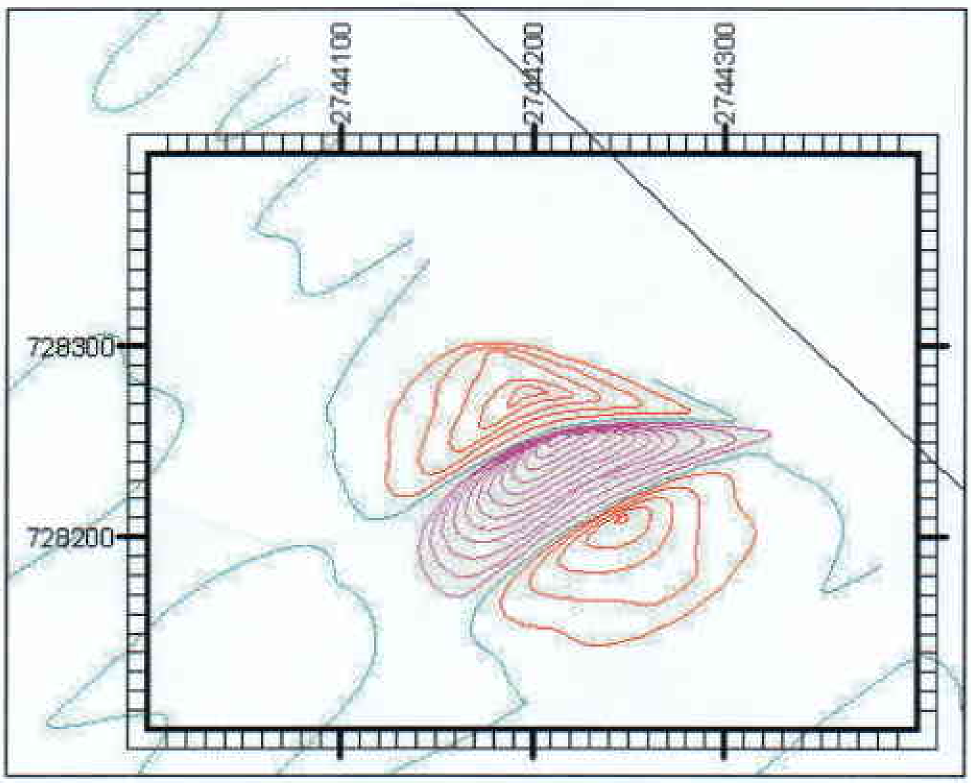

Figure 13. Little River C Magnetic Contour Signature.

Sub-bottom Survey

The sub-bottom profile survey was carried out in concert with the magnetometer and side scan sonar surveys. The purpose of the sub-bottom survey was to identify any potential Late Pleistocene or Holocene deposits that may still support direct evidence of prehistoric occupation within the proposed borrow areas. In addition to the sub-bottom investigations M-AT/ER also examined coring data collected within each borrow area and reviewed past geophysical studies conducted in the region.

Vibracoring was conducted in each borrow area by Athena Technologies, Inc. in 1991. Coring was accomplished using 21 foot long samplers vibrated from a deck operated system aboard the research vessel *Lady Athena*. Cores were vibrated to a depth of 20 feet or less if refusal was met, in which case coring was stopped after five minutes had elapsed.

Also, extensive marine geophysical investigations have been carried out in the Long Bay region between the North Carolina border and Winyah Bay as part of the South Carolina Coastal Erosion Study (SCCES). The study is an ongoing cooperative research program funded by the U.S. Geological Survey Coastal and Marine Geology Program and managed by the South Carolina Sea Grant Consortium (Voulgaris, G. et al. 2004:1).

As part of the SCCES project, geological mapping was conducted in 1999 through 2004 in the region between Little River to Winyah Bay using boomer and Chirp sub-bottom profilers. As a result of these investigations, reflection profiles demonstrate a shallow geologic framework within Long Bay. Bedding planes were formed from eroded and incised Cretaceous and Tertiary strata (reflectors) with an overlying marine transgressive unconformity that is composed of Pleistocene and younger sediments (Figure 14). These transgressive sediments are patchy and discontinuous lens that have filled Pleistocene incisions cut into the bedding planes (Baldwin et. al. 2004).

Previous studies as well as onshore coastal borings in the vicinity of Myrtle Beach and Surfside Beach identified this region to be an intersection of Cretaceous and Tertiary units. Although the approximate area of the unconformity is known to be near Surfside Beach it is difficult to differentiate Cretaceous from the Tertiary in the offshore sub-bottom records (Balwin et. al. 2004).

In the northern part of the study area (Little River) exposed outcrops or hardgrounds appear to be Cretaceous in age. In the central study area (Garden City) hardgrounds were Tertiary in age. In the southern project (Winyah Bay) no exposed hardground was identified within the ancestral Pee Dee River System. Rather the bottom was covered by a continuous modern sediment veneer associated with the fluvial deposit (Schwab 1999).

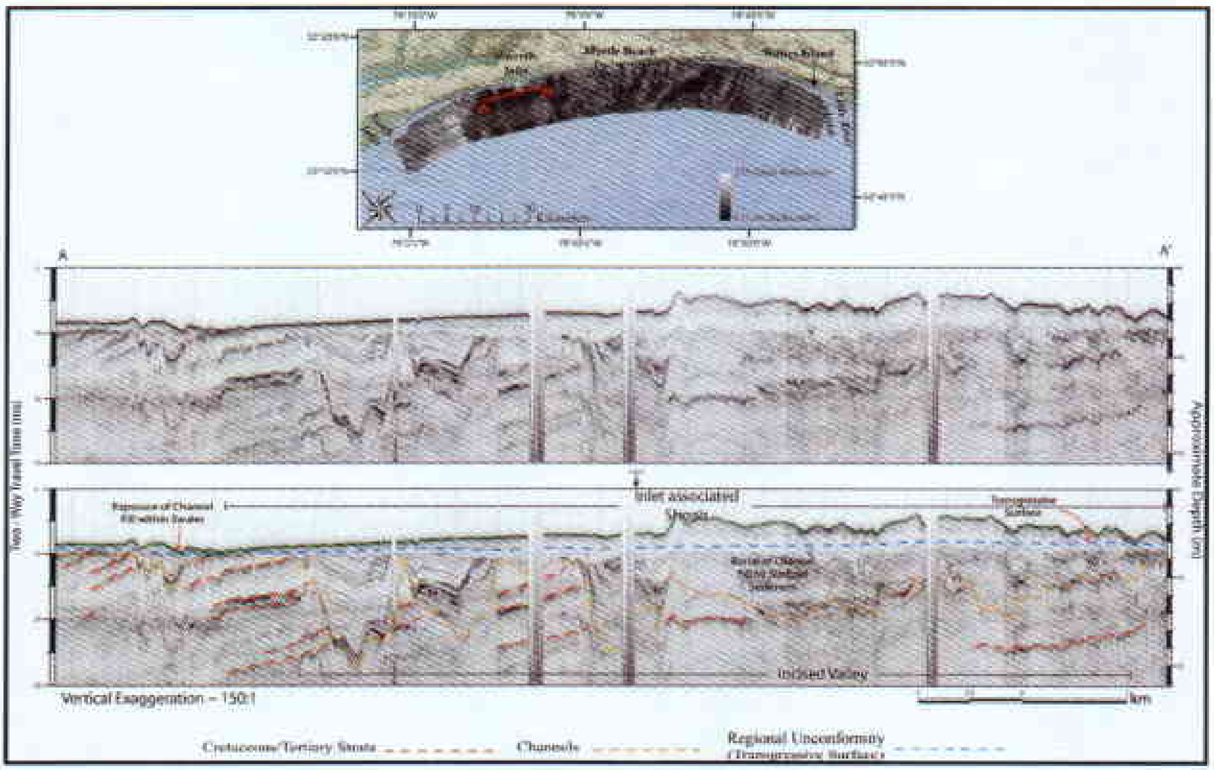

Figure 14. Seimic stratigraphy interpretation of Long Bay from SCCES. (Balwin et. al. 2004)

Sub-bottom Analysis

Analysis of sub-bottom data was based on comparisons of 1991 coring data with sub-bottom data collected by M-AT/ER using the ODEC 10 Hz Stratabox system. Identification of hard reflectors (bedding planes) was based on the findings of the SCCES seismic investigations.

Discussion and Findings of Sub-Bottom Investigations

Late Pleistocene and Holocene strata or structure within the three borrow areas overlies a highly variable Tertiary or late Cretaceous framework. The top of these earlier formations are well eroded or incised by Pleistocene streams or inlets forming readily discernable channels and ridges in seismic profiles. Overlying Pleistocene sediments are discontinuous and their distribution and are depended on the topography of the Tertiary or Cretaceous foundation on which they are seated. Late Pleistocene sediments appear to be thinly arranged in overlapping bedded sequences and distinguished (in core samples) from apparent Holocene deposits by shell lag deposits.

Surfside Borrow Area

In the Surfside Borrow Area sub-bottom records provide clear evidence of regressive and transgressive deposition pattern (Figures 16). A paleochannel or paleoestuary is evident through the central portion of the borrow area. Along northern portion of this channel is a well defined sequence boundary. The channel is filled with layered

Pleistocene deposits to depths exceeding 17 feet. On either side of the paleochannel the surficial and transgressive sediments form a thin (less than 60 inches) to non-existent layer over a gradually sloping Tertiary or Createaceous platform (Figures 17, 18, 19 and 20). These upper sediments appear to be well sorted and reworked by hydrodynamic and or other coastal processes.

Within the sub-bottom records, there is no indication of stratification or protected deposition of surficial (Late Pleistocene or Holocene) sediments that would contain or support any remnant evidence of human occupation or usage. No additional underwater archaeological investigations are recommended within the Surfside Borrow Area.

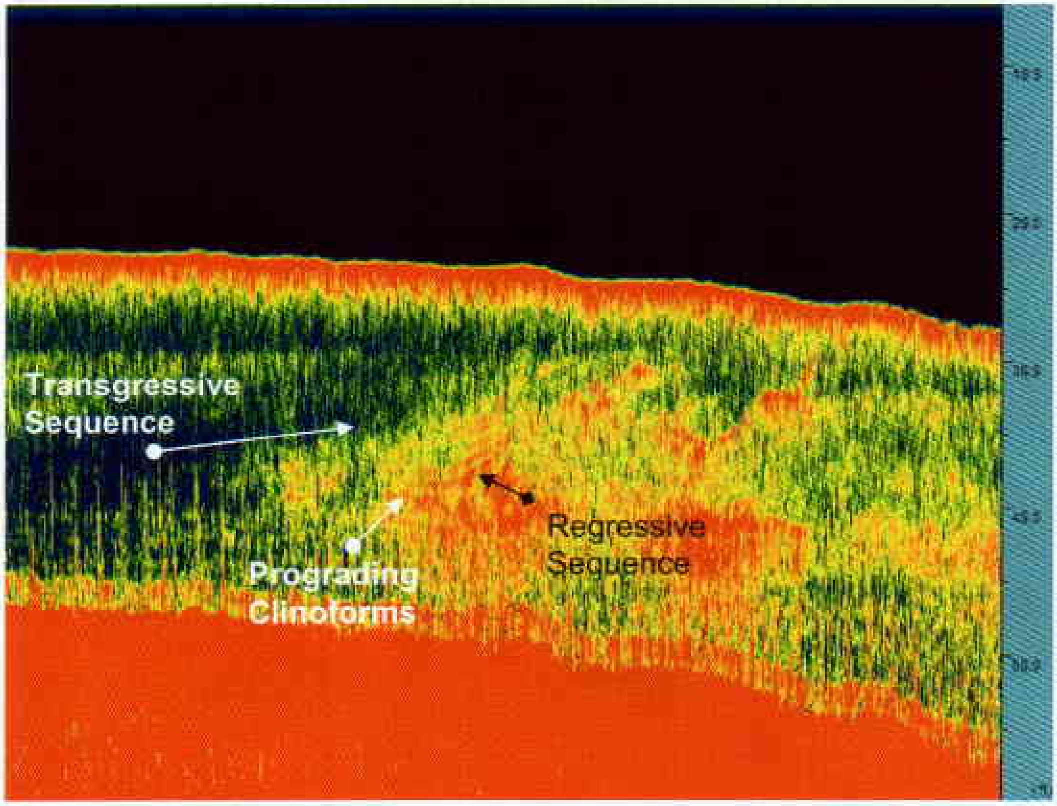

Figure 15. Regressive / Transgressive Sequence Boundary Surfside Borrow Area

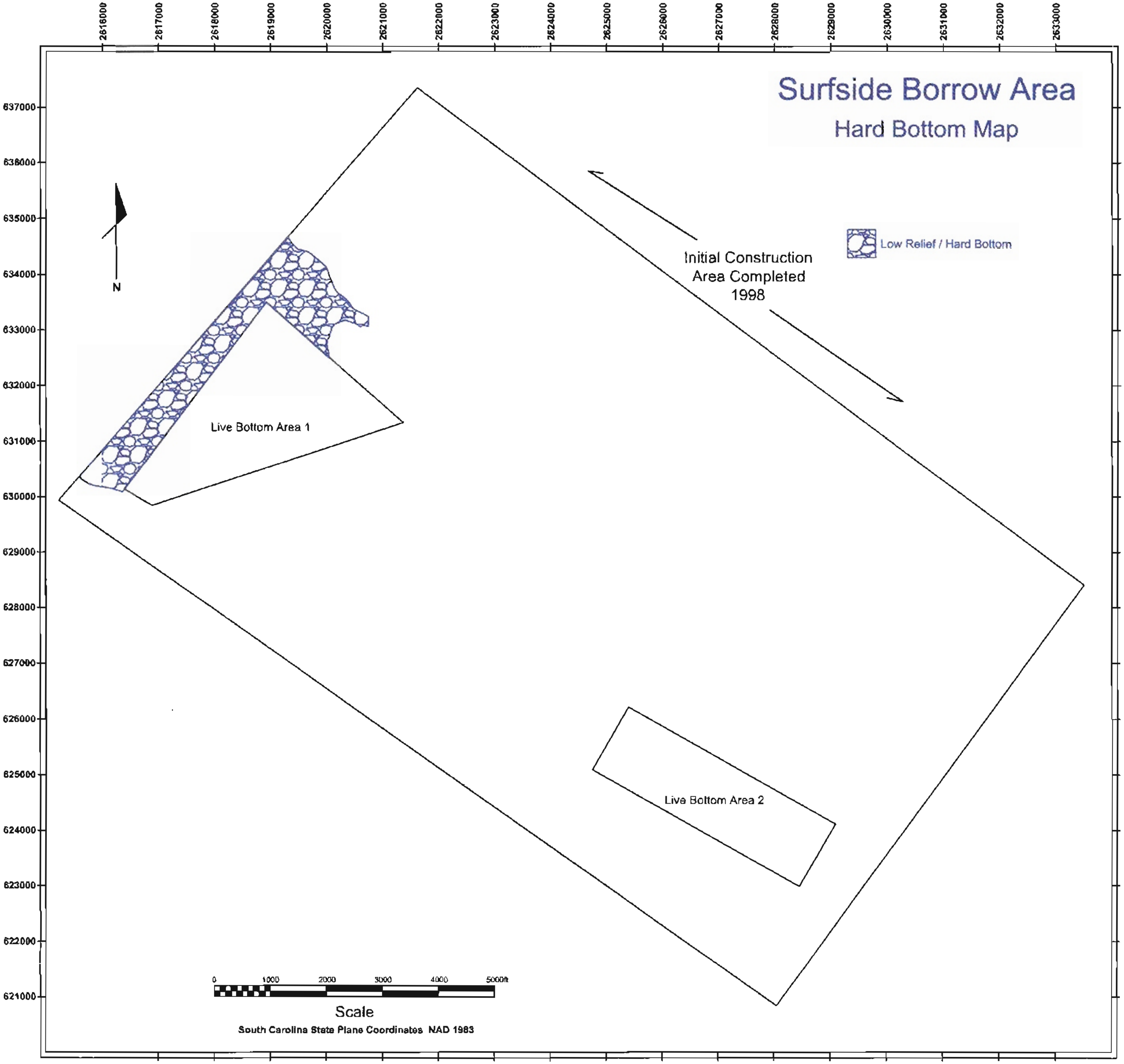

Figure 28. Surfside Borrow Area Hard Bottom Map.

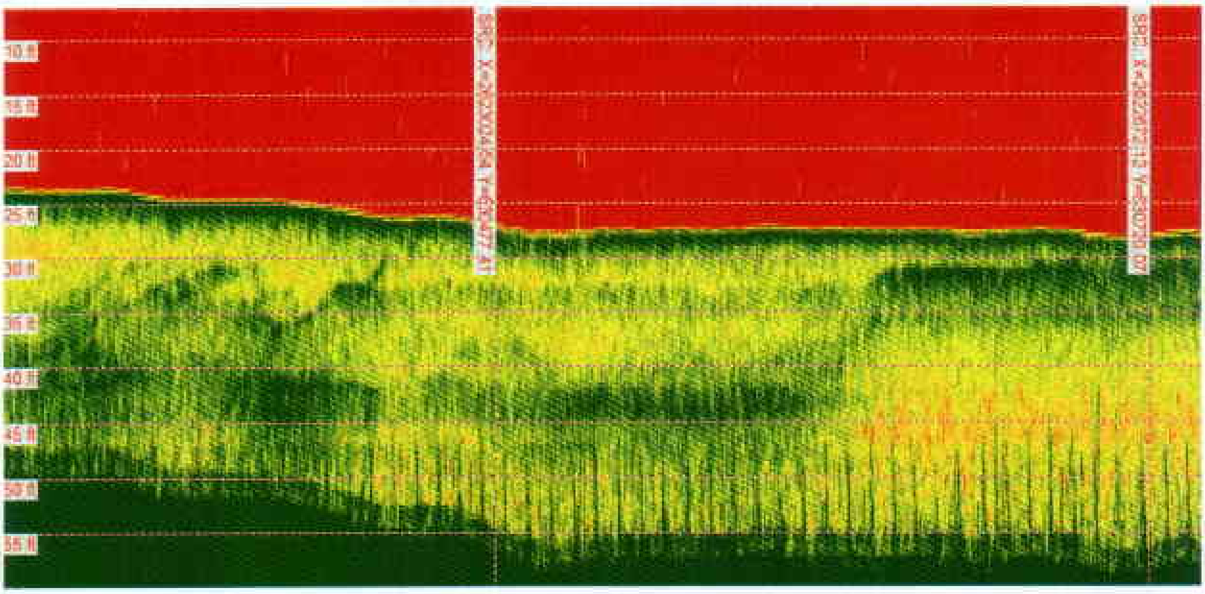

Figure 17. Surfside Borrow Area Regressive / Transgressive Squence Boundary

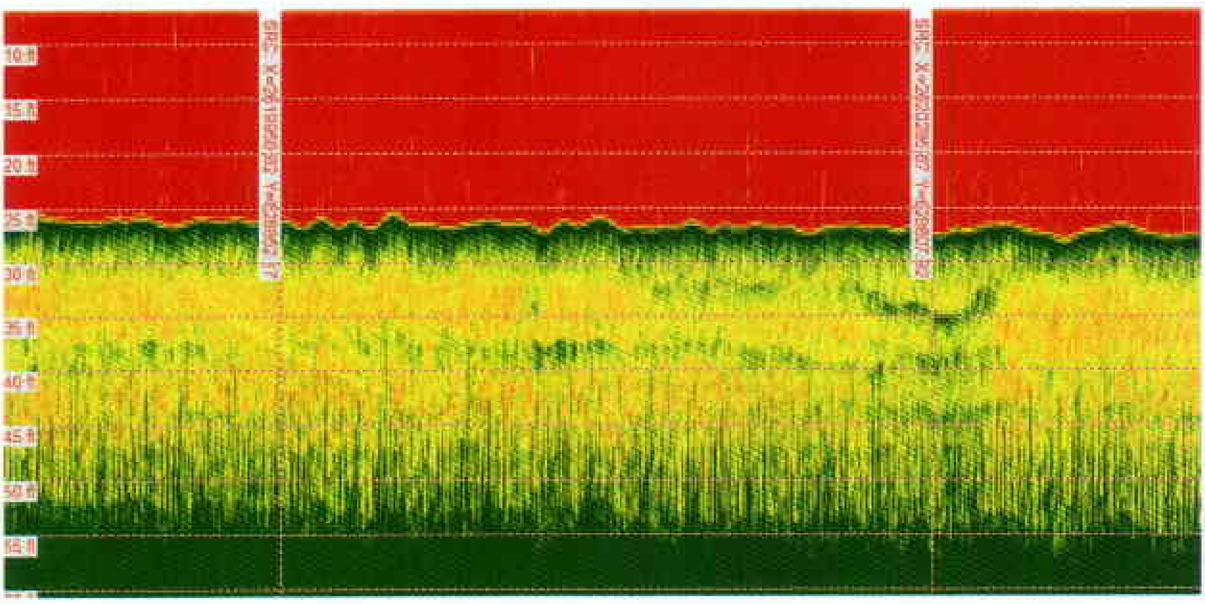

Figure 18. Pleistocene Deposits within PaleoChannel Surfside Borrow Area.

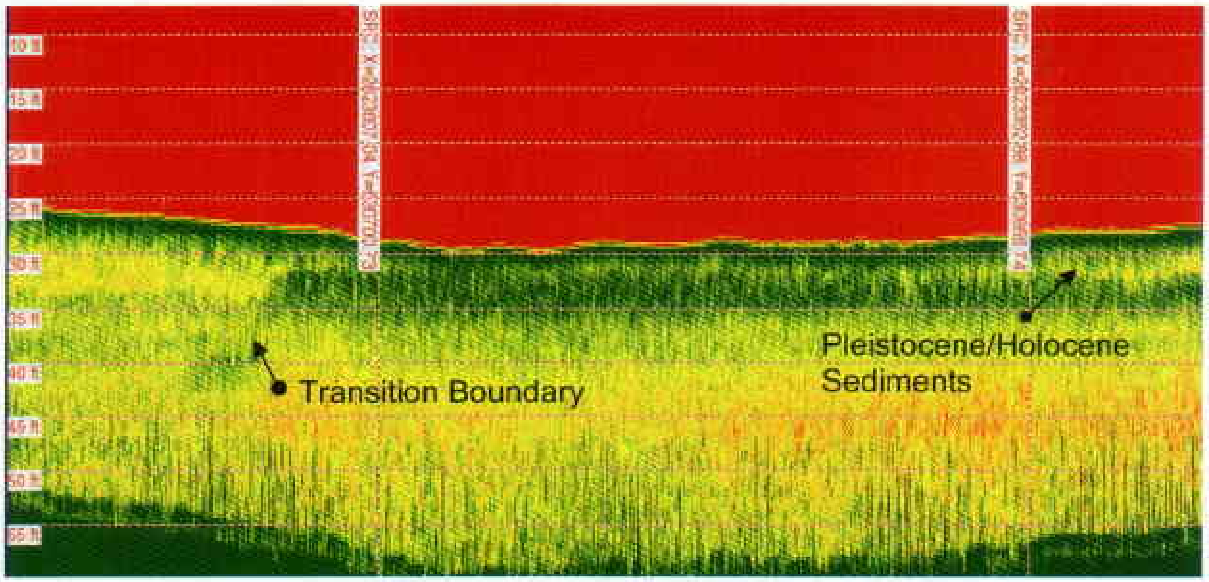

Figure 19. Transition from Paleochannel to Thinly Covered Tertiary/Cretaceous Shelf

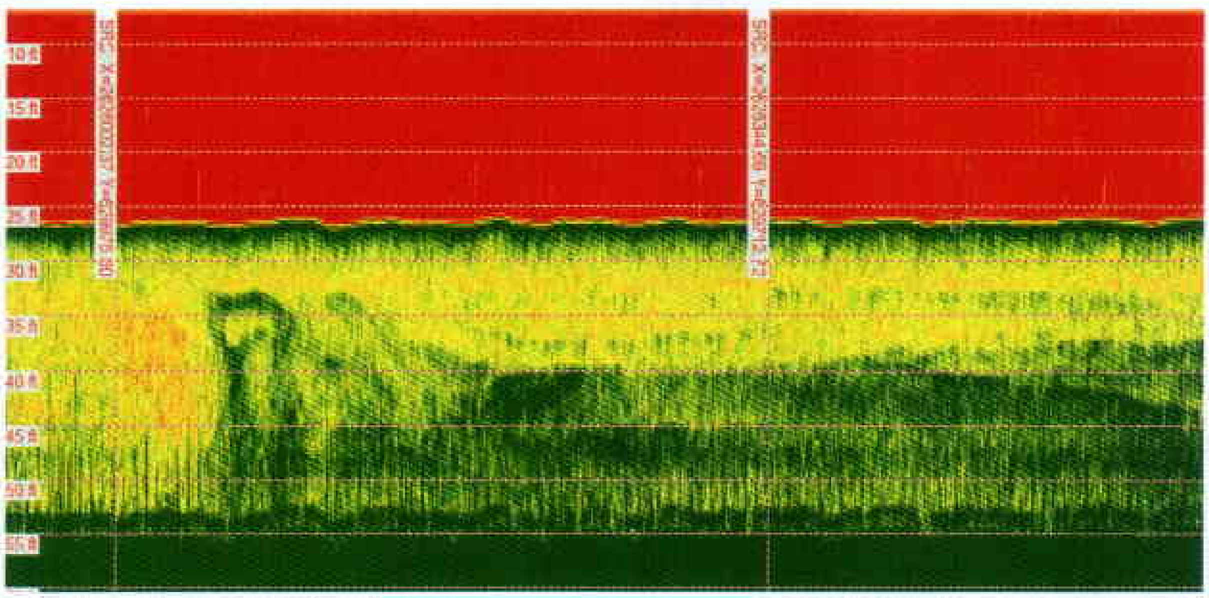

Figure 20. Offshore Paleochannel Boundary Possible Transition to Strandplain

Cane South Borrow Area

In the Cane South Borrow Area sub-bottom records were difficult to interpret but do provide evidence of a regressive and transgressive deposition (Figures 21, 22, and 23). Continental Shelf substrate appears to be incised by at least two diverging paleochannels within the borrow area. The channels are filled with layered Pleistocene deposits to depths exceeding 17 feet. On either side of the paleochannels the surficial and transgressive sediments form a thin (less than 60 inches) to non-existent layer over a gradually sloping Tertiary or Createaceous platform. These upper sediments appear to be well sorted and reworked by hydrodynamic and or other coastal processes.

Within the sub-bottom records, there is no indication of stratification or protected deposition of surficial (Late Pleistocene or Holocene) sediments that would contain or support any remnant evidence of human occupation or usage. No additional underwater archaeological investigations are recommended within the Surfside Borrow Area.

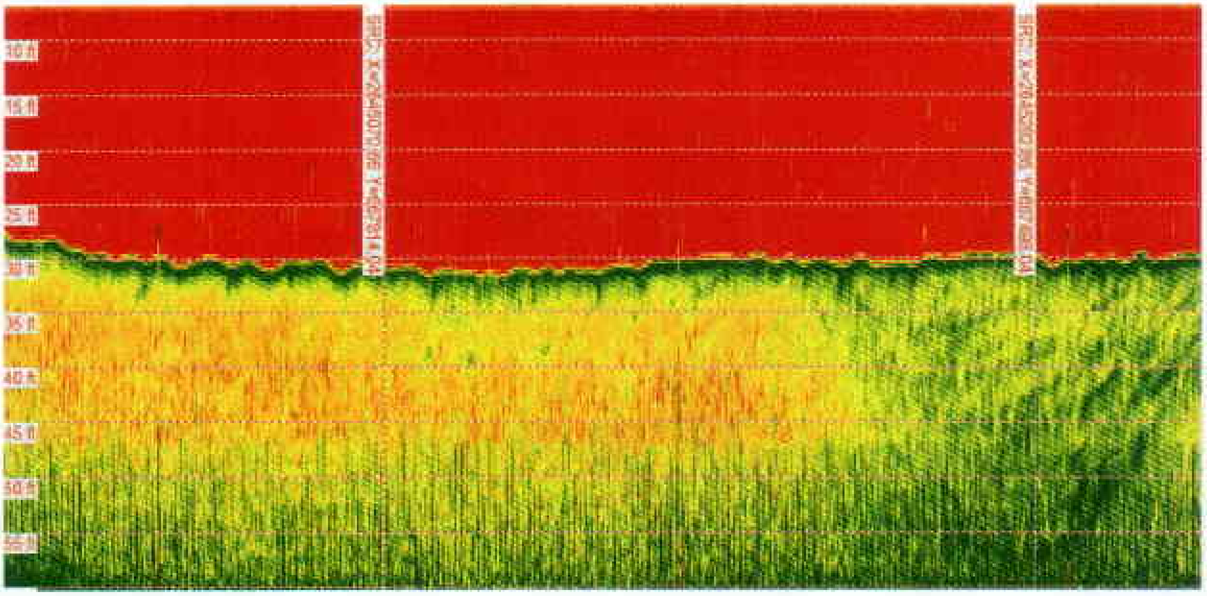

Figure 21. Narrow Incised PaleoChannel Cane Borrow Area.

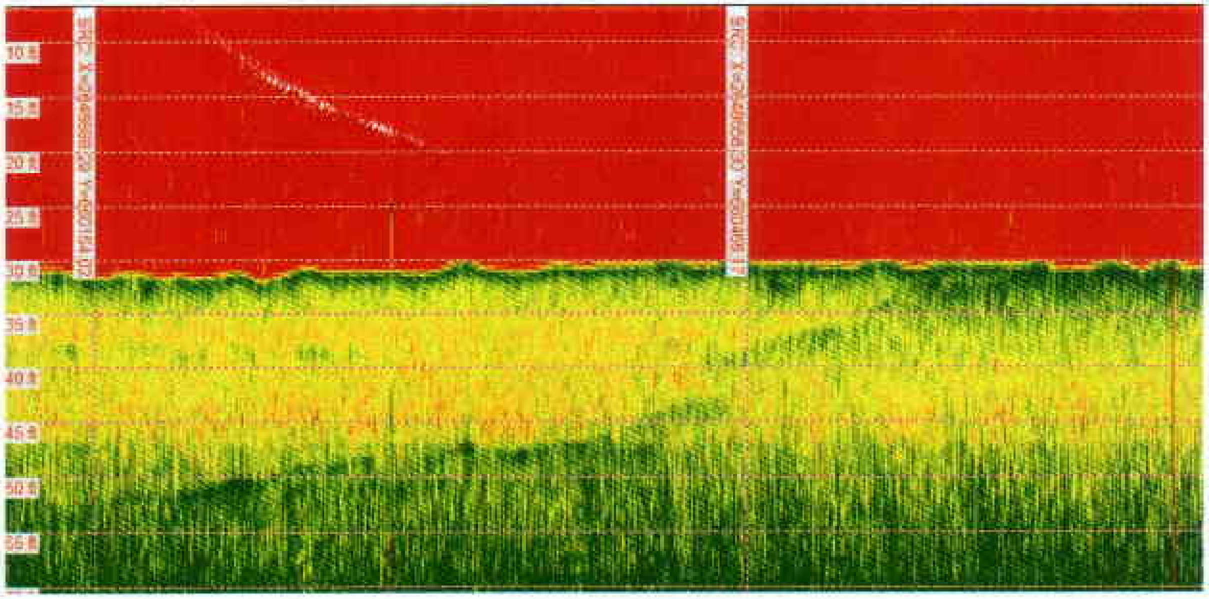

Figure 22. Transition from Paleochannel to Thinly Covered Tertiary/Cretaceous Shelf.

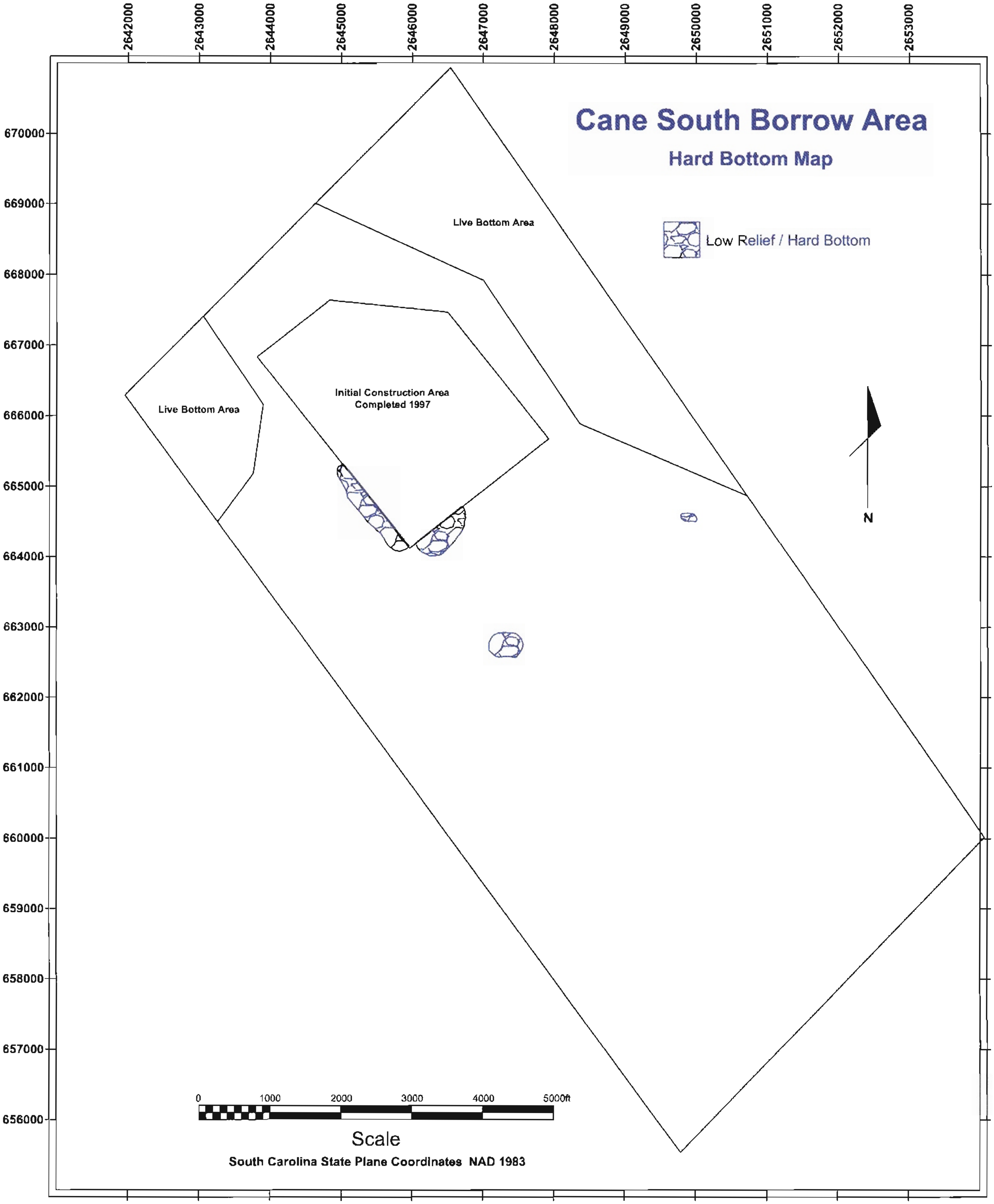

Figure 30. Cane South Borrow Area Hard Bottom Map.

Little River Borrow Area

In the Little River Borrow Area sub-bottom records and coring data identified only a thin (48 inches or less) to nonexistent layer of sediments overlying a relatively flat Cretaceous substrate (Figures 24, 25,and 26). These sediments appear to be well sorted and reworked by hydrodynamic and or other coastal processes.

Within the sub-bottom records, there is no indication of stratification or protected deposition of surficial (Late Pleistocene or Holocene) sediments that would contain or support any remnant evidence of human occupation or usage. No additional underwater archaeological investigations are recommended within the Surfside Borrow Area.

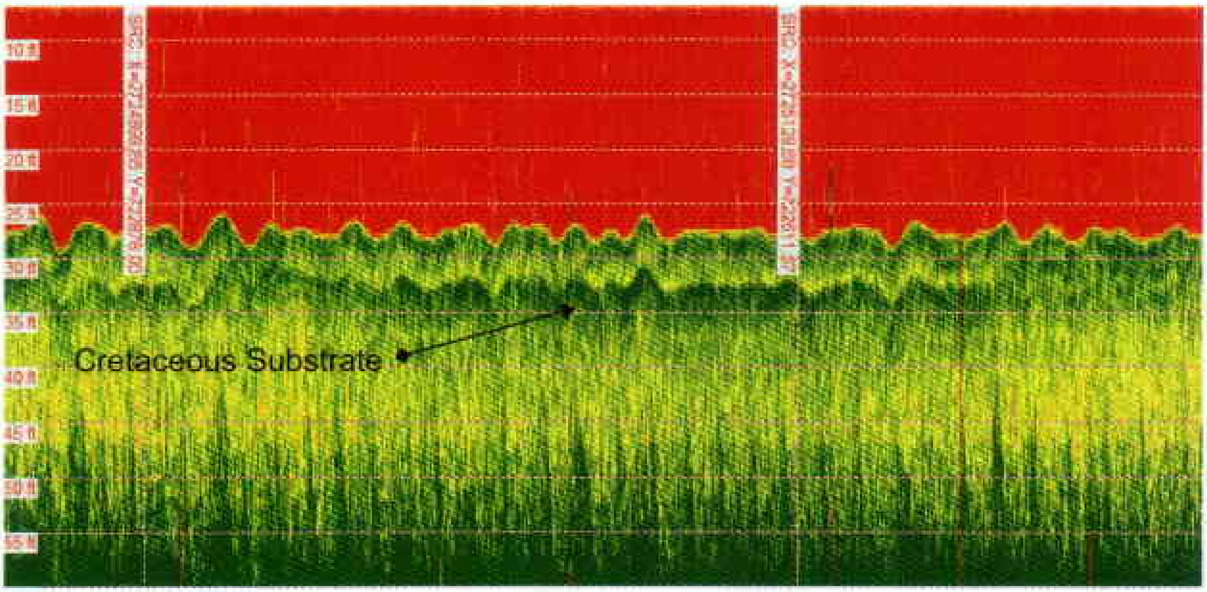

Figure 24. Typical Profile Across Entire Little River Borrow Area.

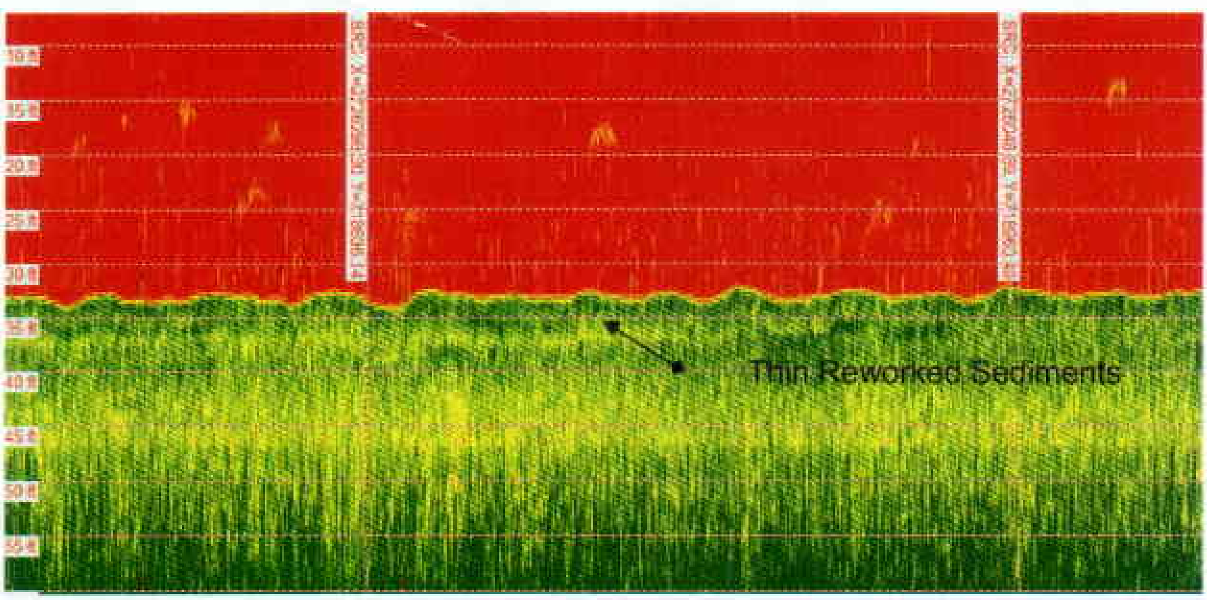

Figure 25. Thin Pleistocene/Holocene Sediments.

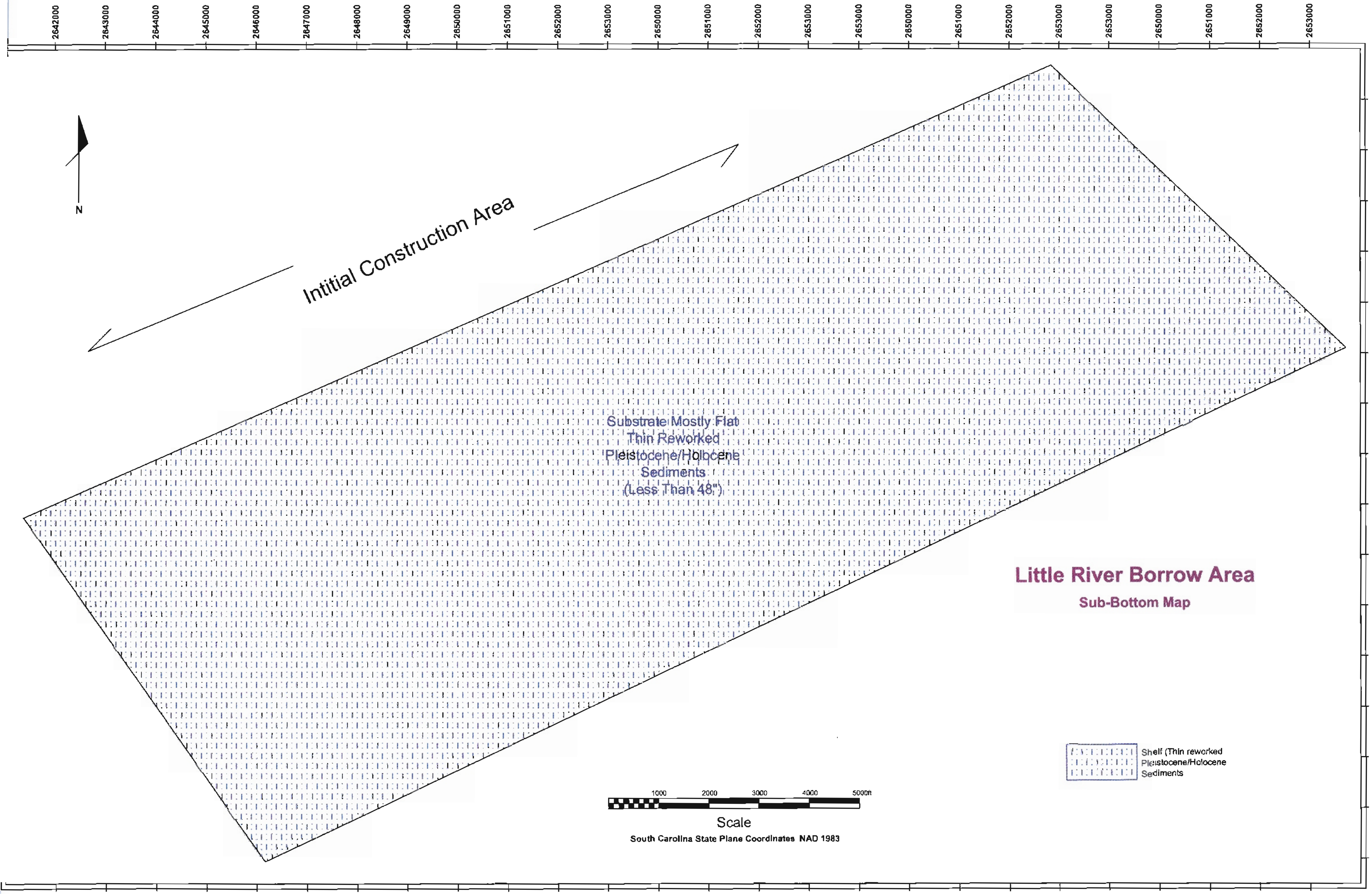

Figure 26. Little River Borrow Area Sub-Bottom Map.

Identification of Hard Bottom Areas

M-AT/ER reviewed acoustic records (side-scan sonar and sub-bottom) to identify and define areas that were "hard bottom" or habitat for marine animals. Hard bottom areas were defined as areas larger than 1,800 square meters. Other characteristics include "low" protrusions – the majority of the area less than .5-meters above the bottom; "moderate" protrusions – the majority of the area 1 to 2 meters above the bottom; and "high" protrusions – more than 2 meters above the bottom.

Surfside Borrow Area

Low relief hard bottom was identified along the northern side of a known "Live bottom" area within the Surfside Borrow Area. Below is a typical example side scan sonar images of low relief hard bottom in that vicinity (Figure 27 and 28).

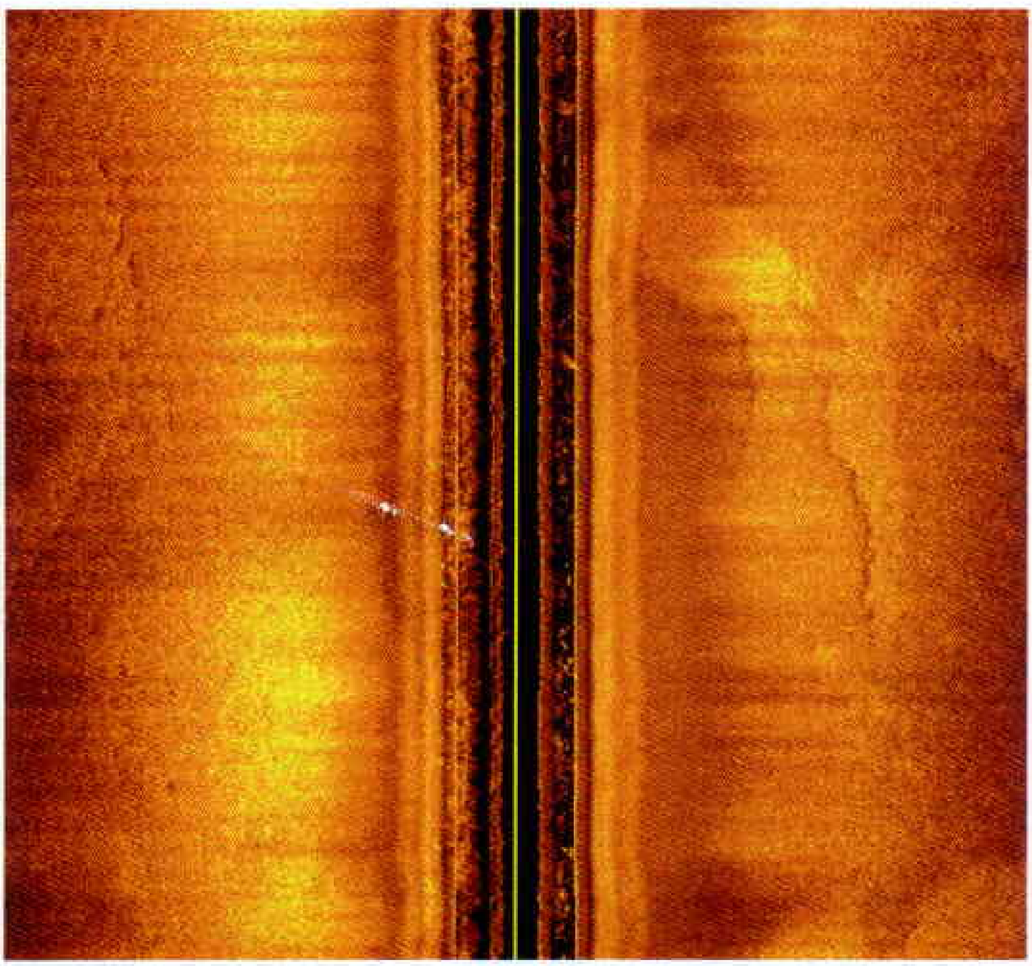

Figure 27. Surfside Borrow Area - Low Relief Hard Bottom.

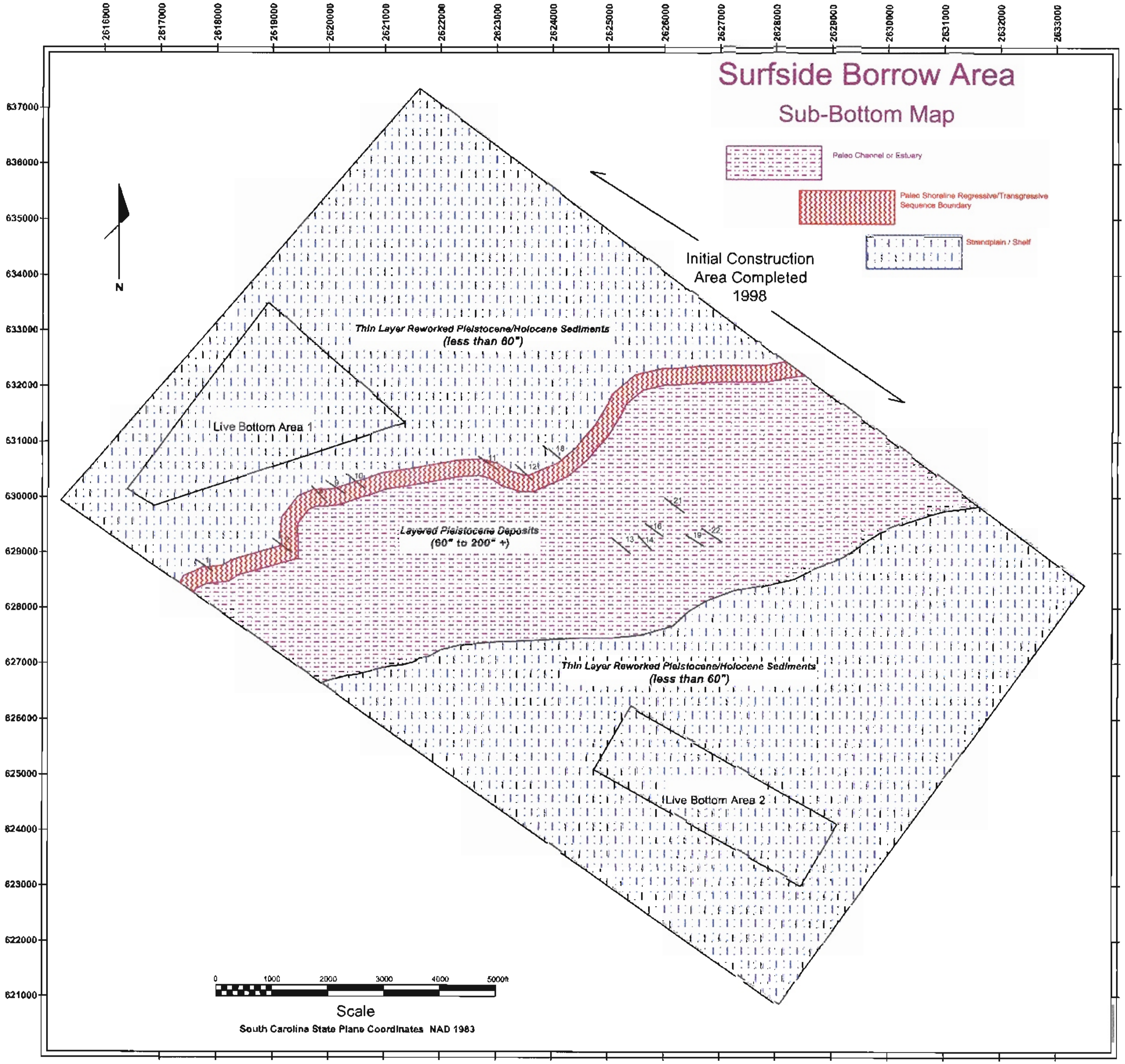

Figure 7. Surfside Borrow Area Sub-bottom Map.

Cane South Borrow Area
Low relief hard bottom was identified to the north of known "Live bottom" area within the northwest portion of Cane South Borrow Area. Below is a typical example side scan sonar images of low relief hard bottom in that vicinity (Figures 29 and 30).

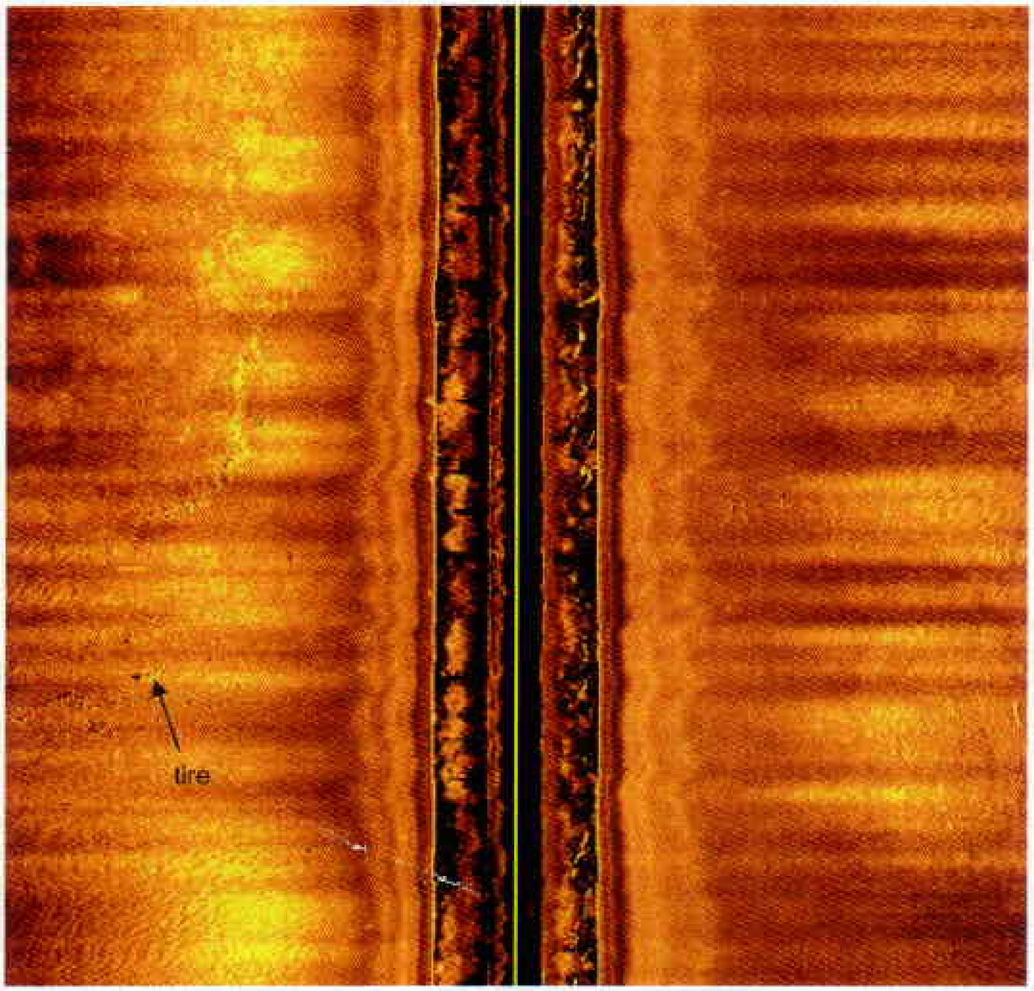

Figure 29. Cane South Borrow Area - Low Relief Hard Bottom.

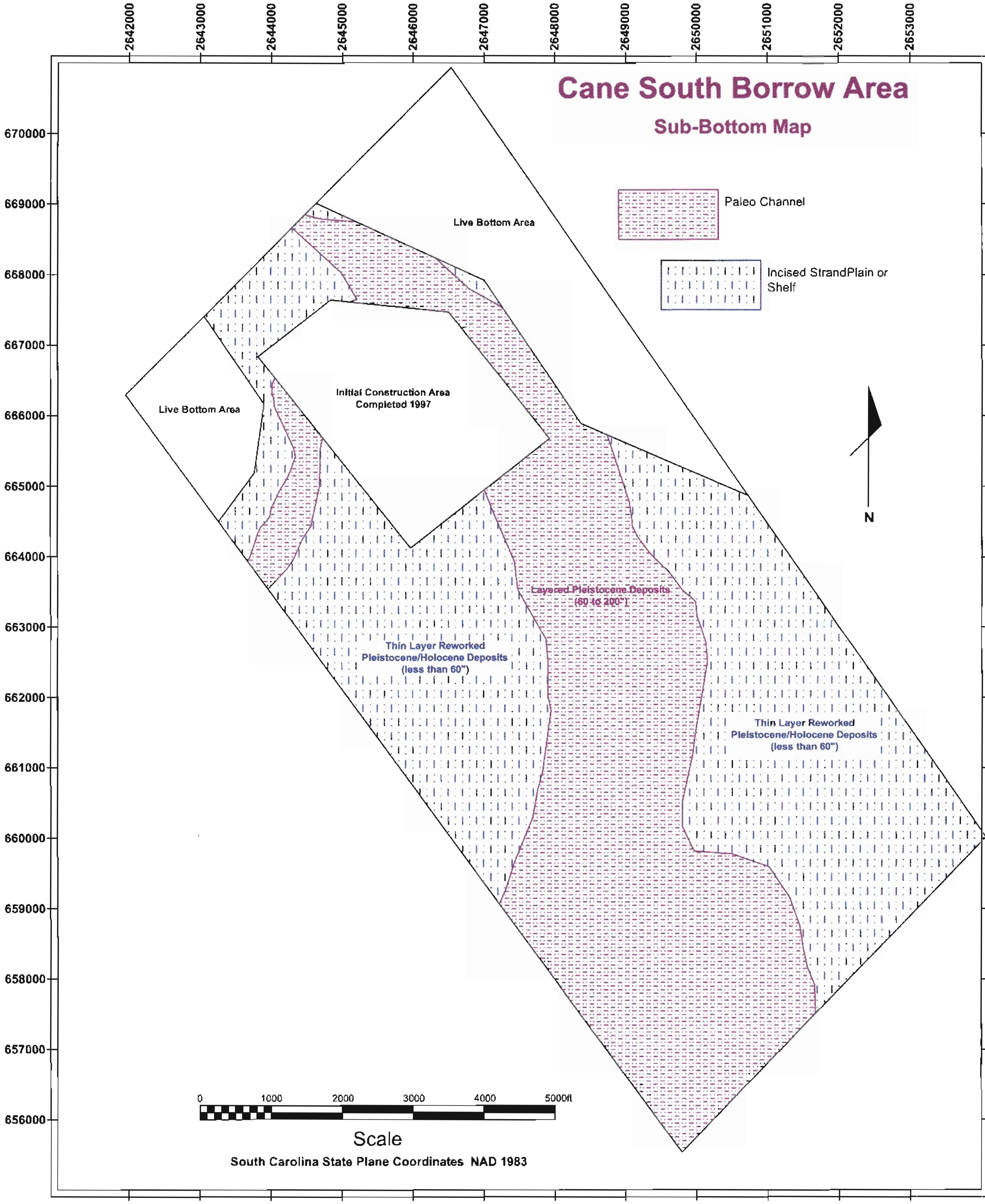

Figure 23. Cane South Borrow Area Sub-Bottom Map.

Little River Borrow Area

A single area of moderate and low relief hard bottom was identified mid southern portion of Little River Borrow Area. Below is a mosaic image of the moderate relief portion of hard bottom area (Figures 30 and 31).

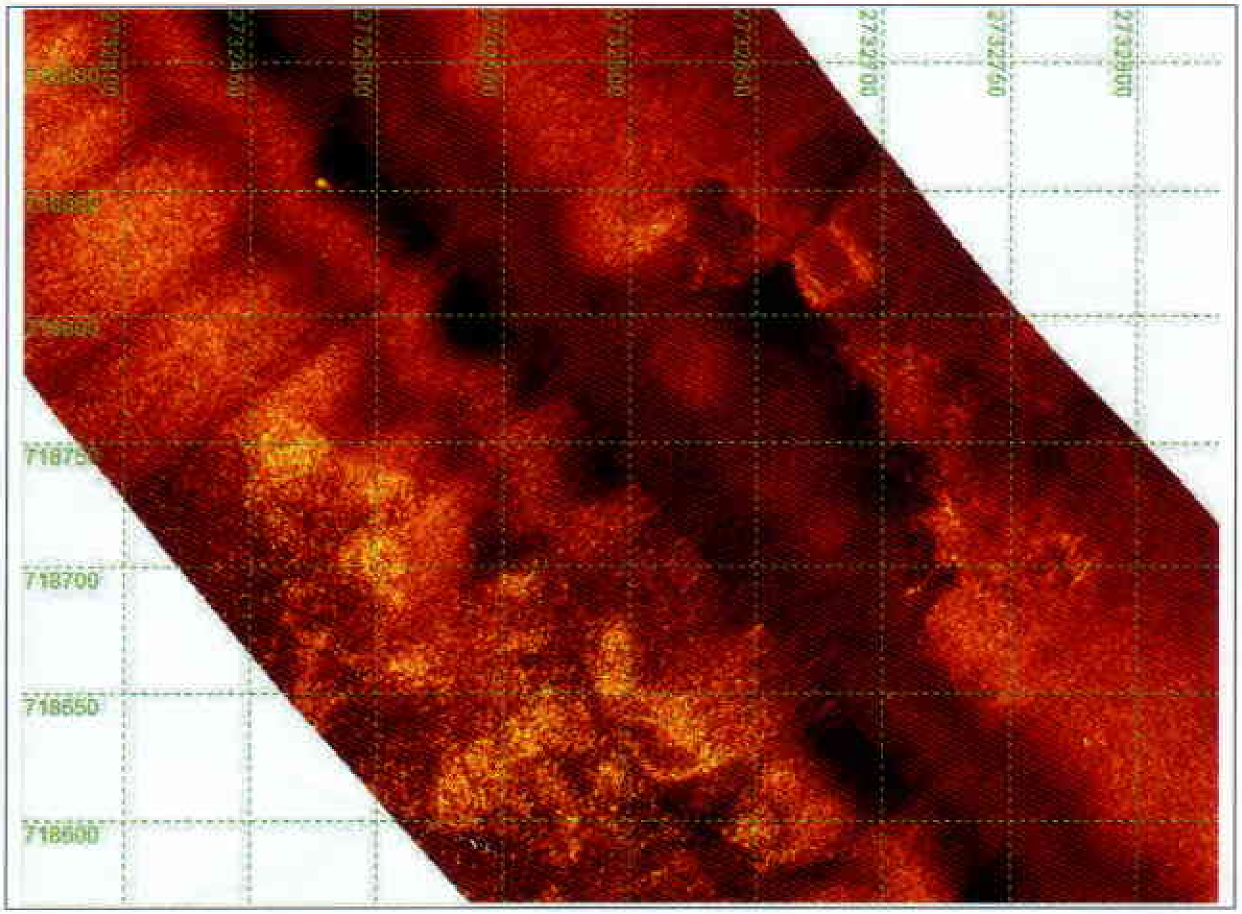

Figure 31. Little River Borrow Area – Moderate Relief Hard Bottom.

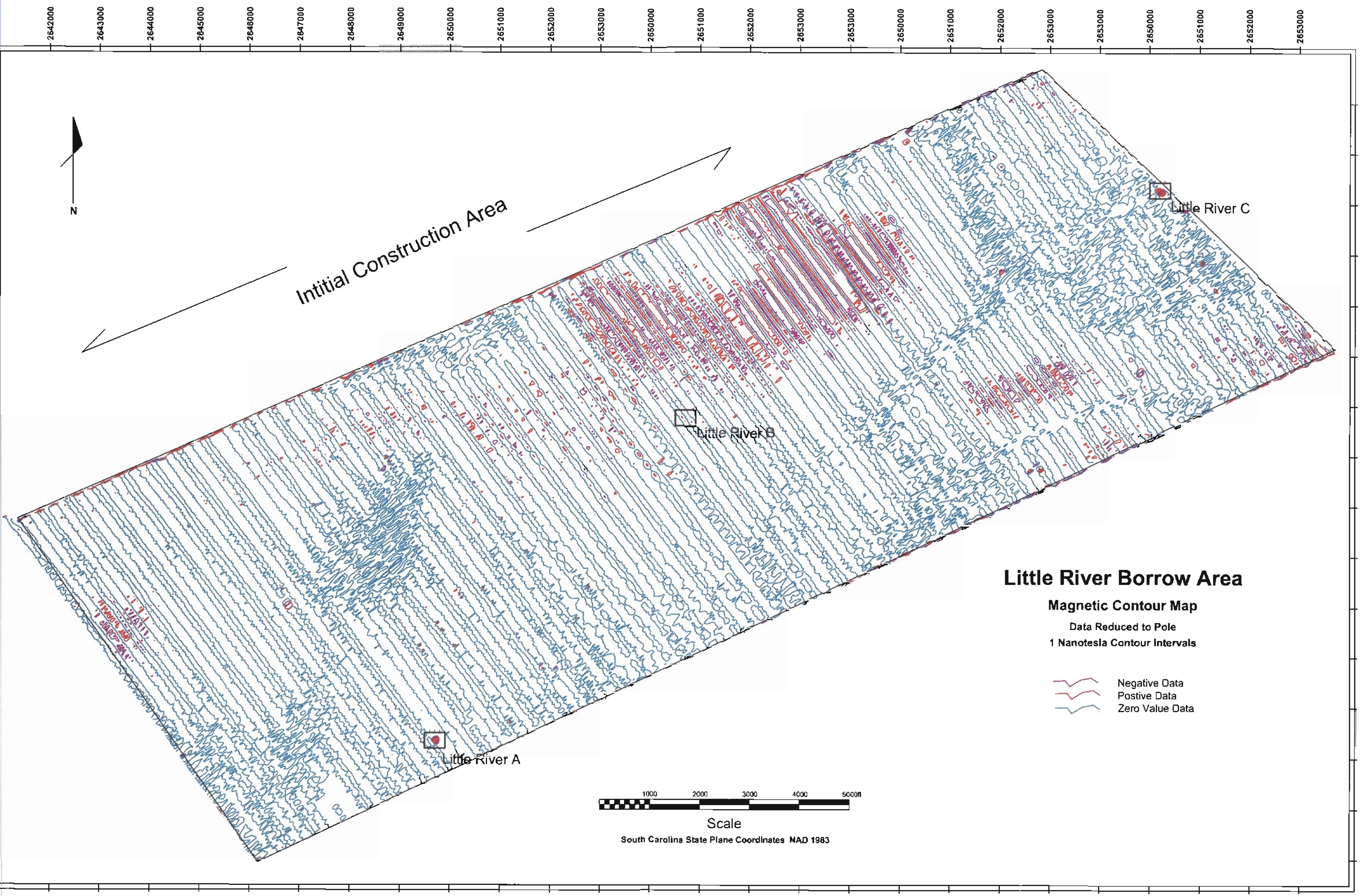

Figure 8. Cane South Borrow Area Magnetic Contour and Target Location Map.

Summary of Findings

A total of five remote sensing targets were identified within the three borrow areas. One target - Surfside A exhibits characteristics that may be associated with a significant submerged cultural resource. Additional underwater investigations to identify and assess Surfside A's potential as an archaeological resource are recommended. If underwater archaeological investigations are not an option, an avoidance buffer of at least 200 feet (radius) around the target coordinates should be established prior to dredging activities.

The remainder of the remote sensing targets identified during the survey of the three borrow areas (Cane South A, and Little River A, B, C) appear to have little potential to be associated with significant cultural resources. No additional underwater investigation or mitigation is recommended.

Analysis of sub-bottom records provide no indication of stratification or protected deposition of surficial (Late Pleistocene or Holocene) sediments that would contain or support any remnant evidence of human occupation or usage. No additional underwater archaeological investigations are recommended related to sub-bottom investigations within the three borrow areas.

Minor hard bottom areas were identified within each of the three borrow areas.

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Appendix: Known Shipwrecks in the general vicinity of Myrtle Beach

Vessel Name	Vessel Type	Date Lost	General Location	Comments
Prince Of Wales	Schooner-rigged blockade runner	1861	North Inlet	Ran aground at North Inlet some 9 miles from the entrance of Georgetown after being fired upon by Union blockading vessel 12/24/1861. Burned to prevent capture.
Liverpool	Schooner-rigged blockade runner	1862	North Inlet	Pursued by USS *Keystone State* and ran aground 04/10/1862 near North Inlet while attempting to reach Georgetown. Set afire and deserted to prevent capture. State site file 38GE64.
Rose	125-foot side-wheel steamer blockade runner	1864	Pawleys Island	Captured by Union forces after running aground near the south end of Pawleys Island 06/02/1864. Burned by crew of USS *Wamsutta*. State site file 38GE67.
Rover	Schooner-rigged steamer blockade runner	1863	Murrell's Inlet	Ran aground at Murrell's Inlet 10/19/1863 and burned to prevent capture.
Virginia Dare	Blockade runner	1861-1865	North Inlet	Sank while attempting to enter Georgetown through the blockade. State site file 38GE65.
Unknown	unknown	?	Litchfield Beach	Shipwreck on lot/beach at Litchfield Beach. State site file 38GE14.

Appendix 7

Water Quality Certification Documentation

D H E C

PROMOTE PROTECT PROSPER

C. Earl Hunter, Commissioner

Promoting and protecting the health of the public and the environment

March 30, 2007

U. S. Army Corps of Engineers
Attn: Mr. Shawn Boone
69A Hagood Avenue
Charleston, South Carolina 29403-5107

RE: Certification in accordance with Section 401 of the Clean Water Act, as amended.

MB Storm Reduction Project
beach nourishment
Atlantic Ocean
Horry County
P/N 92-2R-199

Dear Sir:

The Bureau of Water has reviewed the plans for this project and determined that there is a reasonable assurance that the proposed project will be conducted in a manner consistent with the Certification requirements of Section 401 of the Federal Clean Water act, as amended.

In accordance with provisions of Section 401, we certify that this project will continue to be consistent with applicable provisions of Section 303 of the Federal Clean Water Act, as amended, provided the project is subject to the conditions of the SC Department of Health and Environmental Control's November 19, 1992, certification, and any subsequent modifications, pursuant to Section 401, and the indicated conditions. We also hereby certify that there are no applicable effluent limitations under Sections 301(b) and 302, and that there are no applicable standards under Sections 306 and 307.

1. All necessary measures must be taken to prevent oil, tar, trash, debris and other pollutants from entering the adjacent waters or wetlands during construction

2. Only clean sand free of all potential sources of pollution must be used for beach nourishment.

3. Sand used for the project must consist of appropriate grain sizes to be compatible for beach nourishment.

4. Sand used must be at least 80 percent sand.

5. The permittee must adhere to any recommendations of the U.S. Fish and Wildlife Service and/or the S.C. Department of Natural Resources to protect any identified threatened and/or endangered species and the habitats of such species in the area of the proposed project.

The Department reserves the right to impose additional conditions on this Certification to respond to unforeseen, specific problems that may arise and to take any enforcement action necessary to ensure compliance with State water quality standards.

Sincerely,

Heather Preston, Director
Division of Water Quality
Bureau of Water

cc: SC DHEC, Myrtle Beach EQC Office District Office
SC DHEC, Waccamaw District Office
OCRM

South Carolina
DHEC
Department of Health and Environmental Control
2600 Bull Street, Columbia, SC 29201

November 19, 1992

U. S. Army Corps of Engineers
Attn: Mr. Jim Woody
P.O. Box 919
Charleston, SC 29402

Re: Certification in Accordance with Section 401 of the Clean Water Act, as amended.

MB Storm Reduction Project
beach nourishment
Atlantic Ocean
Horry County
P/N 92-2R-199

Dear Sir:

We have reviewed plans for this project and determined there is a reasonable assurance that the proposed project will be conducted in a manner consistent with the Certification requirements of Section 401 of the Federal Clean Water Act, as amended. In accordance with the provisions of Section 401, we certify that this project, subject to the indicated conditions, is consistent with applicable provisions of Section 303 of the Federal Clean Water Act, as amended. We also hereby certify that there are no applicable effluent limitations under Sections 301(b) and 302, and that there are no applicable standards under Sections 306 and 307.

This certification is subject to the following conditions:

1. The applicant must follow the requirements of the USFWS biological opinion discussed in their August 17, 1992 letter.

2. The applicant must develop a monitoring plan to observe any biological and physical changes of the borrow areas. This plan should be coordinated with the appropriate resource agencies.

3. A buffer area should be established around all live bottom areas within and adjacent to the borrow areas. The applicant should coordinate with the appropriate resource agencies to determine the minimum buffer area necessary.

The S. C. Department of Health and Environmental Control reserves the right to impose additional conditions on this Certification to respond to unforeseen, specific problems that might arise and to take any enforcement action necessary to ensure compliance with State water quality standards.

Sincerely,

Chester E. Sansbury
Director, Division of Water Quality
and Shellfish Sanitation

CES:MRG
cc: Waccamaw District Office
S.C. Coastal Council

404(b)1 EVALUATION
BEACH EROSION CONTROL STUDY
MYRTLE BEACH AND VICINITY
GEORGETOWN AND HORRY COUNTIES, SOUTH CAROLINA

1. PROJECT DESCRIPTION

a. Location. The study area includes approximately 37 miles of South Carolina coastline between Hog Inlet to the north and Murrells Inlet to the south, an area known as the Grand Strand. With the exception of the Murrells Inlet area which is located in Georgetown County, the majority of the project is located in Horry County.

b. General Description.

(1) The Grand Strand is the state's top tourist area. Each year, thousands of visitors come to the area to participate in a variety of water oriented recreational activities. Shoreline erosion and increasing property damage caused by storms have become a serious concern to local officials and private and commercial development interests and those who utilize the beach for recreational purposes. In many areas, the erosion problem has been exacerbated by property owners constructing hard protection measures such as seawalls and groins in an effort to protect their investments.

(2) The selected plan involves storm damage protection for the beach in each of three reaches as described below to protect against a 5-year storm event.

(a) North Myrtle Beach (Reach 1). An 8.3 mile reach will be protected with approximately 750,000 cubic yards of sand obtained from an offshore borrow site (see the attached map). The area will be nourished from the same source with an estimated 400,000 cubic yards of material every eight years.

(b) Myrtle Beach (Reach 2). An 8.5 mile reach will be protected with approximately 1,400,000 cubic yards of sand obtained from an offshore borrow site (see the attached map). Nourishment will be required every eight years with approximately 400,000 cubic yards of sand obtained from the same source.

(c) Garden City/Surfside Beach (Reach 3). A 7.1 mile reach will be protected with approximately 2,700,000 cubic yards of sand obtained from an offshore borrow site (see the attached map). Nourishment will be required every eight years with approximately 400,000 cubic yards of sand obtained from the same source.

(3) Sand will be pumped from offshore borrow sites and placed above the low tide elevation in the beach fill area.

c. Authority and Purpose. The authority for construction of this project has been authorized by Congress. The purpose is for storm damage reduction.

d. General Description of Fill Material.

(1) General characteristics of fill material. Fill material will consist of sand with a grain size similar to that of the existing beach. The fill material will consist specifically of fine to medium sand 0.8 mm - 0.73 (composite mean) grain size from Little River Site; 0.45 mm (composite mean) from Cain patch and 0.73 mm (composite mean) from Surfside.

(2) Quantity of material proposed for discharge. Quantities of fill material that would be required for beach restoration and periodic nourishment are discussed in part 1(b)(2) above.

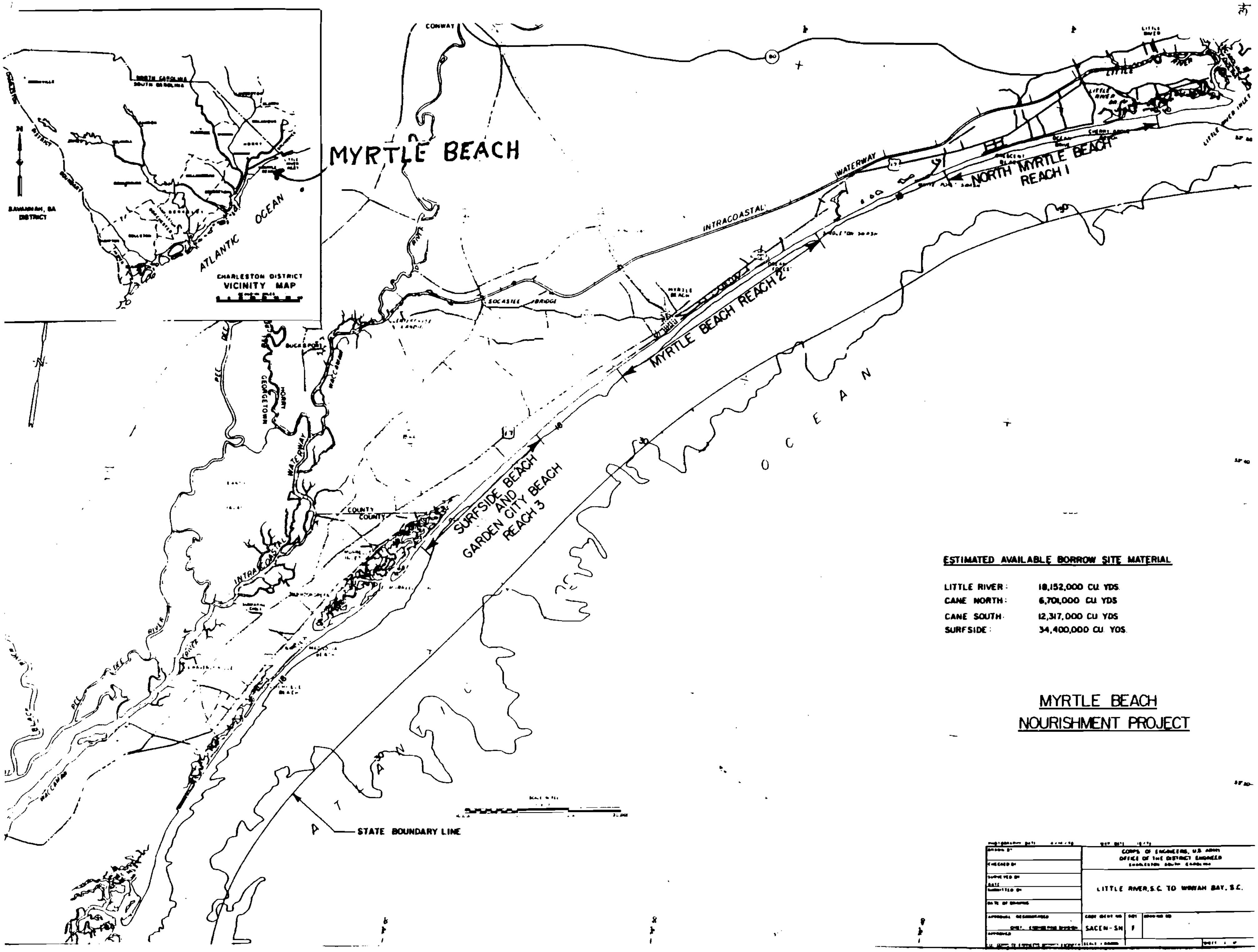
(3) Source of fill material. All beach nourishment material will come from offshore borrow areas. These borrow areas are located from 1.5 to 5 miles offshore from the beaches to be nourished. (An attached map locates the beaches to be nourished).

e. Description of the Proposed Discharge Site.

(1) Location and size. Locations and size of proposed discharge sites are described in part 1(b)(2) above. The exact location and size of periodic nourishment areas cannot be predicted due to varying rates of annual erosion.

(2) Type of site. The storm damage protection sites are all Atlantic Ocean coastal beaches composed of sand, silt, and shell particles which have been eroded by wind, waves, and currents, and by seasonal storms. In general terms, the intertidal portion of beaches in the study area are mildly sloping and of low elevation. This combination results in a relatively wide low tide beach, but often, a minimal to nonexistent high tide beach. In areas of sparse to no development, there generally is an active dune system. In developed areas, the dune system has often been replaced by buildings and hard shore protection structures. This combination generally results in no high tide beach and in some areas minimal to nonexistent low tide beach.

(3) Type of habitat. In general, fill areas contain three basic habitat types. Above the mean high water line (MHWL) there is loose dry sand and/or shore protection structures or development. Between the MHWL and mean low water line (MLWL) are frequently inundated sandy areas with a width dependent upon the eroded bottom slope. Below the MLWL is a sandy bottom shallow water habitat with depths varying according to the rate of erosion in each area. The area below



ESTIMATED AVAILABLE BORROW SITE MATERIAL

LITTLE RIVER:	18,152,000 CU. YDS.
CANE NORTH:	6,701,000 CU. YDS.
CANE SOUTH:	12,317,000 CU. YDS.
SURFSIDE:	34,400,000 CU. YDS.

MYRTLE BEACH
NOURISHMENT PROJECT

the MHWL provides habitat for permanent bottom- burrowing filter feeders and permanent and transient benthic invertebrates that prefer shallow to periodically inundated beach areas. Beach areas also provide feeding areas for several species of mammals and shorebirds and may provide nesting habitat for sea turtles once initial construction is completed.

(4) Timing and duration of discharge. The initial beach restoration could potentially begin in the summer of 1995 and will require 2 to 4 years to complete. Periodic nourishment will be required at about 8-year intervals.

f. Description of Borrow Sites. Sand for nourishment of the beaches will come from 4 areas. These areas were identified through a process of vibra core sampling. Two hundred vibra core samples showed the areas to have sufficient sand reserves to initially construct the project and to maintain it over the project life (50 years). Once the sand sources were identified, live bottom habitat surveys were performed within the areas using side scan sonar and television cameras. Live bottom features were located so they could be avoided during borrow operations. The locations of these borrow areas are described below (map attached).

a. Little River - This site is between Cherry Grove Beach and Little River Inlet. The site extends from approximately 1.5 to 4 miles offshore and contains approximately 14 sq. miles of ocean bottom.

b. Cain Patch - These two sites are comprised of old buried channels offshore of Cain Patch Creek and north of Myrtle Beach. These channels are 1.5 miles off the beach and extends out to approximately 4.5 miles off the beach. The total area is approximately 4.5 sq. miles of ocean bottom.

c. Surfside Beach - This site is located from Surfside Beach south to the vicinity of Garden City Beach. The area extends from 2 to 5 miles offshore. This total area is approximately 6.0 sq. miles.

g. Description of Discharge Method. Sand fill material will be hydraulically pumped from offshore to beach areas where it will be moved around by scrapers and bulldozers to provide the necessary protection.

2. FACTUAL DETERMINATIONS

a. Physical Substrate Determinations.

(1) Substrate Elevation and Slope. Intertidal portions of study area beaches are generally mildly sloping and of low elevation. This combination creates a wide low tide beach and a narrow to nonexistent high tide beach. In areas with limited or

no development, there is generally an active dune system. Along areas that are heavily developed, this dune system has often been replaced with hard shore protection structures.

(2) Sediment Type. Fine to medium sand 0.8 mm - 0.73 (composite mean) grain size from Little River Site; 0.45 mm (composite mean) from Cain patch and 0.73 mm (composite mean) from Surfside.

(3) Fill Material Movement. The sandy fill materials will be eroded away at varying rates and moved varying distances according to the severity of wave and current action and storms. Accurate forecasts of fill material movement are not possible due to unpredictable variations in intensity and frequency of sea and weather conditions.

(4) Physical Effects on Benthos. Benthic animals associated with high energy beaches are continually subjected to effects of erosion and accretion and major physical changes resulting from storms and hurricanes, beach nourishment and renourishment will not unduly stress beach and intertidal animals beyond their adaptive capabilities.

Monitoring studies conducted by Coastal Science and Engineering, for the City of Myrtle Beach permit support this conclusion. After three years of study, it was concluded that "biological effects caused by beach nourishment at Myrtle Beach were minimal. Furthermore, detrimental effects to a few common species which were detected during and immediately after nourishment were short-lived."

b. Water Circulation, Fluctuation, and Salinity Determination.

(1) Water column effects. Depths would be decreased somewhat in beach fill areas. Where water columns would be eliminated by fills, water columns at borrow sites would be increased by approximately 3 feet, the losses would be considered acceptable and desirable to meet the purpose and need for the project.

(2) Current patterns and circulation. No significant effect.

(3) Normal water level fluctuations and salinity gradients. No significant effect. Storm-tide flooding upland of the fill sites is expected to be decreased by the proposed actions.

c. Suspended Particulate/turbidity Determinations.

(1) Expected changes in suspended particulates and turbidity levels in the vicinity of the disposal site. The fill material would be similar to the receiving substrate, therefore, the area's waters would not experience a significant change in the type of suspended particulates. Turbidity levels in waters immediately adjacent to the beach fill areas would be increased slightly by wave wash as newly placed materials are inundated and distributed during each tidal cycle. Turbidity levels may also increase slightly for a short distance offshore of the surf zone. No significant adverse effects would be expected as a result of project induced turbidity increases.

(2) Effects on chemical and physical properties of the water column.

(a) Light penetration. Possible short-term reduction resulting from temporary increase in turbidity caused by filling activities.

(b) Dissolved oxygen. Possible short-term decrease with temporary increase in turbidity. Will return to normal when turbidity dissipates.

(c) Toxic metals, organics, and pathogens. None identified.

(d) Aesthetics. Appearance of water column would be temporarily degraded by turbidity at the restored and periodic nourishment sites.

(3) Effects on Biota.

(a) Primary productivity and photosynthesis. Temporary minor disruption possible with rapid recovery at the fill sites.

(b) Suspension/filter feeders. Minimal temporary disruption at fill sites possible, but with rapid recovery.

(c) Sight feeders. Minimal temporary disruption possible with rapid recovery. Most sight feeders are transient and can relocate until fill operations are complete. Many shore birds will feed on animals deposited by the hydraulic dredge during pumping operations.

d. Contamination Determinations. None identified.

e. Aquatic Ecosystem and Organism Determinations. The subject beaches and their adjacent shallow, sandy bottoms provide habitat for benthic organisms and feeding areas for aquatic animals and birds. These bottom areas support benthic organisms and typical intertidal beach animals, such as sand dollars, sea urchins, scallops, mollusks, crabs, shrimp, wedge shells, polychaete worms, sand bugs, amphipods, and isopods. There are no significant natural resources that would be adversely affected by this project. Sand borrow sites offshore have been surveyed for hard bottom habitat. Hard bottom areas will be avoided during dredging operations.

(1) Threatened and endangered species. Loggerhead Sea Turtles may be affected by this project during their nesting season. Impacts to this threatened species have been coordinated with the U.S. Fish & Wildlife Service. All reasonable and prudent measures necessary to prevent effects to the continued existence of this species will be employed. The presence of a slow moving hopper dredge in this area will pose no threat to migrating whales.

(2) Other Wildlife. No adverse effect.

f. Proposed Disposal Site Determinations.

(1) Mixing zone determination. No contaminants are known to be in the proposed fill material that would violate applicable water quality standards. The fill material is the same composition as the fill area substrate. In view of these conditions, a limited mixing zone in the immediate vicinity of the discharge site is allowed.

(2) Determination of compliance with applicable water quality standards. No conflict with applicable water quality standards for the discharge of fill material would be anticipated. Water quality impacts will be limited to a temporary increase in turbidity and possibly a slight reduction in dissolved oxygen in waters adjacent to the fill site.

(3) Potential effects on human use characteristics.

(a) Municipal and private water supplies. None

(b) Recreational and commercial fisheries. None

(c) Recreation activities. The desirable characteristics would be improved and maintained.

(d) Aesthetics. Improved and maintained.

(e) Coastal Zone Management programs. The proposed action is consistent with the S. C. Coastal Zone Management program.

(f) Parks, national and historic monuments, national seashores, wilderness areas, research sites, and similar preserves. None

g. Determination of Cumulative Effects on the Aquatic Ecosystem. There will be a positive effect on the aquatic ecosystem. As fill materials become stabilized they will provide: additional habitat for important invertebrate species which inhabit the swash zone; additional feeding and resting areas for shorebirds; and more available food for fishes of commercial and recreational importance.

3. FINDINGS OF COMPLIANCE OR NONCOMPLIANCE WITH THE RESTRICTIONS ON DISCHARGE

a. No significant adaptations of the guidelines were made relative to this evaluation.

b. No practicable alternative exists which meets the study objectives that does not involve discharge of fill into waters of the United States.

c. The discharge of fill materials would not cause or contribute to, after consideration of disposal site dilution and dispersion, violations of any applicable State water quality standards. The discharge operation will not violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

d. The placement of fill material, in accordance with the U.S. Fish & Wildlife Service biological opinion, would not jeopardize the continued existence of any species listed as threatened or endangered or result in the destruction or adverse modification of any critical habitat as specified by the Endangered Species Act of 1973, as amended.

e. The placement of fill materials would not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreational and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. The life stages of aquatic species and other wildlife would not be adversely affected. Significant adverse effects on aquatic ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values would not occur.

4. FINDINGS

I find, based upon the above evaluations and conclusions, that the proposed discharge site for dredged magerial has been specified as complying with the requirements of the Section 404(b)1 Guidelines.

Mark Vincent

MARK E. VINCENT
Lieutenant Colonel, EN
Commanding

Appendix 8

Borrow Area Impact Analysis

Borrow Activity Impact Statement
for the
Myrtle Beach, South Carolina
Shore Protection Project

The project area, often referred to as the Grand Strand, lies on the northeastern Atlantic Ocean coast of South Carolina, or more properly on Long Bay, a concave indentation of the coast. The feasibility study of this project identified numerous potential sources of borrow material, both upland and offshore. After the initially recommended borrow sites along the Atlantic Intracoastal Waterway (AIWW) were no longer viable options, the original shore protection project made use of available offshore borrow sources. This re-nourishment project will focus on the same borrow sites relied upon for the initial project construction. The borrow areas (Little River, Cane South, and Surfside), originally identified and utilized for initial construction from 1997 to 1999, are between 1.52 and 4.98 miles offshore, with the Surfside borrow area being the farthest from land. Figure 1 identifies the borrow areas and the storm damage reduction project boundaries. Increasingly, beach compatible sediment sources are more difficult to locate within State waters and in proximities deemed acceptable for dredging activities. As such, more and more borrow sources are being identified farther offshore on the Federal Outer Continental Shelf (OCS). The resources of the OCS are managed by the U.S. Department of the Interior's Minerals Management Service (MMS). While it has not been determined that this project will require dredging in the OCS, the identified borrow areas do contain portions within the OCS. Therefore, it is necessary to provide documentation that the Federal mineral resources will be managed properly with respect to physical and biological oceanographic processes.

Renourishment of the three reaches (North Myrtle Beach, Myrtle Beach, and Garden City/Surfside) of the Myrtle Beach, South Carolina Shore Protection Project will require placement of approximately 2.9 million cubic yards of beach compatible sand from a total of three offshore borrow areas. This brief report will present background information regarding the identified borrow areas and will provide necessary evidence that the proposed dredging operations within these borrow areas will be carried out in such a way as to be consistent with responsible resource management and with negligible impact to oceanographic processes.

Background Information

The shoreline of the Grand Strand area, from Murrells Inlet in the south to Little River Inlet in the north, exhibits a gentle concave curve from west to east. In general, the intertidal beaches in this area have a relatively low elevation and mild slope, which results in a wide low tide beach and minimal high tide beach. The nearshore and inner shelf areas do not exhibit significant variations in bottom depth on a large-scale. Two exceptions are the Murrells Inlet ebb tide shoal and a shoal offshore of the northeastern edge of the Myrtle Beach fill area. Otherwise, sea floor formations landward of the -12 meter (-39 feet) contour are mostly localized. Seaward of the -12 meter contour, the sea floor features appear as a series of ridges and valleys.

Existing water depths for the proposed borrow areas vary between 29.5 and 39.4 feet below mean high water (MHW), with the Little River borrow area being the deepest. More detailed information is provided later in this section. Figure 1 illustrates the spatial relationship of each borrow area to each other and to the project areas.

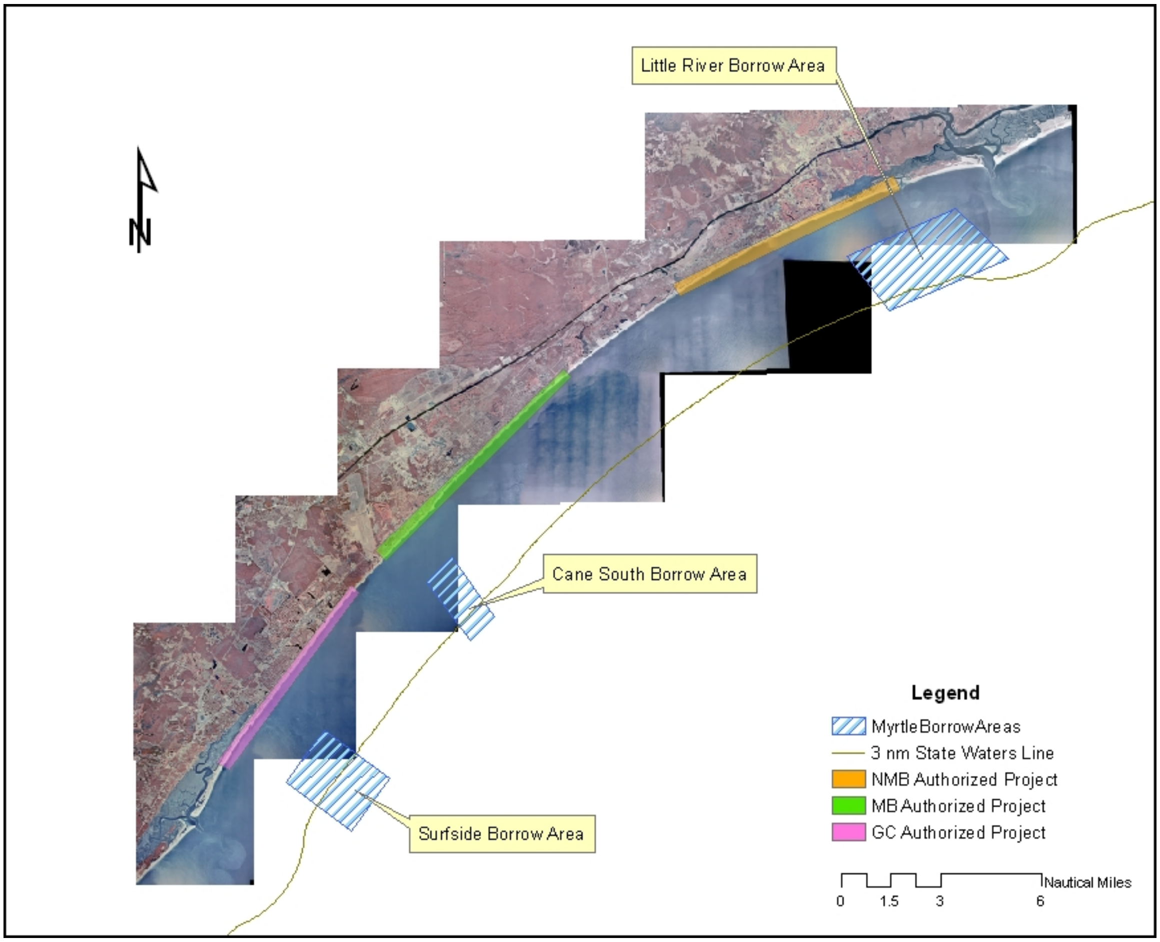


Figure 1: Location map of Myrtle Beach Storm Protection Project areas and associated offshore borrow areas.

Offshore investigations in 1991 concluded that there was sufficient compatible material in the identified borrow areas for the initial nourishment and all subsequent periodic re-nourishments for the 50-year life of the project. Recent borrow site investigations show that the Little River borrow area contains at least 11.2 million cubic yards of quality borrow material, the Cane South area contains at least 10.3 million cubic yards of quality material, and the Surfside area contains at least 15.2 million cubic yards. More material is available if less stringent quality comparison criteria are implemented. The current re-nourishment will require placement of approximately 0.7, 1.4, and 0.8 million cubic yards of beach compatible material, which will come from the Little River, Cane South, and Surfside Borrow areas respectively. Over the next 40 years, starting with this re-nourishment cycle to the end of the 50-year project life in 2047, it is estimated that 2.17, 3.31, and 2.30 million cubic yards will need to be placed on the Grand Strand beaches and come from the Little River, Cane South, and Surfside Borrow areas respectively.

Prior to initial construction in 1997, grab samples of the native beach sediments at eight standard, cross-shore locations along 33 profile lines were taken and compared to the results from a 1991 vibracore analysis for grain size and composition compatibility. It is worth noting that several beach fill projects by the local governments prior to and after Hurricane Hugo had altered the grain size of the native beach. The following paragraph serves as a brief summary of that comparison.

The composite mean grain size of the subaerial beach in North Myrtle Beach was 0.26 mm (1.93 phi) and the composite mean for all samples (subaerial and subaqueous) was 0.24 mm (2.09 phi). Correspondingly, the sediment in the Little River Borrow site was classified as a medium sand in the Unified Soil Classification System and had a composite mean grain size of 0.80 mm (1.16 phi). The differences in grain sizes and sorting between the North Myrtle Beach native material and the Little River Borrow site resulted in an overfill factor of 1.08. Ultimately, this means that, after sorting, approximately 1.08 cubic yards would be required from the borrow source in order to equal 1.0 cubic yards on the beach. In Myrtle Beach, the composite mean grain size of the subaerial beach was 0.44 mm (1.18 phi) and the composite mean for all samples was 0.47 mm (1.09 phi). The Cane South borrow area was also classified as medium sands and had a composite mean grain size of 0.73 mm (1.37 phi). The differences between the Myrtle Beach native material and the Cane South borrow material resulted in an overfill factor of 1.10. The Garden City and Surfside beaches had a subaerial composite mean grain size of 0.44 mm (1.21 phi) and a total composite mean of 0.42 mm (1.25 phi). Medium sand was also found in the Surfside Borrow area was characterized by a composite mean grain size of 0.60 mm (1.20 phi). These differences between the Garden City and Surfside native material and the Surfside Borrow area resulted in an overfill factor of 1.10.

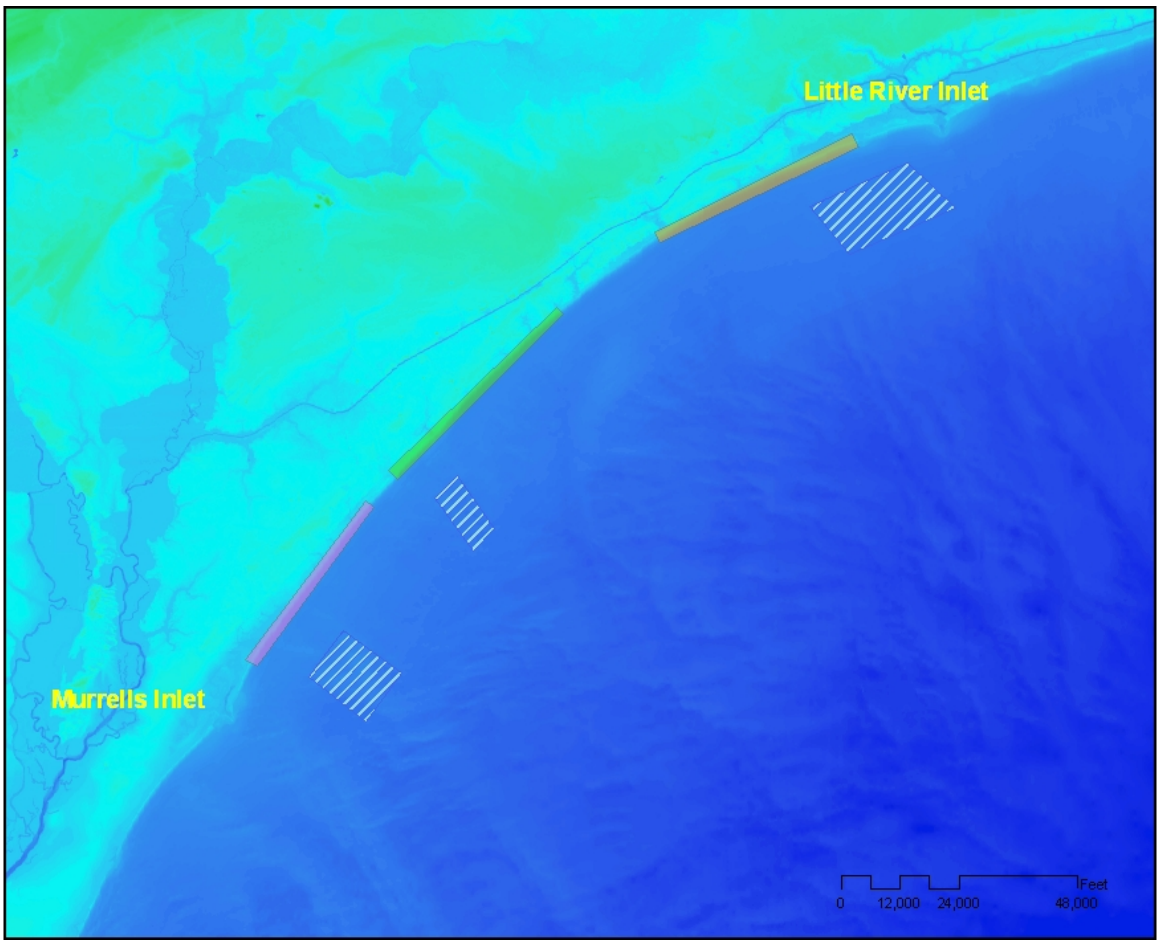


Figure 2: Topographic/Bathymetric Contour Map of the Grand Strand Area.

Prior to finalizing construction plans and specifications for the upcoming renourishment, recently collected vibracore samples are being analyzed to determine the anticipated quantity and configuration of available beach compatible sediment within the borrow areas. Based on preliminary results from this analysis, thicknesses of beach quality sediment vary between 1 and 4 feet in the Little River Borrow area with only 5 percent of the total area having deposits of at least 4 feet in thickness. Similarly, thicknesses of beach quality sand in the Cane South Borrow area range from 1 to 10 feet with approximately 50 percent of the total area having thicknesses of less than 6 feet. Finally, thicknesses of beach quality sand in the Surfside Borrow area vary from 1 to 9 feet and are equal to or less than 6 feet over approximately 50 percent of the total area. These results are consistent with observations during the initial construction activities.

Potential Impact Analysis

Physical Impacts to Hard Bottom Areas. The Grand Strand is not only characterized by idyllic sandy beaches, but also by shoreface, inner shelf, and offshore hard bottom habitat areas. A 4-year study by the Coastal Carolina University Center for Marine and Wetland Studies in association with the South Carolina Department of Natural Resources and the US Army Corps of Engineers concluded that offshore habitats had not been significantly impacted by the initial beach fill. The study found that while some areas of hard bottom experienced deposition and burial, other hard bottom habitats were uncovered due to erosion of their surface sediments. Consequently, the dredging and placement activities were found to have only marginally greater impacts on hard bottom habitat than the system's own natural variability (Ojeda et. al, 2001).

Construction of the re-nourishment project will incorporate several measures to limit the potential for impact to hard bottom habitat within and immediately adjacent to the fill areas and within the borrow areas. For example, a buffer zone of 600 feet has been placed around all hard bottom habitat areas within the borrow areas. In addition, the maximum allowable side slope in the borrow areas has been set at 3H:1V. Given the size of the buffer zone, the relatively shallow nature of the compatible sediment in the borrow areas, the use of a hopper dredge, and the limitation on side slopes, significant precautions have been taken to prevent adverse impacts on hard bottom habitat within the borrow areas. Finally, the dredge pipe will not be allowed to come onshore in the vicinity of shoreface or inner shelf hard bottom habitat.

Impacts to Coastal Processes. The following section will compare and contrast the existing plans for the Myrtle Beach renourishment to scientific findings from recent detailed studies of similar situations. Technologic advancements in numerical modeling of ocean and coastal processes along with increases in computing power and understanding of the effects of dredging operations have produced numerous applicable studies.

Assessing the potential impacts of the Myrtle Beach sand removal activities involved reviewing borrow area impact study reports for seven different states (on the East and Gulf Coasts) and eight different sets of borrow areas. Most of these reports were prepared for and in conjunction with the MMS and generally contained information on 1)the character of the offshore borrow areas; 2)circulation, wave, and sediment transport modeling and/or calculations; 3)potential impacts; and 4)conclusions. Table 1 summarizes the relevant parameters from each of the study reports as well as providing a quick glance at the relevant information for the upcoming Myrtle Beach project.

Though the inclusion of all the parameters in Table 1 was not consistent in each report, enough information was provided in order to draw reasonable comparisons to the Myrtle Beach project.

One of the parameters that would have been beneficial to have more information on is the distance of the borrow areas relative to the adjacent shorelines. The Myrtle Beach borrow areas compare reasonably well with those studies that did provide an offshore distance. The studies in Alabama and North Carolina are the most natural comparisons to Myrtle Beach in this regard. Only one of these eleven sites (S1, Dare County B in North Carolina) received a questionable rating with regard to adverse impacts. That sand resource area, S1 in Dare County, is generally closer to the shoreline than the Myrtle areas and has a deeper average sand layer thickness and much larger dredging needs than any of the Myrtle areas. Therefore, sand resource area S1 would create a much larger and deeper seabed depression closer to the shore than any of the identified Myrtle Beach borrow areas.

The water depth of the three Myrtle Beach areas is also very similar to the other studies in Table 1. Only the five sites in New York/New Jersey are significantly and consistently situated in deeper water. Due to the large fluctuation in surface areas between all the sites listed, it is difficult to qualify the relative importance of this parameter.

The available sand layer thicknesses in the Myrtle Beach borrow areas represent the low end of the spectrum when compared to the other sites. Because of the spatial variability of the beach quality sediment thicknesses in the Myrtle Beach borrow areas, the actual dredged depths, most likely between 3 and 6 feet, are anticipated to be similar to those in the New York/New Jersey study, between 2.3 and 5.9 feet. All five (5) sand resource areas in the New York/New Jersey study were found to be acceptable, low impact borrow scenarios.

The available volume of beach compatible sand in the Myrtle Beach borrow areas, 11.3 to 16.7 million cubic yards, is within the range exhibited in the other studies, 5.2 to 320 million cubic yards ("Sand Volume Est" in Table 1). Like the surface area parameter, the large fluctuation makes it difficult to qualify the importance of this parameter on its own. However, when combined with the surface area, sand layer thickness, and dredging needs, one can gain a more accurate understanding of the degree of borrow area depletion. The anticipated needs of the Myrtle Beach borrow areas over the remainder of the 50-year project life are relatively small when compared to most of the quantities for the other sand resource areas ("Dredging Needs" column in Table 1). In fact, of the fourteen (14) areas with less than 10 million cubic yards of sediment being removed, only one (1) received a questionable rating, area C1 (north) of the Central East Coast of Florida study. The Florida study came to the conclusion that a reduction in the maximum dredging depth would most likely reduce the site impacts. The minimum water depth of sand resource area C1 (north) was 25 ft NGVD, while the maximum dredge depth was 39.5 ft NGVD. This resulted in a maximum change in bed surface of 14.5 feet, significantly larger than any change possible in any of the Myrtle Beach borrow areas. Furthermore, all five (5) areas with less than 5 million cubic yards of sediment being removed were found to be acceptable borrow scenarios.

The mean wave height and period at the Myrtle Beach borrow areas were determined from appropriate Wave Information Study (WIS) hindcast locations and are similar to the other studies referred to in Table 1. The mean wave heights and periods at the Myrtle Beach borrow areas are certainly comparable to those listed for the other studies.

Wave Modeling

Numerical model simulations of wave transformation were required to evaluate changes in the magnitude and spatial variation of wave parameters due to the anticipated dredging activities within the Myrtle Beach borrow areas. The steady-state spectral wave model STWAVE (Smith, Sherlock, and Resio 2001) was applied for wave transformation modeling. STWAVE was forced with directional wave spectra based on typical and storm waves hindcast by the Wave Information Studies (WIS). This section describes the STWAVE wave transformation modeling approach, the model input, and model results.

Bathymetry Grids. Two STWAVE Cartesian grids were generated for this study. The first grid represents the existing condition bathymetry, while the second represents the Myrtle Beach borrow areas at the end of the 50-year project (or with-project condition). The with-project condition grid reflects the removal of 2.72 million cubic yards from the Surfside Borrow area, 4.73 million cubic yards from the Cane South Borrow area, and 6.45 million cubic yards from the Little River Borrow area. Each of these volumes is more than the estimated need for the remaining 40 years of the authorized project life. The removed volumes were determined by removing thicknesses of between 1 and 2 meters of material within sub-areas of each borrow area. The sub-areas were identified during the plans and specifications phase of the 2007 renourishment effort. Dredging in these areas are the only differences between the existing condition and with-project STWAVE grids.

The grid origin is x = 740543.56 m and y = 3733459.50 m in UTM NAD83 Zone 17, and the grid orientation is 131.93 deg (which is the orientation of the grid x-axis measured counter-clockwise from East). The grid domain is 40.7 km (cross shore, 407 cells) by 66.5 km (alongshore, 665 cells) with a resolution of 100 m. The offshore boundary of the grids is located in depths between 15 and 20 meters. Figure 3 shows the STWAVE grid and identifies the location of all three Myrtle Beach borrow areas.

Input Wave Conditions. Instead of selecting discrete time periods for wave simulation, this study used a 20-year hindcast record to develop a binned approach based on joint probability of wave direction, period and height. The offshore wave information for these simulations were hindcast by the Wave Information Studies (WIS) using the wave generation and propagation model WISWAVE (Hubertz 1992).

Wave conditions were taken from the latest WIS hindcast (1980-1999) at Station 325 (http://frf.usace.army.mil/cgi-bin/wis/atl/atl_main.html). WIS Station 325 is located at 33.49 deg North, 78.66 deg West in a water depth of 16 m, which is approximately on the offshore boundary of the STWAVE grids.

Table 1: Summary of previous borrow source impact analyses.

Study	Sand Resource Area	Distance Offshore (miles)	Water Depth (feet)	Surface Area (sq. mi.)	Sand Layer Thickness (feet)	Sand Volume Est (cu. yd)	Dredging Depth for Modeling (ft)	Dredging Needs (cu. yd)	Mean Wave Height (ft)	Mean Wave Period (sec)	Dominant Wave Direction	Modeling Conclusion
Alabama	1	3.4 - 7.5	28 - 48	16.0	3 - 14	170,000,000	9.8	7,590,000	-	-	150 - 175	Acceptable
	2	3.4 - 9.6	33 - 60	28.5	6.5	248,500,000	9.8	2,220,000	-	-	150 - 175	Acceptable
	3	3.1 - 7.5	28 - 60	26.0	12 - 15	320,500,000	13.1	6,150,000	-	-	150 - 175	Acceptable
	4	5.3 - 9.9	39 - 53	30	10	15,700,000	9.8	10,990,000	-	-	125 - 150	Acceptable
North Carolina	1	> 3	32 - 66	0.93	9.8	173,500,000	9.8	9,400,000	4.92	8.3	E-NE	Acceptable
Dare County A	2	> 3	32 - 66	0.75	9.8	44,900,000	9.8	7,590,000	4.92	8.3	E-NE	Acceptable
	3 (west)	> 3	32 - 66	0.32	9.8	64,700,000	6.6	3,270,000	4.92	8.3	E-NE	Acceptable
	3 (east)	> 3	32 - 66	0.27	6.6	64,700,000	9.8	1,800,000	4.92	8.3	E-NE	Acceptable
	4	> 3	32 - 66	0.45	6.6	23,200,000	6.6	3,000,000	4.92	8.3	E-NE	Acceptable
Dare County B	N1	0.5 - 2.0	35 - 45		8 - 10	5,192,000	8 - 10	4,300,000	-	-	E-NE	Acceptable
	S1	1.0 - 3.0	35 - 45		8 - 10	104,454,000	8 - 10	70,280,000	-	-	E-NE	Questionable
New Jersey	A-1	-	-	0.85	6.5 - 19	-	13.1	11,500,000	3.94	7.7	E-NE	Acceptable
	A-2	-	-	1.0	6.5 - 19	-	9.8	10,200,000	3.94	7.7	E-NE	Acceptable
	M8	-	-	1.5	6.5 - 19	-	6.5	10,500,000	3.94	7.7	E-NE	Acceptable
Virginia, SE	A	-	26 - 42	0.69	19.7	-	9.8	6,930,000	3.94	8.7	E-NE	Acceptable
	B	-	26 - 42	0.89	19.7	-	9.8	9,020,000	3.94	8.7	E-NE	Acceptable
Florida Cape Canaveral	2	9.3 - 12.4	23 - 46	1.9	10 - 16	-	17.1	34,000,000	4.27	9.3	E-NE	N/A
Florida	A1	7.5 - 9.3	26 - 46	2.1	10 - 14	-	-	17,800,000	4.27	9.3	E-NE	Questionable
Central East Coast	B1	7.5 - 9.3	26 - 46	1.8	6 - 8	-	-	14,400,000	4.27	9.3	60 - 90 deg	Acceptable
	B2	7.5 - 9.3	26 - 46	1.3	6 - 8	-	-	9,940,000	4.27	9.3	60 - 90 deg	Acceptable
	C1 (north)	7.5 - 9.3	26 - 46	2.0	10 - 22	-	-	7,590,000	3.94	9.1	30 - 60 deg	Questionable
	C1 (south)	7.5 - 9.3	26 - 46	1.8	6.6	-	-	11,500,000	3.94	9.1	30 - 60 deg	Questionable
	D2	7.5 - 9.3	26 - 46	0.87	-	-	-	5,360,000	3.61	8.8	30 - 60 deg	Acceptable
New York/New Jersey	H1	-	46 - 66	1.3	6.5 - 16.4	6,300,000	4.9	-	3.1	4.2	S	Acceptable
	H2	-	49 - 66	5.1	6.5 - 16.4	12,400,000	2.3	-	3.1	4.2	S	Acceptable
	3	-	62	3.6	5.9 - 10.5	14,700,000	3.9	-	3.2	4.3	S	Acceptable
	4W	-	52 - 66	4.7	5.9 - 10.5	25,900,000	5.2	-	3.2	4.3	S	Acceptable
	4E	-	52 - 66	3.6	6.2 - 15.1	21,800,000	5.9	-	3.2	4.3	S	Acceptable
South Carolina	Little River	1.5 - 3.9	32 - 39	10.4	2 - 4	11,800,000	≈3	2,170,000	3.08	5.25	SE	Acceptable
Myrtle Beach	Cane South	1.7 - 4.2	30 - 39	3.0	1 - 10	11,300,000	≈6	3,310,000	3.44	5.75	ESE	Acceptable
	Surfside	2.2 - 5.0	29 - 39	6.3	1 - 9	16,700,000	≈6	2,300,000	3.44	5.75	ESE	Acceptable

Table 2 below reports the percentages of the wave hindcast record at Station 325 which fall into the categories created by the corresponding rows and columns. The left-hand column lists the wave direction, as reported in meteorological convention with waves from the north at 0 deg and waves from the east at 90 deg. The subsequent column headings indicate the wave period (in seconds) and the cells below provide the percentage of the hindcast record that meet those criteria.

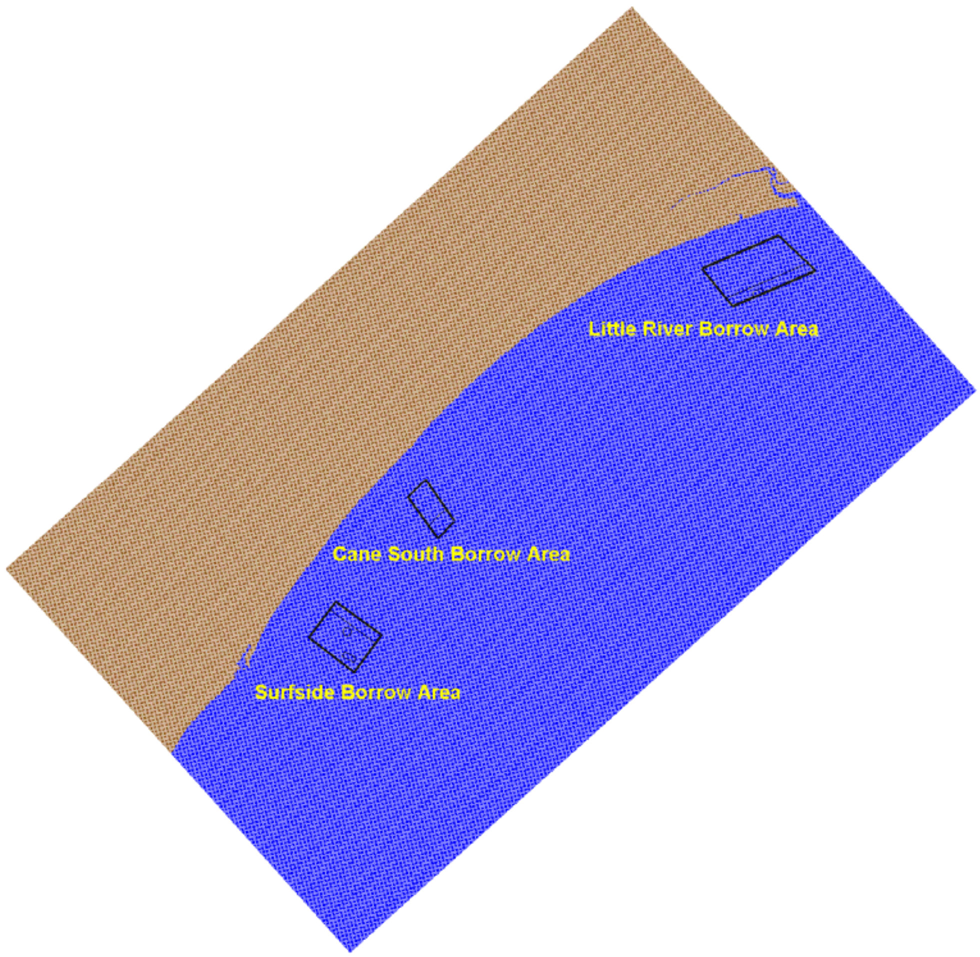


Figure 3: STWAVE Model grid overlaid with Myrtle Beach borrow areas.

For example, the dominant wave direction band, from 112.5 to 120.0 degrees, represents 12.89% of the total number of wave conditions within the 20-year hindcast record. Within the dominant wave direction band, 7.09% of the total number of wave conditions within the 20-year hindcast record have a period between 6 and 8 seconds. Similar tables were also produced for a selection of wave height intervals. Tables A2 through A10 in Appendix A give the percentages based on wave heights between 0 and 20 meters. These tables show that 94.6% of the 20-year hindcast record is characterized by waves between 0.0 and 2.0 meters.

The joint probability analysis was part of the information used to select the most appropriate wave conditions for input into wave transformation modeling. Ultimately, 18 wave direction bins were combined with 6 wave period bins and 7 wave height bins to create 489 height/period/direction combinations for wave transformation modeling. Table A1 in Appendix A summarizes the selected wave height/period/direction bands.

Input wave spectra are required to drive STWAVE on the offshore grid boundary. Parametric spectral shapes were used to generate the input spectra from the offshore wave parameters. The wave energy is distributed in frequency using the TMA spectral shape with a spectral peakedness parameter of 3.3 to 7 (Bouws et al. 1984) and in direction using a $\cos^{nn}(\alpha-\alpha_m)$ distribution, where α_m is the mean wave direction, with *nn* of 4 to 26. The input spectra have 30 frequencies, starting with 0.04 Hz and incrementing by 0.01 Hz. The directional resolution for all simulations is 5 deg.

Table 2: Probability table for all waves in 20-year hindcast record for WIS Station 325.

SUMMARY TABLE FOR ALL WAVES IN RECORD

ALL EVENTS: 20.00 years of data between: 01/01/1980 and 12/31/1999
NOTE: "--" ENTRIES MEAN NO DATA IN THIS BIN
EVENT DISTRIBUTION WITHIN HEIGHT BAND (IN PERCENT)

DIR BINS	T= 00-03	03-06	06-08	08-10	10-12	12-14	14-16	16-18	18-20	20-25	TOTAL
15.0 - 30.0:	--	3.21	0.01	--	--	--	--	--	--	--	3.22
30.0 - 45.0:	--	3.51	0.04	--	--	--	--	--	--	--	3.55
45.0 - 60.0:	--	4.00	0.03	--	--	--	--	--	--	--	4.03
60.0 - 75.0:	--	3.69	0.02	--	--	--	--	--	--	--	3.70
75.0 - 90.0:	--	2.75	0.30	0.12	0.00	0.00	--	--	--	--	3.18
90.0 - 97.5:	--	1.89	0.56	0.41	0.13	0.22	0.07	0.01	--	--	3.29
97.5 - 105.0:	--	1.86	0.77	0.23	0.02	0.02	0.00	0.00	--	--	2.90
105.0 - 112.5:	--	1.50	1.19	0.56	0.14	0.09	0.04	0.02	0.01	--	3.56
112.5 - 120.0:	--	2.53	7.09	2.80	0.35	0.09	0.03	0.01	--	--	12.89
120.0 - 127.5:	--	2.43	3.91	0.80	0.21	0.30	0.09	0.01	--	--	7.74
127.5 - 135.0:	--	2.01	2.17	0.69	0.21	0.12	0.11	0.04	0.01	--	5.34
135.0 - 142.5:	--	1.44	1.10	0.36	0.17	0.17	0.13	0.06	0.00	--	3.43
142.5 - 150.0:	--	1.18	0.73	0.31	0.08	0.05	0.01	--	--	--	2.37
150.0 - 157.5:	--	1.26	0.77	0.33	0.08	0.02	0.00	--	--	--	2.45
157.5 - 165.0:	--	1.44	0.70	0.29	0.03	0.00	--	--	--	--	2.47
165.0 - 172.5:	--	1.71	0.66	0.21	0.05	0.01	0.00	--	--	--	2.64
172.5 - 180.0:	--	1.82	0.71	0.24	0.13	0.00	--	--	--	--	2.90
180.0 - 187.5:	--	1.65	0.40	0.06	0.01	0.00	--	--	--	--	2.13
187.5 - 202.5:	--	3.19	0.50	0.09	0.01	0.00	--	--	--	--	3.79
202.5 - 217.5:	--	3.33	0.43	0.04	0.00	--	--	--	--	--	3.80
217.5 - 232.5:	--	2.76	0.22	0.02	--	--	--	--	--	--	3.01
232.5 - 247.5:	--	2.22	0.08	0.00	--	--	--	--	--	--	2.30
247.5 - 262.5:	--	1.63	0.02	0.00	--	--	--	--	--	--	1.65
262.5 - 277.5:	--	1.76	0.01	0.00	--	--	--	--	--	--	1.77
277.5 - 292.5:	--	1.53	0.01	0.00	--	--	--	--	--	--	1.54
292.5 - 307.5:	--	1.49	0.01	0.00	--	--	--	--	--	--	1.50
307.5 - 322.5:	--	1.50	0.00	0.00	--	--	--	--	--	--	1.50
322.5 - 337.5:	--	1.75	0.00	--	--	--	--	--	--	--	1.75
TOTAL:	--	66.63	22.46	7.57	1.62	1.08	0.49	0.14	0.02	--	100

Wave Modeling Results. Wave transformation results are computed and reported at every ocean grid cell within the STWAVE model domain. While such results are beneficial on a more global scale, capturing the results (wave height, direction and period) at discrete locations is more beneficial for visualizing impacts from specific features. Therefore, in addition to the full domain results, the STWAVE output was captured at multiple points immediately seaward of all three project reaches. These observation points are shown on the STWAVE grid in Figure 4 below. The model results at these observation points were recorded for both the existing and with-project conditions and were then compared to determine what degree of influence the dredging activities within the borrow areas might have on the nearshore wave climate. The existing condition wave heights and directions were subtracted from the with-project heights and directions so that increases in wave heights would result in positive numbers and decreases would result in negative numbers.

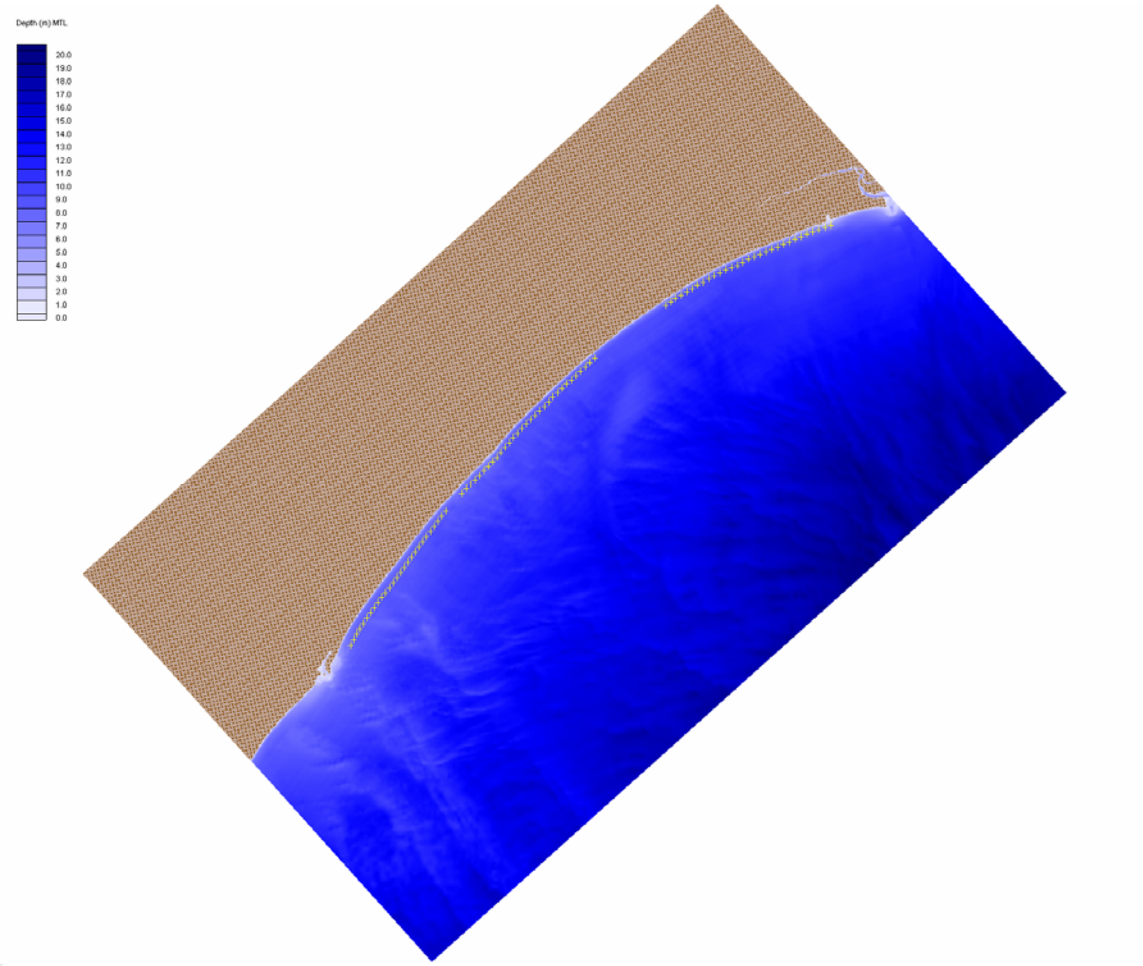


Figure 4: STWAVE grid showing depth (in meters) relative to MTL and observation points for all three nourishment project reaches.

All 489 wave direction/period/height conditions from the WIS hindcast analysis were included in the impact analysis. The mean, maximum, and minimum wave height and direction changes were calculated for each observation point and are plotted in Figures A1-A3 in Appendix A. The observation points for all three reaches exhibit the same trends. The mean wave height differences are all virtually null, as are the mean, maximum, and minimum differences in wave direction. In addition, in the instances where the maximum and minimum wave height differences are distinguishable from the mean, the magnitude of the largest reduction in wave height (minimum) is slightly greater than the largest increase in wave height (maximum). In these same instances, the maximum wave height increases can generally be quantified as +0.1 meters (approx. 4 inches).

Some of the more significant modeled wave conditions were selected to have their full-domain wave height difference contours plotted. These color contour plots of changes in wave heights are presented in Figures A4-A13 in Appendix A, where white signifies no change in wave height, yellows and reds signify increases in wave heights and blues signify decreases in wave heights. Figures A4 and A5 provide the wave height change contours for the most common wave condition in the hindcast record (Dir = 112.5-120.0 degrees [ESE to SE by E], T = 6.0-8.0 sec, H = 0.50-1.00 meters) for the Surfside/Cane South and Little River borrow areas respectively. The wave height difference contours in Figures A6-A13 are the results of waves from the SE with varying periods and heights. Easily discernable changes in wave heights are not present until Figures A10-A13 where the wave periods increase to between 12 and 16 seconds and the wave heights increase to between 3 and 4 meters. Even under these extreme wave conditions, the wave height differences never approach severe magnitudes. In fact, by the time the waves reach the nearshore, the change magnitudes (positive or negative) have dampened to the results seen in Figures A1-A3.

Conclusions

After reviewing a significant number of scientific reports on the potential impacts of offshore sand removal, it is clear that the dredging scenarios in the Myrtle Beach borrow areas (Little River, Cane South, and Surfside) are well within reasonable and prudent parameters for dredging activities. All the significant physical qualities of the Myrtle borrow areas are within the ranges of those study areas which were found to exhibit acceptable sand removal plans. The fact that these same borrow sites were used for the initial construction lends additional support to the finding of no significant impact. The initial construction used more material out of the borrow areas than will be needed during multiple re-nourishments and there has been no evidence of significant adverse impact since completion in 1999.

By including all 489 wave conditions in the wave transformation analysis, equal weight was given to the most severe and least likely scenarios as the milder and more likely scenarios. For example a 4 meter high wave with a period of 12 seconds from the ESE at the offshore boundary, which only occurs 2 times in the hindcast record, was (because of the simplistic analysis) given the same weight as a 0.5 meter high wave with a period of 6 seconds from the ESE, which occurs 7,733 times in the hindcast record. A more sophisticated examination and analytical method could be implemented based on percent chance of occurrence or duration of occurrence, but was not warranted due to the minor wave height and direction differences from the model results.

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APPENDIX A: Tables and Figures

Table A1: Modeled wave condition bin definitions.

Bin	Direction (degrees)	Period (sec)	Height (m)
1	60.0 – 75.0	3.0 – 6.0	0.00 – 0.50
2	75.0 – 90.0	6.0 – 8.0	0.50 – 1.00
3	90.0 – 97.5	8.0 – 10.0	1.00 – 1.50
4	97.5 – 105.0	10.0 – 12.0	1.50 – 2.00
5	105.0 – 112.5	12.0 – 14.0	2.00 – 2.50
6	112.5 – 120.0	14.0 – 16.0	2.50 – 3.00
7	120.0 – 127.5		3.00 – 4.00
8	127.5 – 135.0		
9	135.0 – 142.5		
10	142.5 – 150.0		
11	150.0 – 157.5		
12	157.5 – 165.0		
13	165.0 – 172.5		
14	172.5 – 180.0		
15	180.0 – 187.5		
16	187.5 – 202.5		
17	202.5 – 217.5		
18	217.5 – 232.5		

Table A2: Wave probability table for heights between 0.0 and 0.5 meters.

SUMMARY TABLES BY WAVE HEIGHT BAND

HEIGHT BAND: 0.00 - 0.50: 21715 of 175314 EVENTS (12.39 %)
NOTE: "--" ENTRIES MEAN NO DATA IN THIS BIN
EVENT DISTRIBUTION WITHIN HEIGHT BAND (IN PERCENT)

DIR BINS	T= 00-03	03-06	06-08	08-10	10-12	12-14	14-16	16-18	18-20	20-25	TOTAL
15.0 - 30.0:	--	1.52	--	--	--	--	--	--	--	--	1.52
30.0 - 45.0:	--	2.11	--	--	--	--	--	--	--	--	2.11
45.0 - 60.0:	--	2.03	--	--	--	--	--	--	--	--	2.03
60.0 - 75.0:	--	3.24	0.01	--	--	--	--	--	--	--	3.25
75.0 - 90.0:	--	2.94	0.24	0.17	0.03	--	--	--	--	--	3.38
90.0 - 97.5:	--	1.21	0.46	1.34	0.76	0.62	0.28	0.02	--	--	4.69
97.5 - 105.0:	--	0.88	0.58	0.51	0.06	0.02	--	--	--	--	2.05
105.0 - 112.5:	--	0.64	1.44	1.20	0.3	0.10	--	--	--	--	3.68
112.5 - 120.0:	--	2.62	16.23	6.87	0.64	0.06	--	--	--	--	26.42
120.0 - 127.5:	--	2.48	8.38	0.95	0.16	0.02	--	--	--	--	11.99
127.5 - 135.0:	--	2.57	6.84	1.59	0.17	0.01	--	0.01	0.02	--	11.22
135.0 - 142.5:	--	0.93	2.11	0.47	0.02	--	0.02	0.05	--	--	3.6
142.5 - 150.0:	--	0.66	0.62	0.10	--	--	--	--	--	--	1.39
150.0 - 157.5:	--	0.61	0.82	0.16	--	--	--	--	--	--	1.59
157.5 - 165.0:	--	0.70	0.23	0.04	--	--	--	--	--	--	0.98
165.0 - 172.5:	--	1.10	0.11	0.04	--	--	--	--	--	--	1.25
172.5 - 180.0:	--	2.14	0.46	0.06	--	--	--	--	--	--	2.65
180.0 - 187.5:	--	1.56	0.23	--	--	--	--	--	--	--	1.79
187.5 - 202.5:	--	3.40	0.12	--	--	--	--	--	--	--	3.53
202.5 - 217.5:	--	3.18	--	--	--	--	--	--	--	--	3.18
217.5 - 232.5:	--	1.17	--	--	--	--	--	--	--	--	1.17
232.5 - 247.5:	--	0.83	--	--	--	--	--	--	--	--	0.83
247.5 - 262.5:	--	0.51	--	--	--	--	--	--	--	--	0.51
262.5 - 277.5:	--	0.48	--	--	--	--	--	--	--	--	0.48
277.5 - 292.5:	--	0.53	--	--	--	--	--	--	--	--	0.53
292.5 - 307.5:	--	0.63	--	--	--	--	--	--	--	--	0.63
307.5 - 322.5:	--	0.50	--	--	--	--	--	--	--	--	0.50
322.5 - 337.5:	--	0.70	--	--	--	--	--	--	--	--	0.70
TOTAL:	--	44.24	38.88	13.51	2.14	0.83	0.29	0.08	0.02	--	100

Table A3: Wave probability table for heights between 0.5 and 1.0 meters.

SUMMARY TABLES BY WAVE HEIGHT BAND

HEIGHT BAND: 0.50 - 1.00: 80123 of 175314 EVENTS (45.70 %)
NOTE: "--" ENTRIES MEAN NO DATA IN THIS BIN
EVENT DISTRIBUTION WITHIN HEIGHT BAND (IN PERCENT)

DIR BINS	T= 00-03	03-06	06-08	08-10	10-12	12-14	14-16	16-18	18-20	20-25	TOTAL
15.0 - 30.0:	--	2.96	--	--	--	--	--	--	--	--	2.96
30.0 - 45.0:	--	2.95	--	--	--	--	--	--	--	--	2.95
45.0 - 60.0:	--	2.63	--	--	--	--	--	--	--	--	2.63
60.0 - 75.0:	--	2.02	--	--	--	--	--	--	--	--	2.02
75.0 - 90.0:	--	2.40	0.04	--	--	--	--	--	--	--	2.44
90.0 - 97.5:	--	2.72	0.54	0.25	0.07	0.23	0.07	0.01	--	--	3.89
97.5 - 105.0:	--	2.66	0.61	0.18	0.02	0.02	--	--	--	--	3.49
105.0 - 112.5:	--	2.06	1.15	0.50	0.12	0.06	0.01	0.01	0.01	--	3.93
112.5 - 120.0:	--	3.89	9.65	2.50	0.25	0.01	0.01	0.00	--	--	16.32
120.0 - 127.5:	--	3.81	4.57	0.54	0.17	0.13	0.02	--	--	--	9.25
127.5 - 135.0:	--	2.78	1.78	0.47	0.20	0.07	0.02	0.00	0.01	--	5.34
135.0 - 142.5:	--	1.88	0.69	0.13	0.10	0.04	0.05	0.01	--	--	2.90
142.5 - 150.0:	--	1.53	0.37	0.03	0.00	0.00	--	--	--	--	1.94
150.0 - 157.5:	--	1.57	0.34	0.07	0.00	0.00	--	--	--	--	1.98
157.5 - 165.0:	--	1.64	0.26	0.06	--	--	--	--	--	--	1.96
165.0 - 172.5:	--	2.16	0.37	0.04	0.00	--	--	--	--	--	2.57
172.5 - 180.0:	--	2.21	0.42	0.07	0.00	--	--	--	--	--	2.71
180.0 - 187.5:	--	2.07	0.17	0.01	--	--	--	--	--	--	2.26
187.5 - 202.5:	--	3.77	0.03	0.00	--	--	--	--	--	--	3.80
202.5 - 217.5:	--	3.89	--	--	--	--	--	--	--	--	3.89
217.5 - 232.5:	--	3.17	--	--	--	--	--	--	--	--	3.17
232.5 - 247.5:	--	3.04	--	--	--	--	--	--	--	--	3.04
247.5 - 262.5:	--	1.75	--	--	--	--	--	--	--	--	1.75
262.5 - 277.5:	--	1.71	--	--	--	--	--	--	--	--	1.71
277.5 - 292.5:	--	1.50	--	--	--	--	--	--	--	--	1.50
292.5 - 307.5:	--	1.42	--	--	--	--	--	--	--	--	1.42
307.5 - 322.5:	--	1.33	--	--	--	--	--	--	--	--	1.33
322.5 - 337.5:	--	1.63	--	--	--	--	--	--	--	--	1.63
TOTAL:	--	72.38	21	4.86	0.95	0.56	0.19	0.04	0.01	--	100

Table A4: Wave probability table for heights between 1.0 and 1.5 meters.

SUMMARY TABLES BY WAVE HEIGHT BAND

HEIGHT BAND: 1.00 - 1.50: 47118 of 175314 EVENTS (26.88 %)
NOTE: "--" ENTRIES MEAN NO DATA IN THIS BIN
EVENT DISTRIBUTION WITHIN HEIGHT BAND (IN PERCENT)

DIR BINS	T= 00-03	03-06	06-08	08-10	10-12	12-14	14-16	16-18	18-20	20-25	TOTAL
15.0 - 30.0:	--	4.51	--	--	--	--	--	--	--	--	4.51
30.0 - 45.0:	--	3.01	--	--	--	--	--	--	--	--	3.01
45.0 - 60.0:	--	5.21	--	--	--	--	--	--	--	--	5.21
60.0 - 75.0:	--	6.52	0.00	--	--	--	--	--	--	--	6.52
75.0 - 90.0:	--	3.93	0.06	0.01	--	0.01	--	--	--	--	4.01
90.0 - 97.5:	--	1.63	0.37	0.01	0.02	0.11	0.02	0.00	--	--	2.17
97.5 - 105.0:	--	1.87	1.14	0.12	0.01	0.02	0.01	0.00	--	--	3.18
105.0 - 112.5:	--	1.63	1.05	0.35	0.14	0.14	0.06	0.01	0.01	--	3.40
112.5 - 120.0:	--	1.43	1.74	2.15	0.46	0.19	0.04	0.02	--	--	6.03
120.0 - 127.5:	--	1.19	2.00	0.87	0.26	0.34	0.06	--	--	--	4.72
127.5 - 135.0:	--	1.33	1.08	0.37	0.18	0.07	0.19	0.03	0.00	--	3.24
135.0 - 142.5:	--	1.48	0.95	0.31	0.23	0.19	0.09	0.01	0.01	--	3.26
142.5 - 150.0:	--	1.32	0.80	0.24	0.06	0.02	--	--	--	--	2.43
150.0 - 157.5:	--	1.45	0.73	0.26	0.03	--	--	--	--	--	2.47
157.5 - 165.0:	--	1.94	0.87	0.22	0.01	--	--	--	--	--	3.04
165.0 - 172.5:	--	1.76	0.91	0.25	0.01	--	--	--	--	--	2.94
172.5 - 180.0:	--	1.66	0.71	0.31	0.14	--	--	--	--	--	2.82
180.0 - 187.5:	--	1.48	0.21	0.01	--	--	--	--	--	--	1.71
187.5 - 202.5:	--	3.11	0.05	--	--	--	--	--	--	--	3.16
202.5 - 217.5:	--	3.43	0.02	--	--	--	--	--	--	--	3.45
217.5 - 232.5:	--	3.49	0.01	--	--	--	--	--	--	--	3.50
232.5 - 247.5:	--	2.13	0.01	--	--	--	--	--	--	--	2.14
247.5 - 262.5:	--	2.07	0.00	--	--	--	--	--	--	--	2.08
262.5 - 277.5:	--	2.42	--	--	--	--	--	--	--	--	2.42
277.5 - 292.5:	--	2.14	--	--	--	--	--	--	--	--	2.14
292.5 - 307.5:	--	2.28	--	--	--	--	--	--	--	--	2.28
307.5 - 322.5:	--	2.55	--	--	--	--	--	--	--	--	2.55
322.5 - 337.5:	--	2.89	--	--	--	--	--	--	--	--	2.89
TOTAL:	--	78.59	12.71	5.49	1.54	1.10	0.48	0.08	0.02	--	100

Table A5: Wave probability table for heights between 1.5 and 2.0 meters.

SUMMARY TABLES BY WAVE HEIGHT BAND

HEIGHT BAND: 1.50 - 2.00: 16826 of 175314 EVENTS (9.60 %)
NOTE: "--" ENTRIES MEAN NO DATA IN THIS BIN
EVENT DISTRIBUTION WITHIN HEIGHT BAND (IN PERCENT)

DIR BINS	T= 00-03	03-06	06-08	08-10	10-12	12-14	14-16	16-18	18-20	20-25	TOTAL
15.0 - 30.0:	--	3.82	--	--	--	--	--	--	--	--	3.82
30.0 - 45.0:	--	8.90	--	--	--	--	--	--	--	--	8.90
45.0 - 60.0:	--	9.84	--	--	--	--	--	--	--	--	9.84
60.0 - 75.0:	--	5.30	0.02	--	--	--	--	--	--	--	5.32
75.0 - 90.0:	--	2.19	0.73	0.03	--	--	--	--	--	--	2.95
90.0 - 97.5:	--	0.56	0.56	0.04	0.01	0.03	--	--	--	--	1.20
97.5 - 105.0:	--	0.34	0.54	0.04	--	0.01	--	--	--	--	0.93
105.0 - 112.5:	--	0.42	1.64	0.51	0.11	0.12	0.18	0.12	0.04	--	3.14
112.5 - 120.0:	--	0.46	1.62	1.58	0.18	0.12	0.08	--	--	--	4.04
120.0 - 127.5:	--	0.58	1.97	1.31	0.26	0.80	0.30	--	--	--	5.21
127.5 - 135.0:	--	0.62	1.43	0.59	0.11	0.12	0.20	0.12	--	--	3.20
135.0 - 142.5:	--	0.67	1.72	0.41	0.15	0.41	0.18	0.05	--	--	3.59
142.5 - 150.0:	--	0.49	1.60	0.66	0.11	0.07	--	--	--	--	2.94
150.0 - 157.5:	--	0.78	1.97	0.77	0.17	--	--	--	--	--	3.68
157.5 - 165.0:	--	0.82	1.88	0.68	0.04	--	--	--	--	--	3.42
165.0 - 172.5:	--	1.12	1.32	0.43	0.11	0.01	--	--	--	--	2.98
172.5 - 180.0:	--	0.99	1.16	0.57	0.36	--	--	--	--	--	3.08
180.0 - 187.5:	--	1.14	0.93	0.05	0.01	--	--	--	--	--	2.13
187.5 - 202.5:	--	2.12	1.90	0.03	--	--	--	--	--	--	4.05
202.5 - 217.5:	--	2.45	2.12	0.01	--	--	--	--	--	--	4.57
217.5 - 232.5:	--	2.38	1.11	--	--	--	--	--	--	--	3.49
232.5 - 247.5:	--	1.45	0.43	--	--	--	--	--	--	--	1.88
247.5 - 262.5:	--	1.93	0.13	--	--	--	--	--	--	--	2.06
262.5 - 277.5:	--	2.40	0.09	--	--	--	--	--	--	--	2.49
277.5 - 292.5:	--	1.80	0.07	--	--	--	--	--	--	--	1.87
292.5 - 307.5:	--	1.30	0.02	--	--	--	--	--	--	--	1.31
307.5 - 322.5:	--	1.28	0.01	--	--	--	--	--	--	--	1.29
322.5 - 337.5:	--	1.21	0.02	--	--	--	--	--	--	--	1.23
TOTAL:	--	62.73	25.01	7.69	1.60	1.69	0.94	0.30	0.04	--	100

Table A6: Wave probability table for heights between 2.0 and 2.5 meters.

SUMMARY TABLES BY WAVE HEIGHT BAND

HEIGHT BAND: 2.00 - 2.50: 5978 of 175314 EVENTS (3.41 %)
NOTE: "--" ENTRIES MEAN NO DATA IN THIS BIN
EVENT DISTRIBUTION WITHIN HEIGHT BAND (IN PERCENT)

DIR BINS	T= 00-03	03-06	06-08	08-10	10-12	12-14	14-16	16-18	18-20	20-25	TOTAL
15.0 - 30.0:	--	2.43	--	--	--	--	--	--	--	--	2.43
30.0 - 45.0:	--	6.86	0.08	--	--	--	--	--	--	--	6.94
45.0 - 60.0:	--	5.60	0.15	--	--	--	--	--	--	--	5.75
60.0 - 75.0:	--	2.93	0.30	--	--	--	--	--	--	--	3.23
75.0 - 90.0:	--	0.80	3.55	0.79	--	--	--	--	--	--	5.14
90.0 - 97.5:	--	0.03	2.17	0.74	--	--	0.03	--	--	--	2.98
97.5 - 105.0:	--	--	1.35	0.32	--	--	--	--	--	--	1.67
105.0 - 112.5:	--	--	1.05	0.28	0.03	0.03	0.08	--	--	--	1.49
112.5 - 120.0:	--	--	1.30	1.14	0.33	0.13	--	--	--	--	2.91
120.0 - 127.5:	--	--	1.72	0.95	0.08	0.77	0.65	--	--	--	4.18
127.5 - 135.0:	--	0.02	2.06	1.81	0.27	0.82	0.12	0.12	--	--	5.20
135.0 - 142.5:	--	0.03	2.49	1.25	0.37	0.59	0.72	0.38	--	--	5.84
142.5 - 150.0:	--	0.03	2.99	2.69	0.23	0.02	0.02	--	--	--	5.99
150.0 - 157.5:	--	0.02	3.26	1.77	0.32	0.15	--	--	--	--	5.52
157.5 - 165.0:	--	0.02	3.23	1.54	0.22	--	--	--	--	--	5.00
165.0 - 172.5:	--	0.18	2.43	0.60	0.32	0.07	--	--	--	--	3.60
172.5 - 180.0:	--	0.03	3.55	0.65	1.39	--	--	--	--	--	5.62
180.0 - 187.5:	--	0.08	3.41	0.13	--	--	--	--	--	--	3.63
187.5 - 202.5:	--	0.20	5.96	0.23	--	--	--	--	--	--	6.39
202.5 - 217.5:	--	0.15	4.73	0.13	--	--	--	--	--	--	5.02
217.5 - 232.5:	--	0.13	2.69	0.10	--	--	--	--	--	--	2.93
232.5 - 247.5:	--	0.47	0.92	0.02	--	--	--	--	--	--	1.41
247.5 - 262.5:	--	0.69	0.22	0.02	--	--	--	--	--	--	0.92
262.5 - 277.5:	--	0.97	0.18	0.03	--	--	--	--	--	--	1.19
277.5 - 292.5:	--	0.84	0.07	0.02	--	--	--	--	--	--	0.92
292.5 - 307.5:	--	0.79	0.10	--	--	--	--	--	--	--	0.89
307.5 - 322.5:	--	0.55	0.03	0.02	--	--	--	--	--	--	0.60
322.5 - 337.5:	--	0.62	--	--	--	--	--	--	--	--	0.62
TOTAL:	--	26.48	50.02	15.24	3.56	2.58	1.62	0.50	--	--	100

Table A7: Wave probability table for heights between 2.5 and 3.0 meters.

SUMMARY TABLES BY WAVE HEIGHT BAND

HEIGHT BAND: 2.50 - 3.00: 2243 of 175314 EVENTS (1.28 %)
NOTE: "--" ENTRIES MEAN NO DATA IN THIS BIN
EVENT DISTRIBUTION WITHIN HEIGHT BAND (IN PERCENT)

DIR BINS	T= 00-03	03-06	06-08	08-10	10-12	12-14	14-16	16-18	18-20	20-25	TOTAL
15.0 - 30.0:	--	0.45	0.31	--	--	--	--	--	--	--	0.76
30.0 - 45.0:	--	0.18	2.23	--	--	--	--	--	--	--	2.41
45.0 - 60.0:	--	0.45	2.14	--	--	--	--	--	--	--	2.59
60.0 - 75.0:	--	0.04	0.18	--	--	--	--	--	--	--	0.22
75.0 - 90.0:	--	--	2.67	4.32	--	--	--	--	--	--	7.00
90.0 - 97.5:	--	--	1.83	5.08	--	--	0.04	--	--	--	6.95
97.5 - 105.0:	--	--	0.71	1.03	--	--	0.09	--	--	--	1.83
105.0 - 112.5:	--	--	0.67	1.29	--	--	0.09	--	--	--	2.05
112.5 - 120.0:	--	--	0.13	2.14	0.49	0.27	0.09	--	--	--	3.12
120.0 - 127.5:	--	--	0.40	2.59	0.53	1.03	0.58	0.27	--	--	5.39
127.5 - 135.0:	--	--	0.76	3.70	1.11	0.71	0.85	0.4	--	--	7.53
135.0 - 142.5:	--	--	1.07	4.32	0.98	1.11	0.85	0.36	--	--	8.69
142.5 - 150.0:	--	--	1.03	3.83	0.58	0.27	0.09	--	--	--	5.80
150.0 - 157.5:	--	--	1.47	3.74	1.65	0.18	--	--	--	--	7.04
157.5 - 165.0:	--	--	2.50	3.30	0.49	0.18	--	--	--	--	6.46
165.0 - 172.5:	--	--	1.56	2.41	0.45	--	--	--	--	--	4.41
172.5 - 180.0:	--	--	2.36	1.87	0.31	0.13	--	--	--	--	4.68
180.0 - 187.5:	--	--	2.59	2.14	--	--	--	--	--	--	4.73
187.5 - 202.5:	--	--	5.17	3.52	0.04	--	--	--	--	--	8.74
202.5 - 217.5:	--	--	3.92	1.69	--	--	--	--	--	--	5.62
217.5 - 232.5:	--	--	1.47	1.16	--	--	--	--	--	--	2.63
232.5 - 247.5:	--	--	0.13	0.13	--	--	--	--	--	--	0.27
247.5 - 262.5:	--	--	--	0.18	--	--	--	--	--	--	0.18
262.5 - 277.5:	--	--	--	--	--	--	--	--	--	--	0.00
277.5 - 292.5:	--	0.04	--	0.13	--	--	--	--	--	--	0.18
292.5 - 307.5:	--	0.04	--	0.04	--	--	--	--	--	--	0.09
307.5 - 322.5:	--	0.09	--	--	--	--	--	--	--	--	0.09
322.5 - 337.5:	--	0.09	--	--	--	--	--	--	--	--	0.09
TOTAL:	--	1.56	35.58	48.64	6.64	3.88	2.67	1.03	--	--	100

Table A8: Wave probability table for heights between 3.0 and 4.0 meters.

SUMMARY TABLES BY WAVE HEIGHT BAND

HEIGHT BAND: 3.00 - 4.00: 1053 of 175314 EVENTS (0.60 %)
NOTE: "--" ENTRIES MEAN NO DATA IN THIS BIN
EVENT DISTRIBUTION WITHIN HEIGHT BAND (IN PERCENT)

DIR BINS	T= 00-03	03-06	06-08	08-10	10-12	12-14	14-16	16-18	18-20	20-25	TOTAL
15.0 - 30.0:	--	--	0.85	--	--	--	--	--	--	--	0.85
30.0 - 45.0:	--	--	1.04	--	--	--	--	--	--	--	1.04
45.0 - 60.0:	--	--	0.28	--	--	--	--	--	--	--	0.28
60.0 - 75.0:	--	--	--	--	--	--	--	--	--	--	0.00
75.0 - 90.0:	--	--	1.33	1.52	--	--	--	--	--	--	2.85
90.0 - 97.5:	--	--	0.66	5.13	0.28	--	--	--	--	--	6.08
97.5 - 105.0:	--	--	0.47	3.51	--	--	--	--	--	--	3.99
105.0 - 112.5:	--	--	0.09	1.80	--	--	--	--	--	--	1.90
112.5 - 120.0:	--	--	0.09	1.23	0.09	0.19	0.09	--	--	--	1.71
120.0 - 127.5:	--	--	0.09	1.33	0.57	3.80	0.57	0.66	--	--	7.03
127.5 - 135.0:	--	--	0.19	1.71	2.18	1.23	1.42	0.85	--	--	7.60
135.0 - 142.5:	--	--	0.38	3.61	2.66	1.90	2.94	3.04	--	--	14.53
142.5 - 150.0:	--	--	0.47	2.75	4.75	1.23	0.19	--	--	--	9.40
150.0 - 157.5:	--	--	0.28	3.99	2.94	0.66	0.19	--	--	--	8.07
157.5 - 165.0:	--	--	0.47	5.22	1.80	0.19	--	--	--	--	7.69
165.0 - 172.5:	--	--	0.76	4.08	1.23	0.28	0.19	--	--	--	6.55
172.5 - 180.0:	--	--	0.76	3.13	0.28	--	--	--	--	--	4.18
180.0 - 187.5:	--	--	0.38	3.13	0.66	--	--	--	--	--	4.18
187.5 - 202.5:	--	--	1.52	5.60	0.38	--	--	--	--	--	7.50
202.5 - 217.5:	--	--	1.23	1.80	0.19	--	--	--	--	--	3.23
217.5 - 232.5:	--	--	0.19	0.76	--	--	--	--	--	--	0.95
232.5 - 247.5:	--	--	0.09	0.09	--	--	--	--	--	--	0.19
247.5 - 262.5:	--	--	--	0.09	--	--	--	--	--	--	0.09
262.5 - 277.5:	--	--	--	--	--	--	--	--	--	--	0.00
277.5 - 292.5:	--	--	--	--	--	--	--	--	--	--	0.00
292.5 - 307.5:	--	--	--	--	--	--	--	--	--	--	0.00
307.5 - 322.5:	--	--	--	--	--	--	--	--	--	--	0.00
322.5 - 337.5:	--	--	--	--	--	--	--	--	--	--	0.00
TOTAL:	--	--	11.78	50.52	18.04	9.5	5.6	4.56	--	--	100

Table A9: Wave probability table for heights between 4.0 and 5.0 meters.

SUMMARY TABLES BY WAVE HEIGHT BAND

HEIGHT BAND: 4.00 - 5.00: 120 of 175314 EVENTS (0.07 %)
NOTE: "--" ENTRIES MEAN NO DATA IN THIS BIN
EVENT DISTRIBUTION WITHIN HEIGHT BAND (IN PERCENT)

DIR BINS	T= 00-03	03-06	06-08	08-10	10-12	12-14	14-16	16-18	18-20	20-25	TOTAL
15.0 - 30.0:	--	--	--	--	--	--	--	--	--	--	0.00
30.0 - 45.0:	--	--	--	--	--	--	--	--	--	--	0.00
45.0 - 60.0:	--	--	--	--	--	--	--	--	--	--	0.00
60.0 - 75.0:	--	--	--	--	--	--	--	--	--	--	0.00
75.0 - 90.0:	--	--	--	2.50	--	0.83	--	--	--	--	3.33
90.0 - 97.5:	--	--	--	--	0.83	--	--	--	--	--	0.83
97.5 - 105.0:	--	--	--	0.83	--	--	--	--	--	--	0.83
105.0 - 112.5:	--	--	--	--	--	--	--	--	--	--	0.00
112.5 - 120.0:	--	--	--	0.83	0.83	--	--	--	--	--	1.67
120.0 - 127.5:	--	--	--	--	--	3.33	--	--	--	--	3.33
127.5 - 135.0:	--	--	--	1.67	0.83	1.67	--	--	--	--	4.17
135.0 - 142.5:	--	--	--	2.50	5.00	3.33	4.17	4.17	--	--	19.17
142.5 - 150.0:	--	--	--	1.67	9.17	15.00	0.83	--	--	--	26.67
150.0 - 157.5:	--	--	--	0.83	0.83	2.50	1.67	--	--	--	5.83
157.5 - 165.0:	--	--	--	3.33	3.33	0.83	--	--	--	--	7.50
165.0 - 172.5:	--	--	--	3.33	6.67	3.33	0.83	--	--	--	14.17
172.5 - 180.0:	--	--	--	1.67	2.50	--	--	--	--	--	4.17
180.0 - 187.5:	--	--	--	--	1.67	--	--	--	--	--	1.67
187.5 - 202.5:	--	--	--	1.67	4.17	--	--	--	--	--	5.83
202.5 - 217.5:	--	--	--	0.83	--	--	--	--	--	--	0.83
217.5 - 232.5:	--	--	--	--	--	--	--	--	--	--	0.00
232.5 - 247.5:	--	--	--	--	--	--	--	--	--	--	0.00
247.5 - 262.5:	--	--	--	--	--	--	--	--	--	--	0.00
262.5 - 277.5:	--	--	--	--	--	--	--	--	--	--	0.00
277.5 - 292.5:	--	--	--	--	--	--	--	--	--	--	0.00
292.5 - 307.5:	--	--	--	--	--	--	--	--	--	--	0.00
307.5 - 322.5:	--	--	--	--	--	--	--	--	--	--	0.00
322.5 - 337.5:	--	--	--	--	--	--	--	--	--	--	0.00
TOTAL:	--	--	--	21.67	35.83	30.83	7.5	4.17	--	--	100

Table A10: Wave probability table for heights between 5.0 and 20.0 meters.

SUMMARY TABLES BY WAVE HEIGHT BAND

HEIGHT BAND: 5.00 - 20.00: 138 of 175314 EVENTS (0.08 %)
NOTE: "--" ENTRIES MEAN NO DATA IN THIS BIN
EVENT DISTRIBUTION WITHIN HEIGHT BAND (IN PERCENT)

DIR BINS	T= 00-03	03-06	06-08	08-10	10-12	12-14	14-16	16-18	18-20	20-25	TOTAL
15.0 - 30.0:	--	--	--	--	--	--	--	--	--	--	0.00
30.0 - 45.0:	--	--	--	--	--	--	--	--	--	--	0.00
45.0 - 60.0:	--	--	--	--	--	--	--	--	--	--	0.00
60.0 - 75.0:	--	--	--	--	--	--	--	--	--	--	0.00
75.0 - 90.0:	--	--	--	0.72	0.72	0.72	--	--	--	--	2.17
90.0 - 97.5:	--	--	--	--	1.45	0.72	--	--	--	--	2.17
97.5 - 105.0:	--	--	--	--	0.72	--	--	--	--	--	0.72
105.0 - 112.5:	--	--	--	--	0.72	--	--	--	--	--	0.72
112.5 - 120.0:	--	--	--	--	0.72	1.45	--	--	--	--	2.17
120.0 - 127.5:	--	--	--	--	2.17	4.35	--	--	--	--	6.52
127.5 - 135.0:	--	--	--	--	1.45	8.70	5.07	--	--	--	15.22
135.0 - 142.5:	--	--	--	--	0.72	14.49	11.59	3.62	--	--	30.43
142.5 - 150.0:	--	--	--	--	0.72	21.74	5.80	--	--	--	28.26
150.0 - 157.5:	--	--	--	--	0.72	1.45	--	--	--	--	2.17
157.5 - 165.0:	--	--	--	--	0.72	0.72	--	--	--	--	1.45
165.0 - 172.5:	--	--	--	--	0.72	1.45	1.45	--	--	--	3.62
172.5 - 180.0:	--	--	--	--	--	0.72	--	--	--	--	0.72
180.0 - 187.5:	--	--	--	--	0.72	1.45	--	--	--	--	2.17
187.5 - 202.5:	--	--	--	--	--	1.45	--	--	--	--	1.45
202.5 - 217.5:	--	--	--	--	--	--	--	--	--	--	0.00
217.5 - 232.5:	--	--	--	--	--	--	--	--	--	--	0.00
232.5 - 247.5:	--	--	--	--	--	--	--	--	--	--	0.00
247.5 - 262.5:	--	--	--	--	--	--	--	--	--	--	0.00
262.5 - 277.5:	--	--	--	--	--	--	--	--	--	--	0.00
277.5 - 292.5:	--	--	--	--	--	--	--	--	--	--	0.00
292.5 - 307.5:	--	--	--	--	--	--	--	--	--	--	0.00
307.5 - 322.5:	--	--	--	--	--	--	--	--	--	--	0.00
322.5 - 337.5:	--	--	--	--	--	--	--	--	--	--	0.00
TOTAL:	--	--	--	0.72	12.32	59.42	23.91	3.62	--	--	100

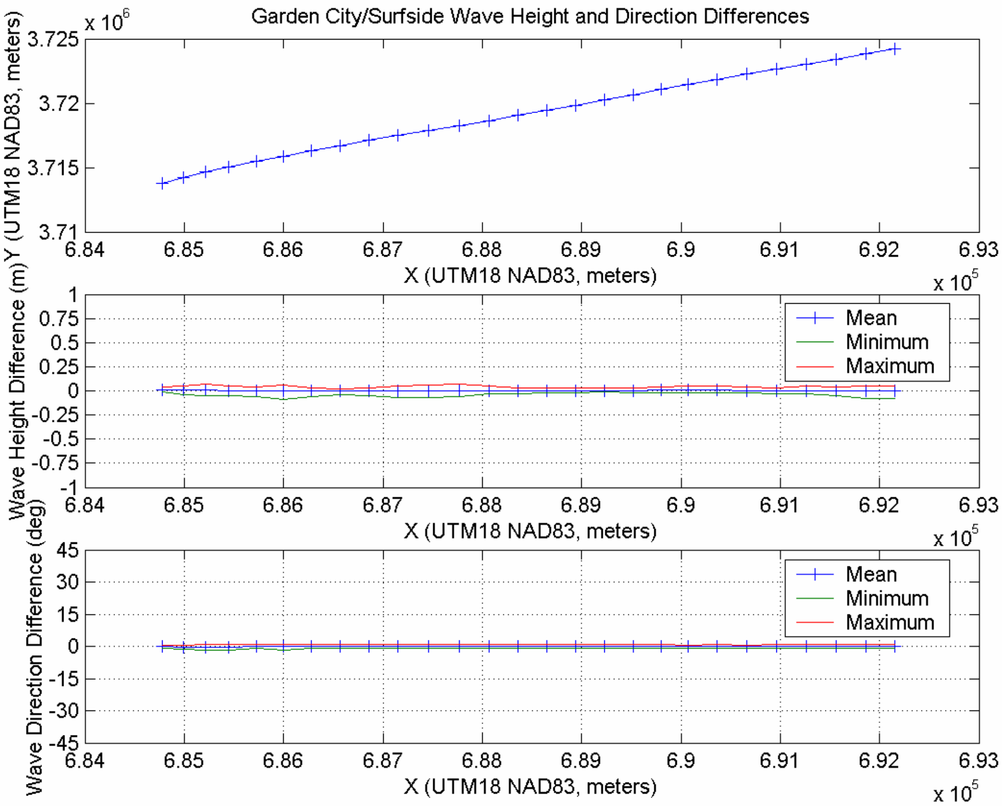

Figure A1: Wave height and direction difference plot for the Garden City/Surfside Reach (all wave condition bins).

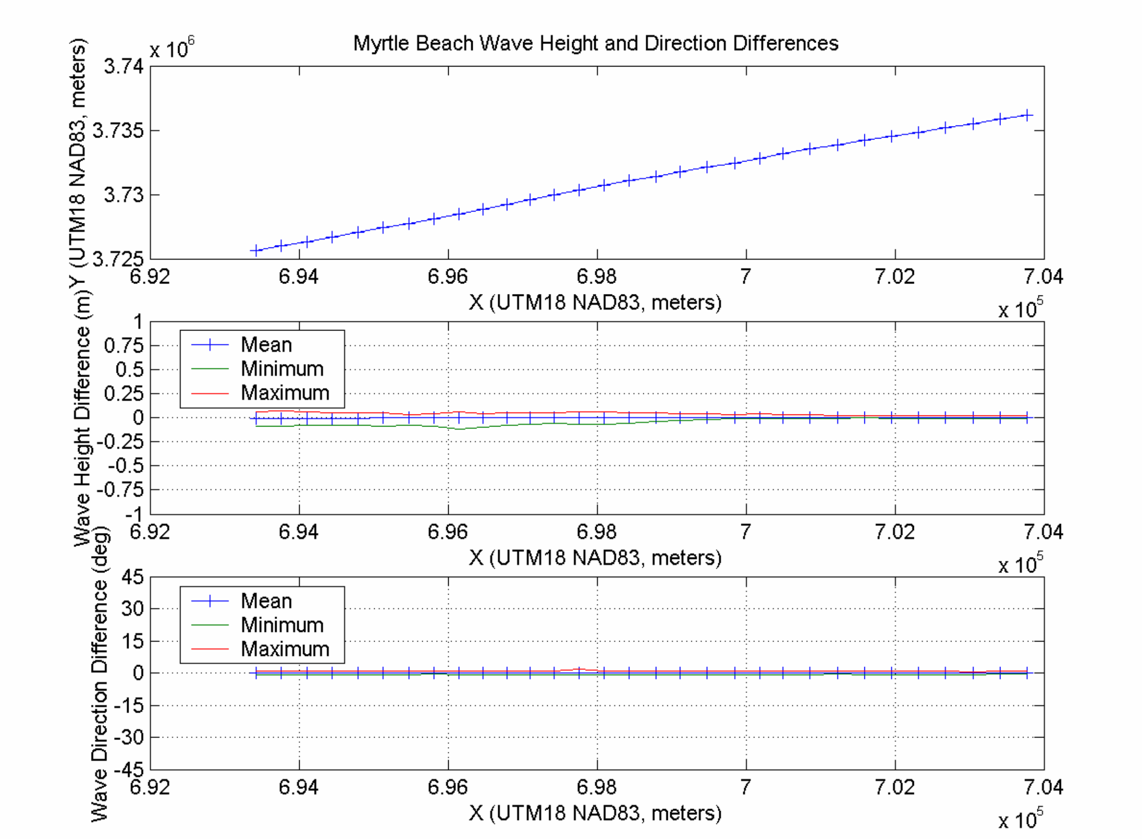

Figure A2: Wave height and direction difference plot for the Myrtle Beach Reach (all wave condition bins).

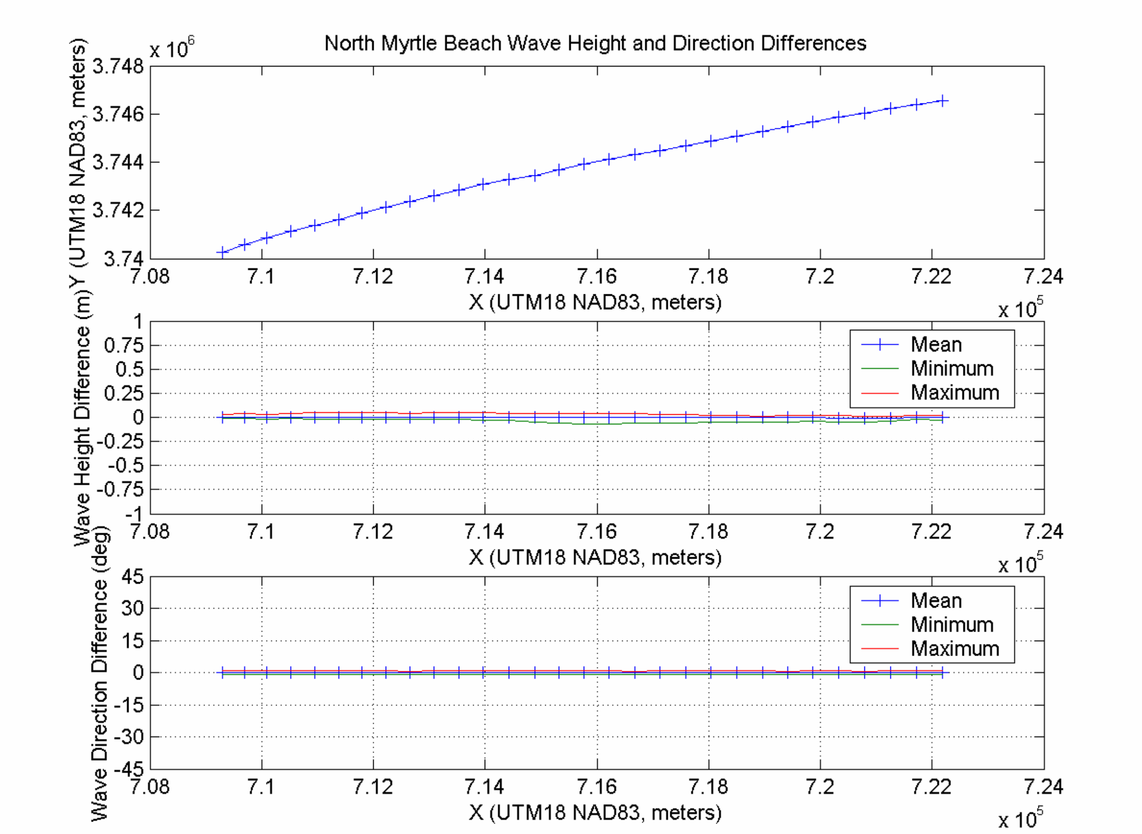

Figure A3: Wave height and direction difference plot for the North Myrtle Beach Reach (all wave condition bins).

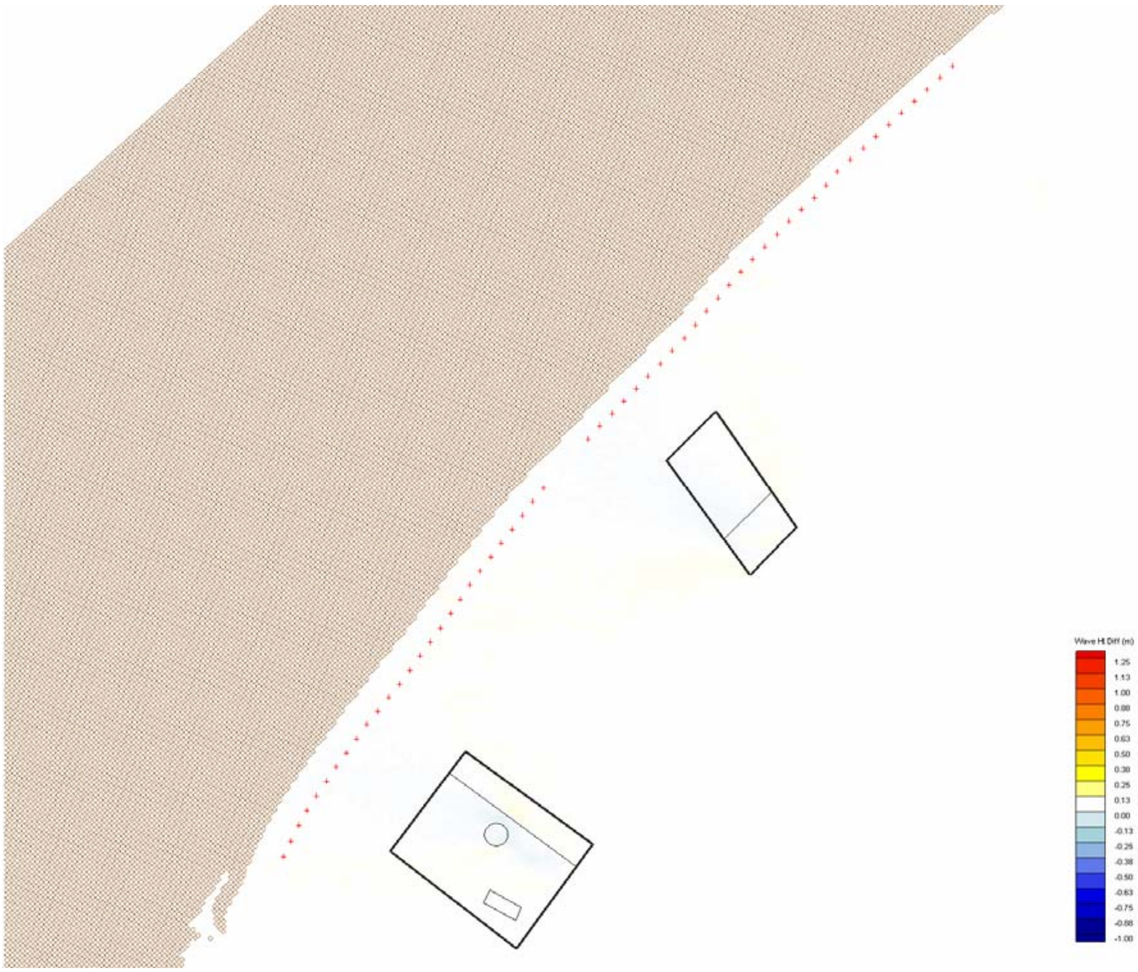

Figure A4: Wave height difference contour plot for the Surfside and Cane South Borrow Areas (Dir = 112.5-120.0 degrees, T = 6.0-8.0 sec, H = 0.50-1.00 meters).

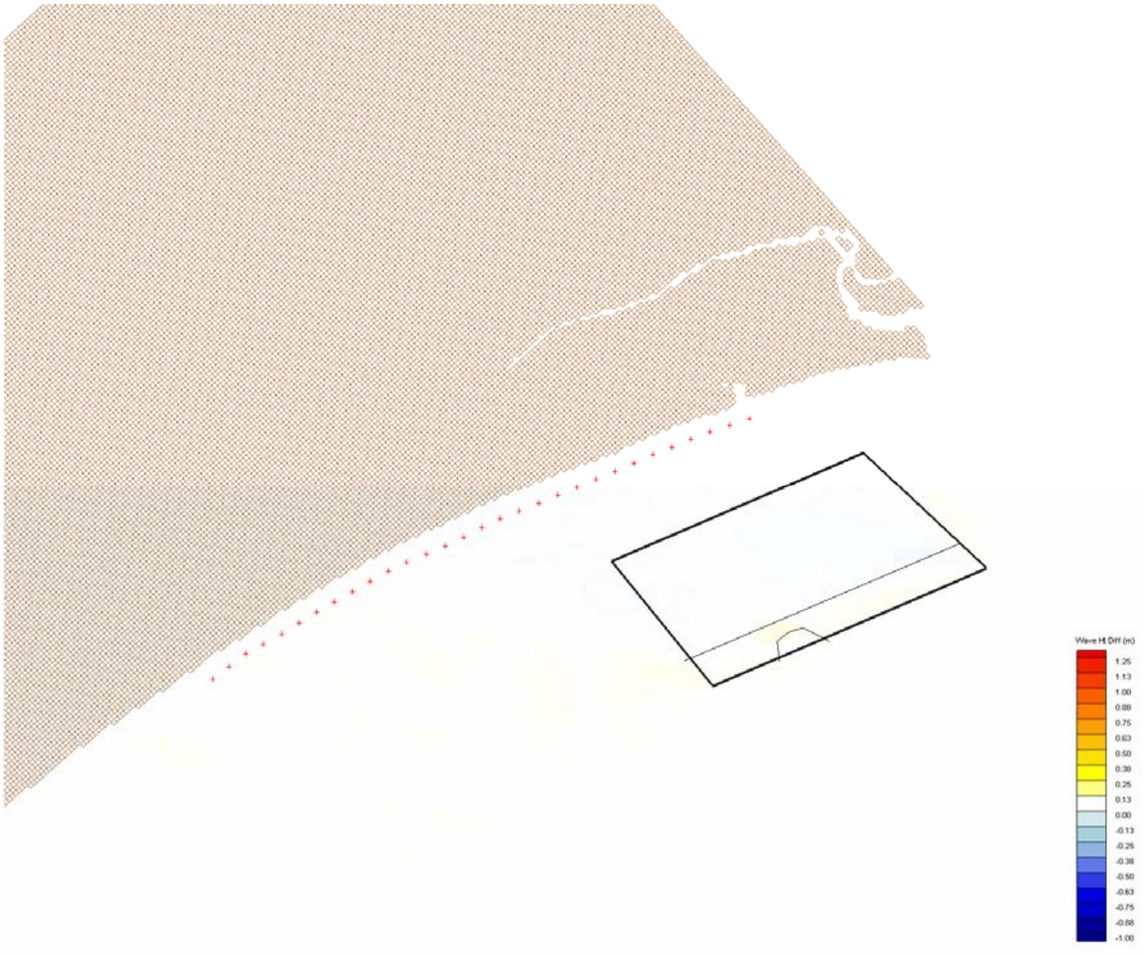

Figure A5: Wave height difference contour plot for the Little River Borrow Area (Dir = 112.5-120.0 degrees, T = 6.0-8.0 sec, H = 0.50-1.00 meters).

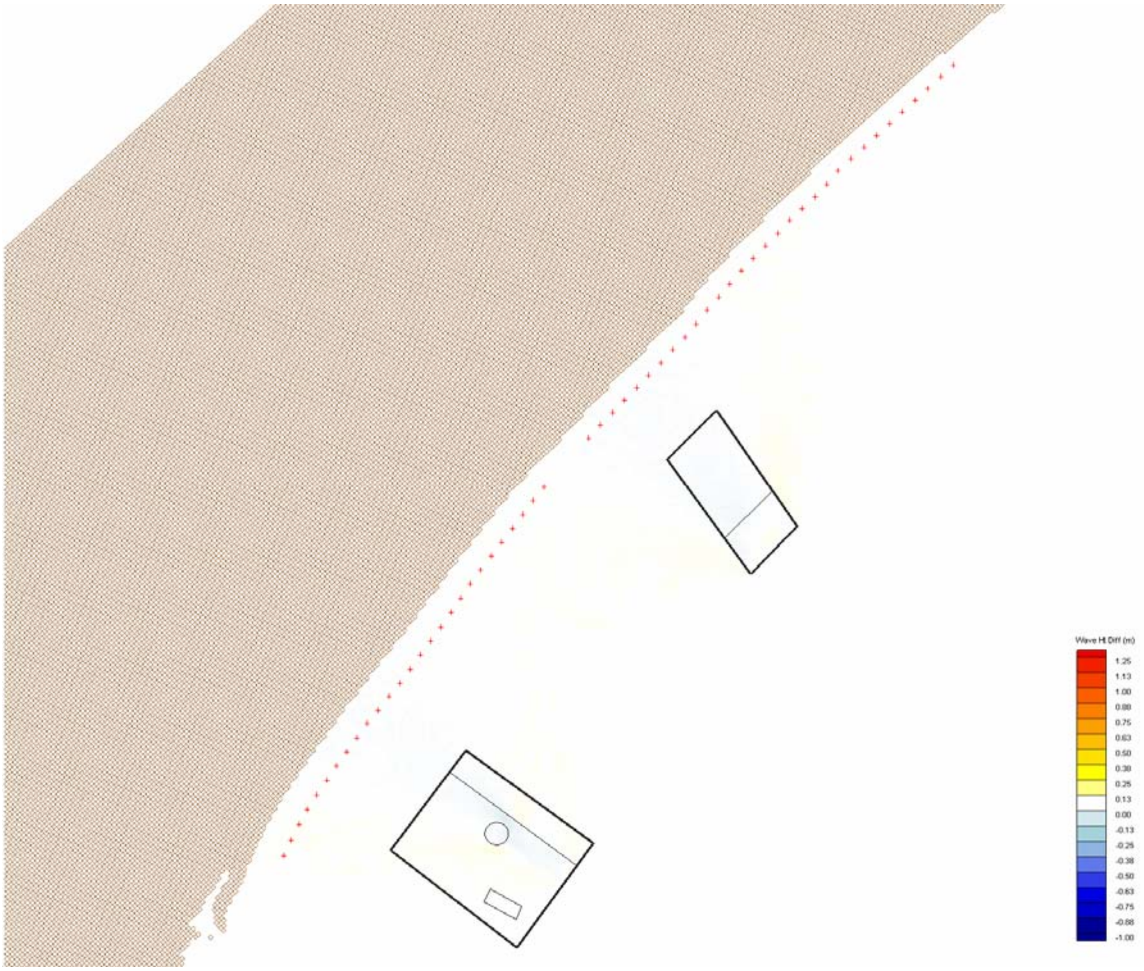

Figure A6: Wave height difference contour plot for the Surfside and Cane South Borrow Areas (Dir = 135.0-142.5 degrees, T = 6.0-8.0 sec, H = 0.50-1.00 meters).

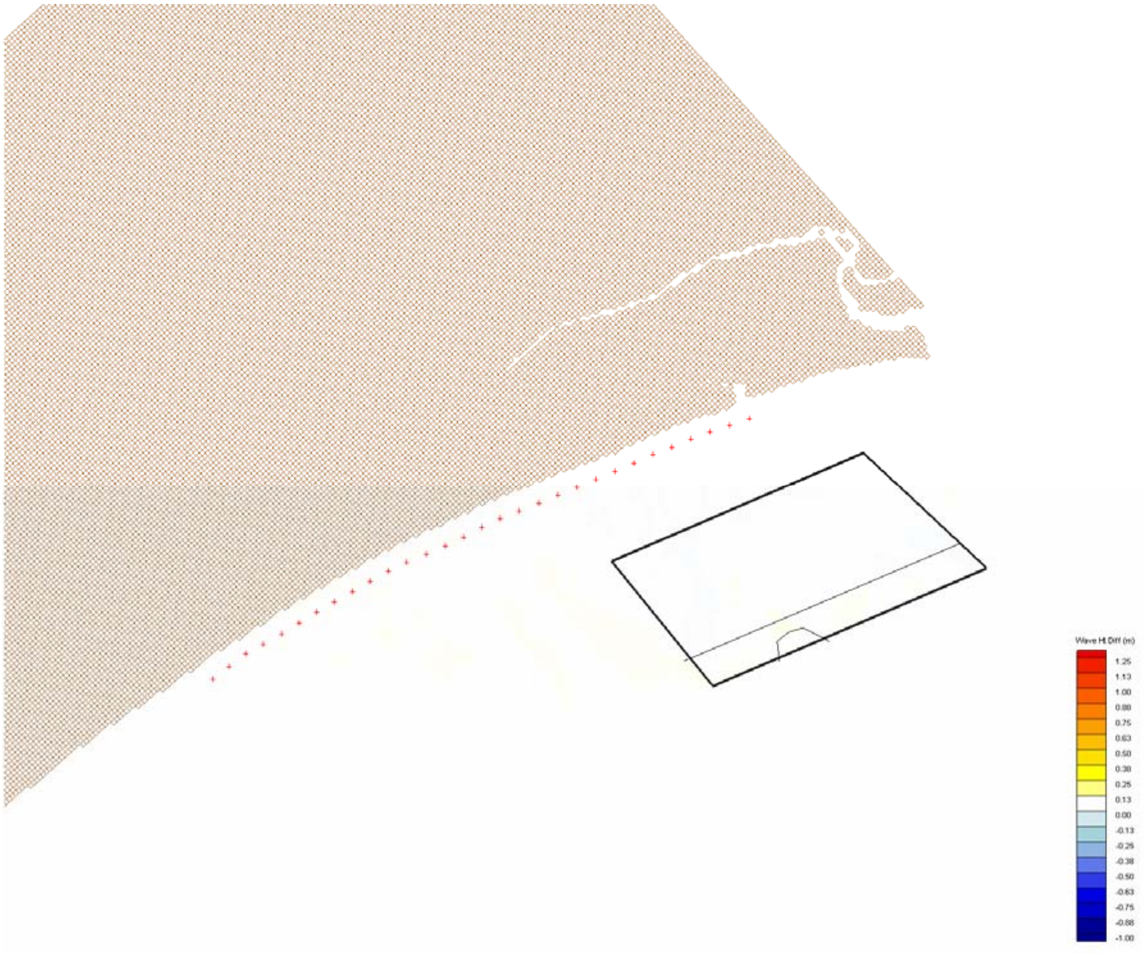

Figure A7: Wave height difference contour plot for the Little River Borrow Area (Dir = 135.0-142.5 degrees, T = 6.0-8.0 sec, H = 0.50-1.00 meters).

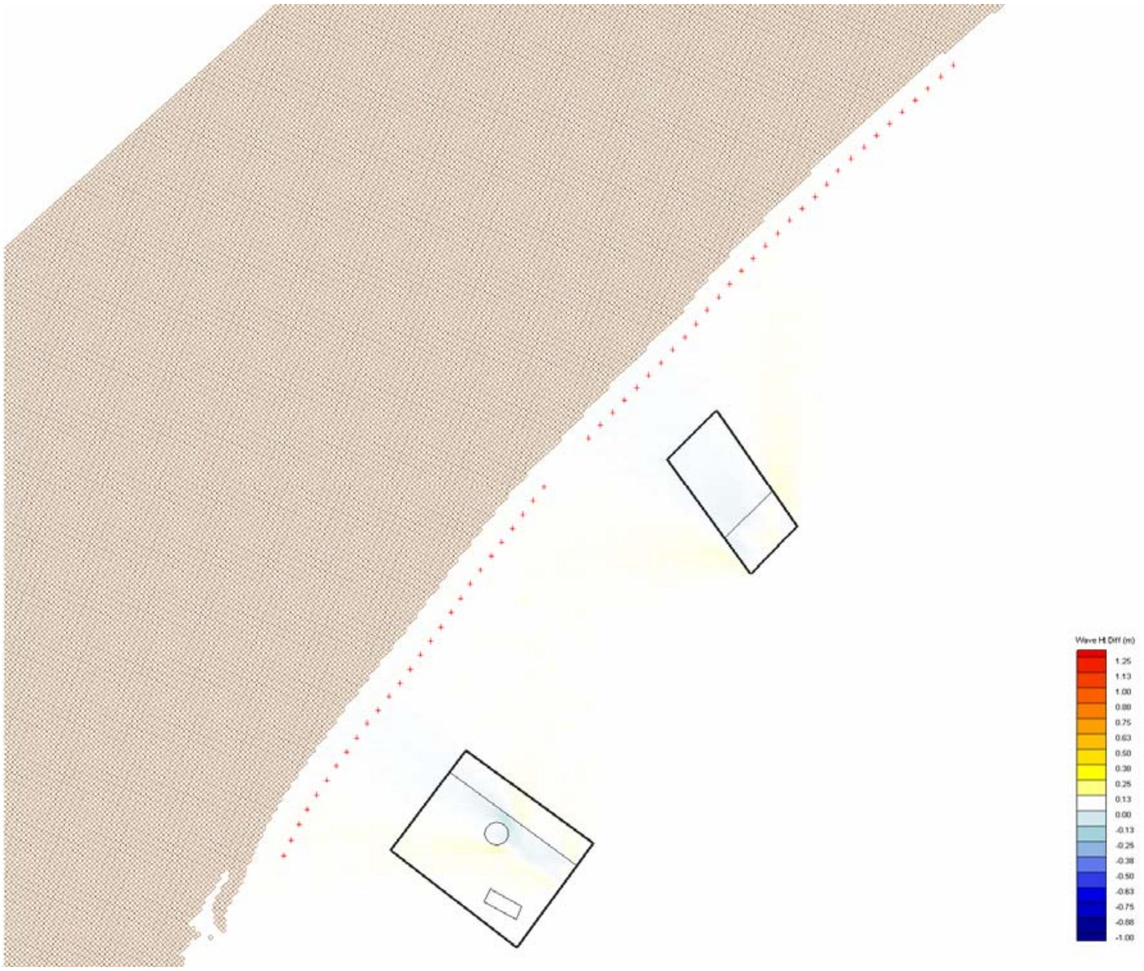

Figure A8: Wave height difference contour plot for the Surfside and Cane South Borrow Areas (Dir = 135.0-142.5 degrees, T = 6.0-8.0 sec, H = 1.00-1.50 meters).

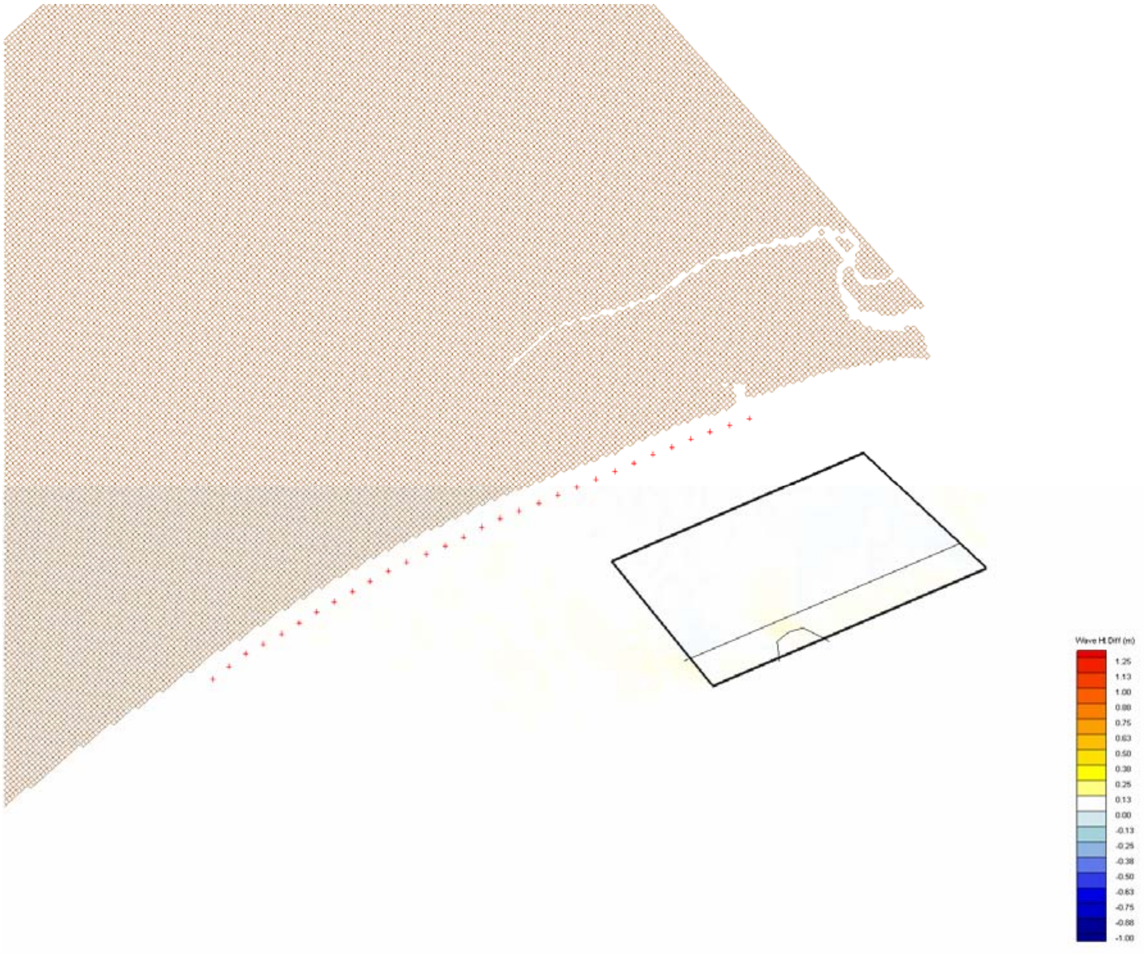

Figure A9: Wave height difference contour plot for the Little River Borrow Area (Dir = 135.0-142.5 degrees, T = 6.0-8.0 sec, H = 1.00-1.50 meters).

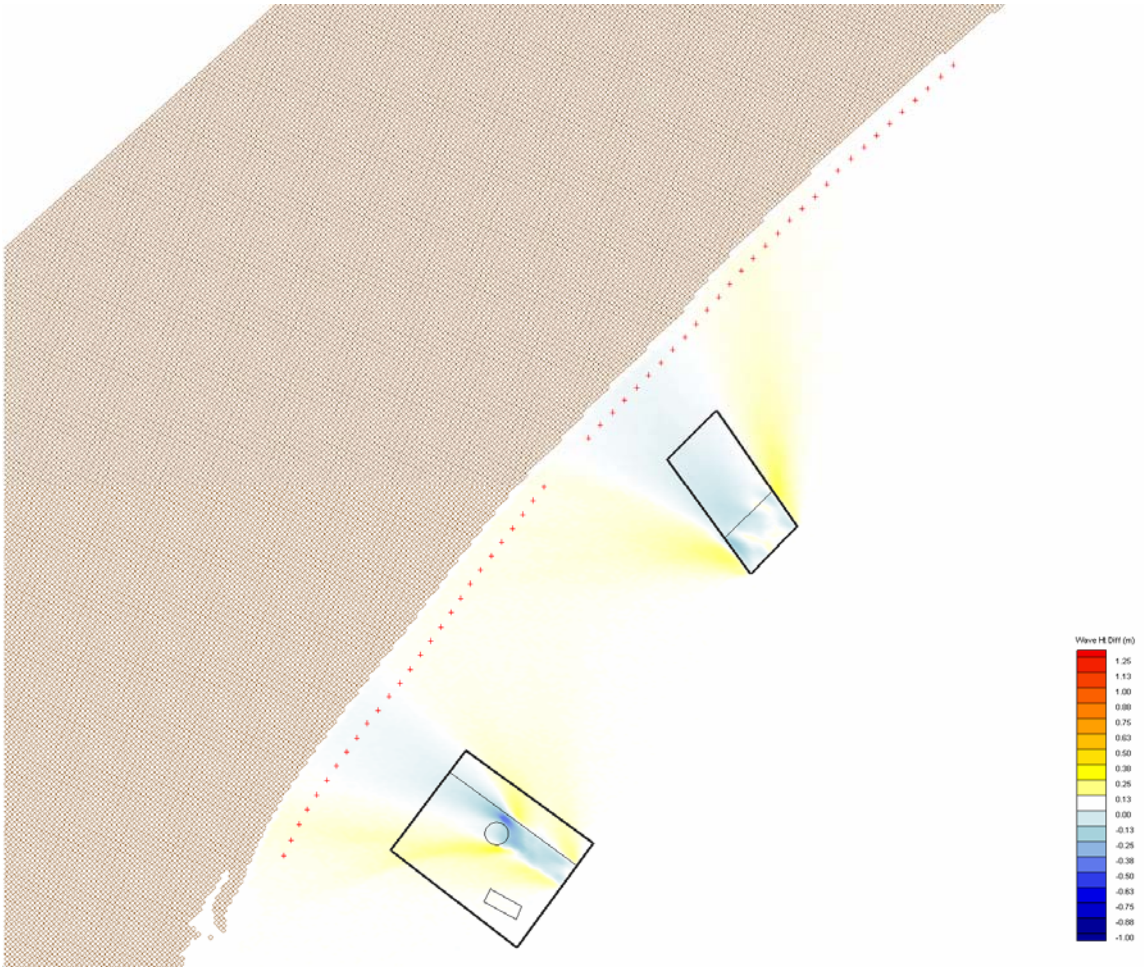

Figure A10: Wave height difference contour plot for the Surfside and Cane South Borrow Areas (Dir = 135.0-142.5 degrees, T = 10.0-12.0 sec, H = 3.00-4.00 meters).

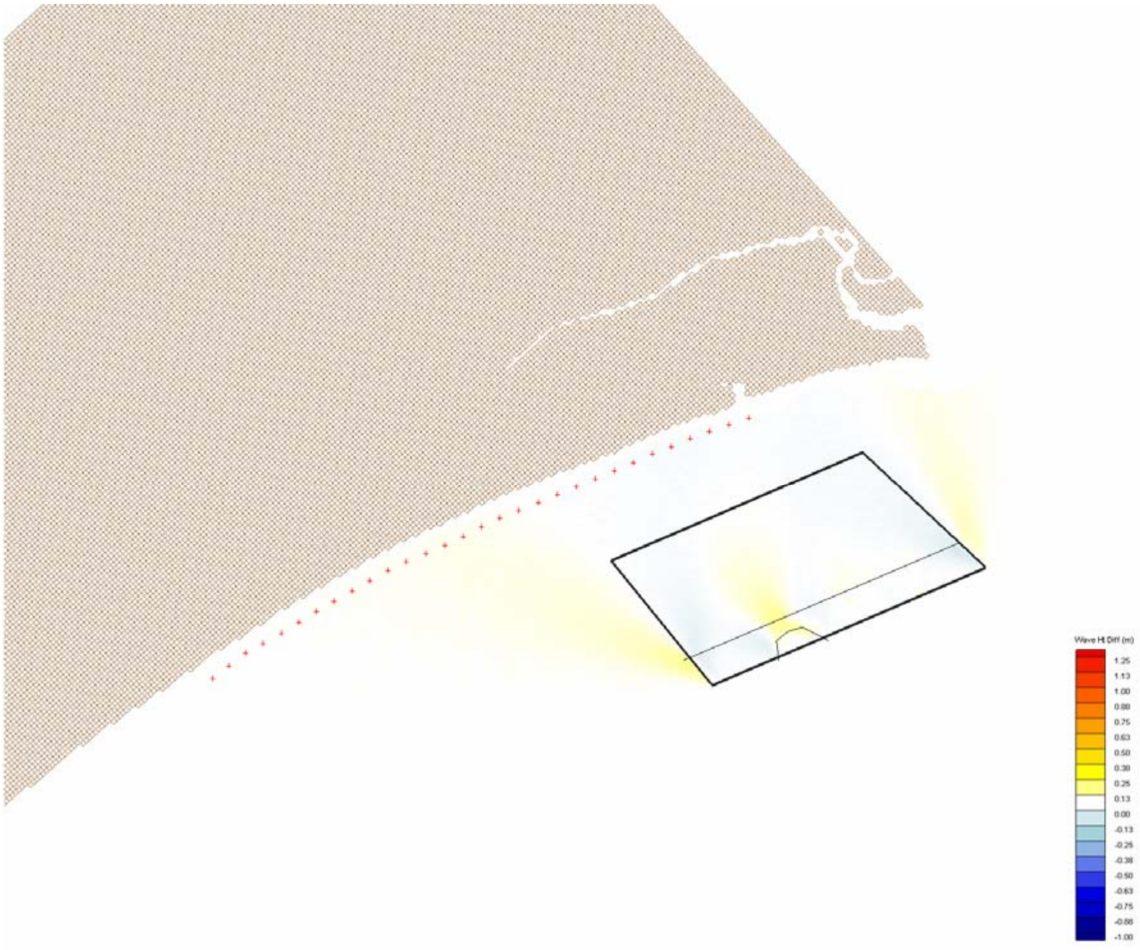

Figure A11: Wave height difference contour plot for the Little River Borrow Area (Dir = 135.0-142.5 degrees, T = 10.0-12.0 sec, H = 3.00-4.00 meters).

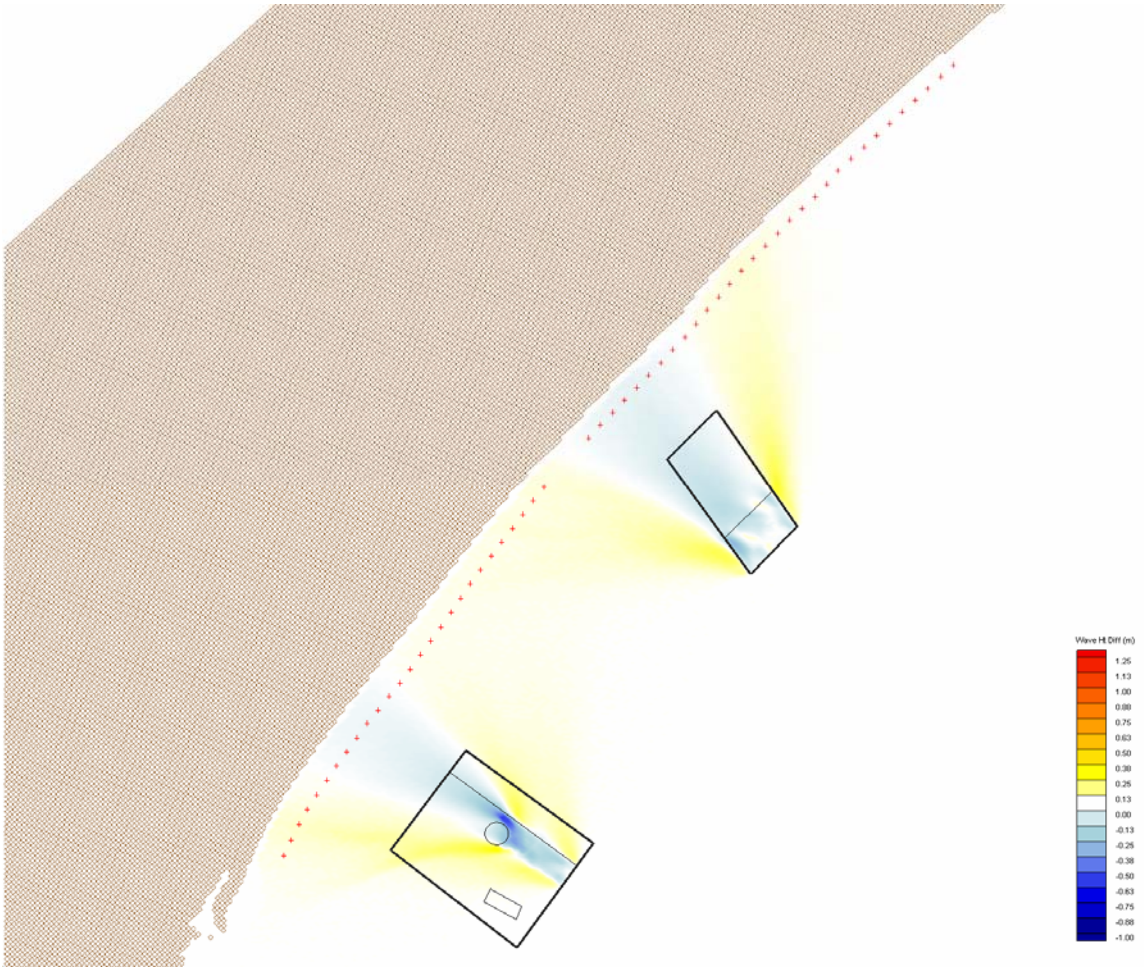

Figure A12: Wave height difference contour plot for the Surfside and Cane South Borrow Areas (Dir = 135.0-142.5 degrees, T = 12.0-14.0 sec, H = 3.00-4.00 meters).

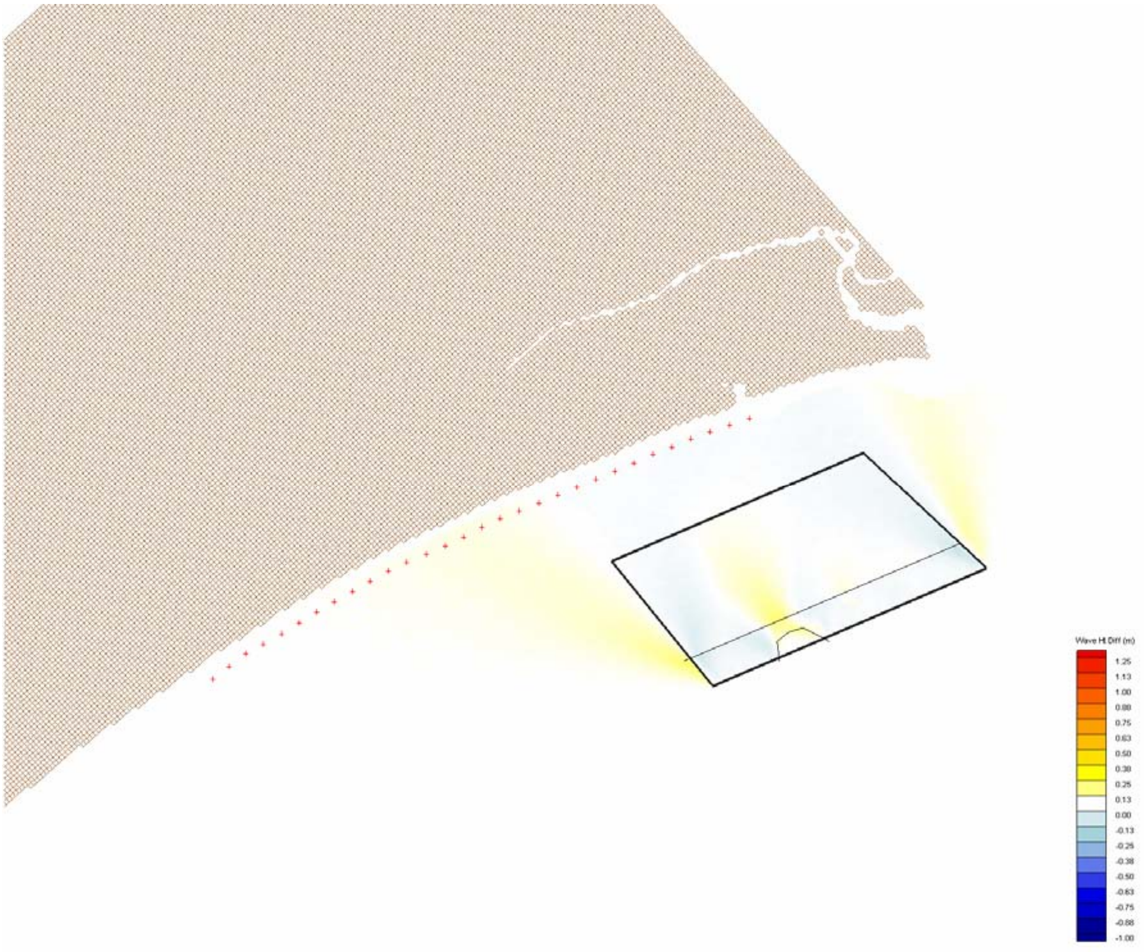

Figure A13: Wave height difference contour plot for the Little River Borrow Area (Dir = 135.0-142.5 degrees, T = 12.0-14.0 sec, H = 3.00-4.00 meters).

Appendix 9

Environmental Monitoring Plan

MRRI CONTROL NO. ____________

MARINE RESOURCES RESEARCH INSTITUTE PROPOSAL SUBMITTAL FORM

TO: R. Boyles

CFDA# (if required): ____________

DATE: 3/22/2007 REQUIRED SUBMITTAL DATE: None

PROJECT TITLE: 2007 Myrtle Beach Renourishment Project: Beach, Nearshore Reef and Borrow Site Monitoring

PRINCIPAL INVESTIGATOR(s): Derk Bergquist, Robert Van Dolah

OTHER PERSONNEL: George Reikerk, Stacie Crowe or TBH, Steve Burns

PROJECT DURATION: 2 years

FUNDING SOURCE: US Army Corps of Engineers

GRANTOR COSTS: $148,981

MATCH COSTS: none

COMMENTS: If Crowe is unable to spearhead project, a new Bio II will be hired

CHECK IF APPROPRIATE:

- ☒ **New Personnel to be Hired**
- ☒ SCUBA diving required
- ☒ Small boat use
- ☐ **Vessel** time required
- ☐ Computer Services required
- ☐ Special Equip.

SIGNATURE ____________ DATE: 3/22/2007

PRESUBMITTAL APPROVAL (Section Manager): ____________

SUBMITTAL APPROVAL (Section Director): ____________

BUDGET APPROVAL (Grants Administration): ____________ 3-22-07

COMMENTS: ____________

3-23-07

DIVISION DIRECTOR SIGNATURE/ACTION: ______________________________

☐ APPROVED ☐ DISAPPROVED ☐ MODIFICATION REQUIRED

COMMENTS: ______________________________

2007 Myrtle Beach Renourishment Project: Beach, Nearshore Reef and Borrow Site Monitoring Scope of Work

Derk C. Bergquist
Robert Van Dolah
South Carolina Department of Natural Resources
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INTRODUCTION:

The beach nourishment project planned for Myrtle Beach will provide valuable protection for beach properties from storm damage and enhance one of the state's popular tourist destinations. While this project provides many potential benefits, it is essential that the project be completed with minimal environmental damage. As planned, the project will nourish three primary segments of coastline starting at Surfside Beach and moving north to Myrtle Beach and then North Myrtle Beach. Fill for these segments will be dredged from three offshore sand sources: Surfside, Cane North/Cane South, and Cherry Grove. Because of its large scale, this nourishment project has the potential to impact ##km of beach habitat, three offshore sand deposits, and it has the potential to impact a system of nearshore hard-bottom reefs. A series of recent studies, garnering much scientific and mainstream attention, have highlighted the kinds of negative impacts that may occur as a result of beach nourishment activities (Peterson and Bishop 2005). Previous monitoring activities in South Carolina suggest great variability in the response of the environment to beach nourishment and borrow pit dredging, from minimal impact and rapid recovery to severe impacts, much longer-term recovery or recovery to an altered physical and biological condition. Here we propose a series of biological monitoring activities to examine environmental impact and recovery associated with the planned Myrtle Beach renourishment project. Specific objectives of the proposed monitoring efforts will be to:

(1) Document changes in beach profile and determine the ecological impacts on and recovery rates of sediment characteristics and burrowing ghost crabs on nourished beaches.

(2) Determine the impacts on nearshore hard-bottom habitats and biological recruitment to those habitats.

(3) Document the impacts on and recovery of native bathymetry, sediment characteristics, and benthic infaunal communities in sand borrow areas

APPROACH AND RATIONALE:

This scope of work includes several monitoring efforts that have proven very informative in past assessment projects and several components long suspected to respond to nourishment activities but rarely, if ever, explicitly examined. Because of the diverse array of habitats to be found within and adjacent to the planned Grand Strand nourishment activities, this project provides a unique opportunity to perform collaborative and inter-disciplinary monitoring efforts involving ecosystem responses to beach nourishment. This scope of work will include cost estimates to perform Before-After-Control-Impact-Paired-Series (BACIPS) studies of all impact areas. The proposal includes monitoring both pre- and post-nourishment/dredging conditions of 1) the beach profile at all nourished sections, 2) sediment characteristics and ghost crab populations on surfside beach and unnourished control areas to the north and south, 3) changes in the amount and distribution of nearshore hardbottom habitat, 4) recruitment to nearshore hard substrates in the vicinity of the nearshore reefs, 5) finfish populations around the nearshore hard bottom habitat, 6) recovery of natural bathymetry in borrow areas, and 7) sediments and benthic infauna in all three borrow areas and two reference areas (interspersed along the coast). Budget and project timetables assume a pre-nourishment monitoring start date of June-July 2007 for reef and beach and March-April for borrow areas. Post-nourishment sampling schedules tentatively assume 3 mo to complete the Surfside Beach segment, 6 months to complete the Myrtle Beach segment and 3 months to complete the North Myrtle Beach segment.

<u>Objective 1.</u> Document changes in beach profile and determine the ecological impacts on and recovery rates of sediment characteristics and burrowing ghost crabs on nourished beaches.

Beach Profile Monitoring (Gayes)

Monitoring of the physical reworking of the initial beach nourishment was completed by augmenting the statewide BERM Survey program to provide two years of quarterly BERM long beach surveys following construction. At that time, the BERM program was surveying each OCRM benchmark once annually, which reduced the cost of the quarterly surveys. The statewide BERM program has continued to monitor the nourished areas annually subsequent to the completion of the initial Corps funded assessment. BERM now uses an ATV-based RTK-DGPS survey system for areas above water level which is very rapid and cost effective and a more complex RTK-DGPS based single beam fathometer based system for the areas located below the waterline.

The BERM program has evolved since 1997 and is presently supported through a consortium of stakeholders lead by SC OCRM, SC SeaGrant, and The City of North Myrtle Beach and Horry County which are supporting a portion of the statewide program in their jurisdictions, as well as some additional surveys to better serve their specific management needs. Through this cooperative each OCRM benchmark in the Grand Strand is surveyed once annually in support of the State's mandate to monitor coastal erosion and administer the SC Beachfront Management Act. OCRM benchmarks in Surfside/Garden City, North Myrtle Beach and the Arcadian Shores area of Myrtle Beach are surveyed a second time annually following a significant storm event to satisfy the local partner (Horry County and City of North Myrtle Beach) obligation for monitoring the Grand Strand beach nourishment fill over the long term. In addition, the Mean High Water (MHW) contour line is surveyed monthly in Surfside/Garden City and North Myrtle Beach to assist those municipalities identify and better manage local hotspots and high frequency erosional events.

The present proposal seeks to forge a similar partnership with the BERM consortium to assess the physical change and dispersal of the upcoming Grand Strand Renourishment building on the experience and findings of past monitoring efforts as well as results of the much larger SC Coastal Erosion Study. This is expected to provide a much better and user-friendly representation of beach change for engineering, planning and public access to information about the renourishment projects function and behavior. As funding mechanisms become increasingly limited and complex the latter element may be expected to continue to increase in importance as well as aid the Corps engineering-based needs In addition, this system is also structured to make data available to the US Army Corps of Engineers as part of their regional data product managing system developed in concert with another CCU working group.

For the upcoming renourishment project, funds are first requested to cover a second BERM long survey of the Myrtle Beach section not presently funded by the BERM cooperative program. That will result in continuity of historic documentation of long profiles across the project areas and consistent bi-annual data sets for all three phases for very limited new costs. This will provide an assessment of sediment volumes moving across the full active beach system including the shoreface. During the first nourishment project, cross-shore transport and storage of sand on the shoreface was found to be a significant proportion of the total reworking of the beach fill. In addition, the flux of sand through this zone is of concern as the source of potential adverse impacts within the local hardground habitats on the adjacent shelf (focus of associated Index Reef Study).

Very practical interests in the stability and rate of reworking of the upper (subaerial) beach fill would be better served by more frequent sampling. Funding is requested to modify the existing BERM program of bi-monthly survey of the MHW contour along the Surfside/Garden City and North Myrtle Beach areas to include the Myrtle Beach section but to also adjust that effort to be completed every three months (quarterly) at sufficient gridding to generate an accurate 3-D representation of the fill above the MHW contour rather than tracking a single contour on the lower beach. This will would require a very modest amount of funding and would yield a product that would be far more versatile in quantifying volumetric change spatially. Regrettably, the costs and logistical demands of a similar product for the areas below Mean Low Water would be prohibitive using single beam technology. A proposal is presently pending that would establish newer swath bathymetry capabilities within the BERM program which would vastly improve efforts to document beach geometry and volume changes. Should that capability be funded through a different and pending proposal it is intended to be integrated into the effort proposed here.

As a result the proposed physical monitoring of the beach fill would be composed of bi-annual long BERM profiles at the historic series of BERM profiles (OCRM benchmark series) within the areas being nourished as well as for a kilometer on the adjacent unnourished beaches to help quantify cross shore reworking of the fill as has been done in the past. This would be augmented by quarterly surveys of the main body of the fill above Mean Low Water at sufficient resolution to better represent spatial variability in geometry and volume of the upper fill and vastly improve monitoring of the width of the upper permanent beach fill elevation along the coast. The subaerial gridding should begin during July 2007 to ensure two quarters pre-nourishment conditions are documented. The existing BERM program should be able to adequately define the pre-condition for long profiles of the Grand Strand and subaerial beach gridding for the Surfside/Garden City and North Myrtle Beach areas (May/June 2007 time frame). The results and associated data products would allow for valid profiles at any location along the project above MLW and support data transfer, analysis and data products to be GIS based from the resulting DEM's.

It is also recommended that, for at least one key location in each phase of the project, a digital Beachcam system be installed to provided daily snapshot, time averaged and rectified time averaged imagery a 500-1000 meter section of the project. This would build on the system established as part of the Coastal Erosion Study and adopted by Horry County to provide high resolution temporal coverage a specific area of concern (hotspot). It is recommended that these systems be placed in areas of known controversy and conflict associated with the past beach nourishment (at local swash entrances) or where the time averaging technology could aid in identifying bar configurations and prevalence of rip circulation. There is interest from other groups and stakeholders related to issues of rip circulation and use patterns of local beaches that may expand this network. Should any additional camera systems be established for other purposes, the data feed and results would be folded into the nourishment project study products as well.

For a nominal initial cost, such systems can provide a constant (daylight hours) record of conditions and change at critical sites as well as document beach fill endurance at least qualitatively daily over long periods of time for limited costs. To facilitate this function spatially, albeit less frequently, modest funds (cost to lease a small plane for 2 hours ~$200/flight plus a student assistant) are sought to support quarterly collection of oblique digital aerial photographs and oblique digital video as well as immediate before and after any major storm events. This is not envisioned to be expensive orthophotographic imagery but to support web-based dissemination of behavior of the project and at least a qualitative time series across the length of the project. This element should begin during the summer of 2007 so that the system is fully functional and establishes an adequate pre-nourishment baseline.

Impact on Beach Burrowing Macrofauna (Bergquist and Van Dolah)

Several studies assessing the effects of beach nourishment on intertidal communities in South Carolina have found that impacts in the intertidal zone are often short-term with respect to benthic infaunal organisms such as polychaetes and amphipods (Van Dolah *et al.* 1994, Jutte *et al.* 1999b). However, emerging research from along the east coast of the US indicates that nourishment has a significant negative impact on large, burrowing macroinvertebrates. Peterson *et al.* (2000) studied the short-term consequences of nourishment and bulldozing on the dominant large invertebrates of a sandy beach in North Carolina, and documented dramatic declines in the abundance of several species (mole crabs, bean clams, and ghost crabs) following these physical disturbances. The burrowing organisms inhabiting South Carolina beaches represent a major food source for surf fishes, shorebirds, and predatory crabs and form a significant component of the detritivore and scavenger feeding guilds that ensure proper functioning of the beach ecosystem (Brown and McLachlan 1990; Wolcott 1978, DeLancey 1989).

The potential impacts of the physical disturbance caused by beach nourishment activities on the sizes and recovery rates (greater than one year) of burrowing macroinvertebrate populations remain relatively unstudied in South Carolina and will be investigated in the current study.

The proposed assessment will focus on ghost crabs as they are readily and consistently identifiable. Both the overall abundances of ghost crabs and their population size structure have been shown to respond negatively on short time scales to nourishment activities in South Carolina (SCDNR, unpublished data); however, the time required for ghost crab populations to recover is largely unknown. To investigate recovery of ghost crab populations in the Grand Strand, four survey stations will be selected along the Surfside Beach shoreline including two stations within the nourished segment, one station on the un-nourished segment just north of Surfside Beach and one station on the un-nourished segment just south of Surfside Beach. Each station will represent a 100m wide section of beach parallel to the shoreline and extend from the dunes to the upper intertidal zone. Within this 100m-wide section, four 10m-wide transects will be randomly chosen for examining ghost crabs and sediment characteristics in any one sampling period. Counts of active ghost crab burrows (identified by tracks around the opening of the burrow (Wolcott 1978)) will be made along the four replicate 10 m wide transects. Because burrow diameter is directly proportional to the size of the ghost crab inhabiting it, potential population-level impacts on ghost crabs can be investigated by measuring the burrows to the nearest mm. Along each transect, a composite set of five sediment core samples will be collected for analysis of grain size, sediment composition, and total organic matter.

All surveys of ghost crab population sizes will be performed during summer months as ghost crabs close their burrows during the winter, preventing accurate estimates of population sizes during cooler months. Beach stations will be sampled during the late spring/early summer 2007 to establish pre-nourishment status of the ghost crab population in each of the four segments. Additional surveys will be performed and samples will be collected immediately following nourishment and during the summers of 2008 and 2009 to determine the extent of nourishment impact and the amount of recovery of these populations.

<u>Objective 2:</u> Determine the impacts on nearshore hard-bottom habitats and biological recruitment to those habitats.

Marine hard-bottom habitats provide attachment substrate, predator refugia and foraging grounds for a wide range of invertebrates and fish, including many important fishery species (Grimes et al 1982; Wenner et al 1983; Sedberry and Van Dolah 1984). The Grand Strand hosts the only significant aggregation of nearshore (surfzone) hard-bottom habitats in South Carolina, but their associated communities and importance to local fishery resources remain largely unknown. Renourishment of the Grand Strand is practically guaranteed to impact these reefs as sand placed along the beach migrates offshore and alongshore. The purpose of the proposed monitoring activities is to determine the impact of migrating sediments on 1) the rates of change in the amount of hard-bottom habitat at varying distances from the proposed nourishment project, 2) the community structure and recruitment of habitat-structuring invertebrates to these hardbottom habitats, and 3) the composition of benthic finfish utilizing the hard-bottom habitats.

Physical Habitat Characterization and Monitoring (Gayes)

A time series of side scan sonar and bottom video characterizations of 13 known nearshore hardbottom areas was completed in 199# to assess potential change in critical reef habitat associated with any potential influx of sand from the initial Grand Strand Beach Nourishment Project (Figure 1; Ojeda et al. 2001). In that study, sites were partitioned with respect to proximity to location of beach fill emplacement both along the beach and in an on-offshore direction. Most areas exhibited only modest change in habitat and that was largely balanced with amount of characterized habitat loss being roughly equivalent to habitat gain (Table 1-modified from Ojeda, Gayes and Sapp, 2001). Two areas (Sites 3 and 4), both located proximal to the constructed beach nourishment in inshore locations, were interpreted to have exhibited modest change in habitat with a small net loss of hardbottom habitat. These results indicate that there is some potential for adversely impacts to the nearshore reef communities in areas immediately adjacent to the nourishment project in this region.

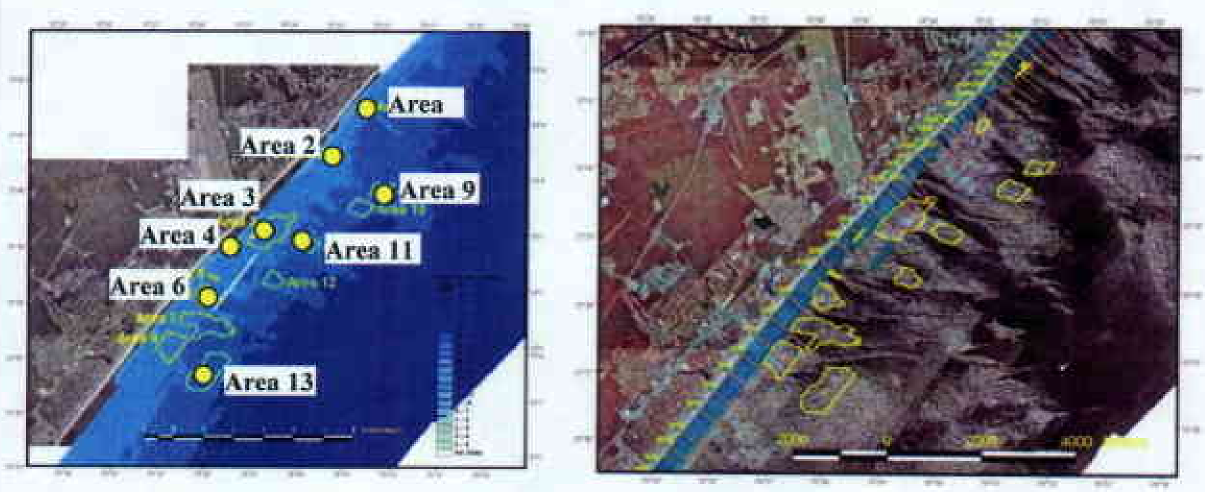

Figure 1. Location of 13 index Reef Sites monitored during the initial Grand Strand Nourishment Project (left). These same locations are shown superimposed on the regional SC Coastal Erosion Study regional side scan sonar mosaic (right).

Table 1 (below) shows the Net Change Analysis for these sites associated with the 1997-2001 study of the initial Grand Strand Nourishment Project (after Ojeda, Gayes and Sapp, 2001). Sites 3 and 4 exhibited modest change with small net habitat loss in the initial study. Sites 1, 2, 11 and 13 exhibited modest change with no net habitat loss in the initial study and site. Sites 5 and 9 exhibited modest change with a small net gain in hardbottom habitat during the initial study.

Table 1. Results of Change Analysis from 1997 to 2001						
Proximity to Phase II	Area	Sand to Sand	Hardbottom to Hardbottom	**Sum of no change**	Hardbottom to Sand	Sand to Hardbottom
Nearshore Proximal	1	32	40	**72**	14	14
	2	0	91	**91**	4	5
	3	5	68	**73**	21	6
	4	5	46	**51**	31	18
Offshore Proximal	9	4	59	**68**	7	25
	10	8	58	**66**	18	16
	11	18	47	**65**	17	18
	12	9	65	**74**	10	16
Nearshore Distal	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	6	1	86	**87**	7	6
	7	7	58	**65**	20	15
	8	2	80	**82**	10	8
Offshore Distal	13	2	74	**76**	16	8

Based on these results, it is recommended that monitoring of the upcoming second phase or "*renourishment*" of the Grand Strand Nourishment Project focus attention on the nearshore locations located proximal to the project particularly off Myrtle Beach where the greatest impact was seen during the first nourishment. This should include Sites 1, 2, 3 and 4 which are located inshore and proximal to the Myrtle Beach section of the project. In addition, two sites (Sites 9 and 11) are proposed offshore of the Myrtle Beach section of the project and two sites (one inshore-Site 6 and one offshore-Site 13) are proposed adjacent to the Surfside-Garden City section of the project. These sites will serve to assist with assessment of natural variability in these critical inner shelf habitats as well as document change in an area of extensive hardbottom exposures off Surfside Beach.

Continued monitoring of beach volumes through the BERM program shows that following an initial period of relatively modest loss of constructed beach during the first two years following nourishment, losses of sediment from the construction template increased over time and may have further modified the nearshore system, particularly over the last three years. As a result a pre-construction characterization of the index reef environments is necessary to both serve as the baseline to assess potential impacts of the upcoming project as well as provide the basis to assess longer term changes associated with the initial beach nourishment.

The methods proposed to accomplish this are similar to those utilized during the initial study (Ojeda, Gayes and Sapp, 2001). Side scan sonar surveys will be completed over each of the eight proposed index reefs and the imagery assembled into rectified mosaic images. The same textural analysis and habitat change analysis routines developed for the initial project will be applied and output used to compare with the finding of the 2001 study. In addition, bottom video lines will also be conducted along lines of survey. If visibility allows, additional lines of video survey will be completed to help assess habitat and change following the upcoming renourishment.

The proposed geophysical analysis of habitat change of the index reefs sites will coincide and integrate with SCDNR efforts focused on biological impacts of the projects (below). In reality, due to the nature of data acquisition and operations, broader areas of the inner shelf will be imaged to generate mosaics for textural analysis and change maps.

These areas will provide a larger spatial context for aiding DNR work assessing potential impact on invertebrate recruitment at specific locations on the inner shelf.

Impact of Sand Migration on Invertebrate Communities and Recruitment (Bergquist and Van Dolah)

As beach fill migrates seaward toward the nearshore hard-bottom habitats, substrate burial and sand scour can negatively impact communities of sessile invertebrates that are key to the proper functioning of these reefs. Sedimentation has been shown to decrease the growth rates, densities and recruitment success of many sessile invertebrates such as corals, sponges and ascidians and in more extreme cases completely smother living reef habitats (Hunt and Wittenberg 1992; Miller et al 2002; Golbuu et al 2003; Fabricius 2005; Dikou and Woesik 2006). To examine the potential impact on invertebrate communities of sediment migration resulting from the nourishment, community structure on and recruitment to nearshore reefs will be monitored pre- and post-nourishment.

The proposed biological monitoring will take place at in each of four areas based on their proximity to the Phase II nourishment (nearshore proximal, nearshore distal, offshore proximal and offshore distal) also being monitored for changes in amount of exposed hard bottom habitat (Gayes). Within each area, five randomly chosen stations will be established at which a monitoring array will be deployed (Fig 2). At each station, the surrounding hardbottom communities will be monitored by photographing four 1.0 m^2 quadrats centered at least 1.5 m from the recruitment array. The quadrats will be established on hardbottoms hosting communities at the time of the initial pre-deployment period. The percent cover of various sessile invertebrate taxa will be determined in each quadrat by overlaying a grid of 100 evenly-spaced points on each photo and counting the number of points that fall on each taxon. To reduce costs, no funds are requested to process photos at this time and so should not be considered as a deliverable in the current proposal.

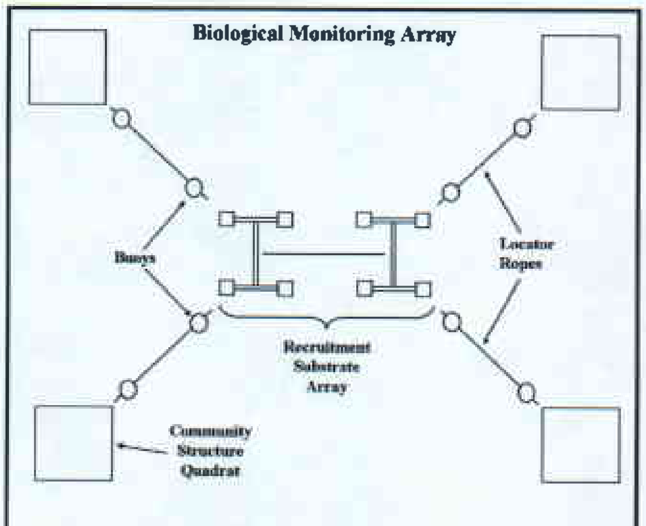

Figure 2. Biological monitoring array to be deployed at each station

Artificial recruitment substrates (12.5cm X 12.5cm unglazed ceramic tiles; as recommended by Harriot and Fisk 1987) will be deployed as part of the biological monitoring array. At each station, a total of eight artificial substrates will be deployed: two replicate tiles for each combination of 2 heights above the bottom (on-bottom and 10cm off-bottom) and two deployment periods (6-month and 12-month). The on-bottom substrates are more likely than off-bottom substrates to be affected by sedimentation at all stations and zones. The off-bottom substrates will allow the detection of spatial and temporal differences in larval supply and other natural factors largely independent of sedimentation, thus allowing a more explicit comparison of the influence of sedimentation on recruitment to the on-bottom substrates. The two deployment periods (6-month and 12-month) will also allow for the assessment of sedimentation impacts on both earlier and later successional benthic species. Work primarily conducted in tropical waters suggests that 5 months is sufficient for accurate measurements of recruitment to artificial substrates (Glassom et al 2006). Six and twelve month deployments will be used here to ensure sufficient recruitment time in the high wave energy and cooler temperate waters of the Grand Strand area. For a period of two years, half of the tiles at each station will be collected and replaced each six months and the other half will be collected and replaced each year (Table 2; based on projected project start date of 7/2007).

All tiles will be photographed prior to collection in order to visually characterize extent of sediment coverage and biotic colonization. All tiles appropriate for a particular deployment will be removed from the bottom, carefully placed in individual containers, and fixed in 10% formalin on the boat. In the lab, the coverage of sessile fauna that recruited to each surface (upper and lower) of each tile will be determined using a point-quadrat technique. A grid with 100 evenly-spaced points will be placed over the central $100cm^2$ portion of each plate. The presence/absence and identity (to the lowest practical taxonomic affinity) of attached organisms will be determined beneath each point, thus providing estimates of percent cover. General linear models will be used to test for differences in recruitment 1) with proximity to the nourishment, 2) between on-bottom and off-bottom substrates, 3) before and after nourishment (6-month periods only) and 4) along gradients of sedimentation as determined by side scan sonar surveys.

Table 2. Timeline for recruitment study. Dep. = deploy substrates; Coll. = collect substrates. The deployment/collection period highlighted in yellow will take place immediately prior to the placement of fill adjacent to the reefs.

Deployment Period	Mar-Apr 2007	Sep-Oct 2007	Mar-Apr 2008	Sep-Oct 2008	Mar-Apr 2009
6-month	Dep.	Coll./Dep.	Coll./Dep.	Coll./Dep.	Coll.
12-month	Dep.	--	Coll./Dep.	--	Coll.

Monitoring reef-associated fish communities (Gayes)

Nearshore areas and hard-bottom reefs provide foraging grounds, prey refugia and nursery habitat for a wide variety of fish species, including many recreationally and commercially important species (Sedberry and Van Dolah 1984; Layman 2000). Very little is known about the fish communities associated with the hard-bottom habitats of the Grand Strand or the impact that modifications to that habitat will have upon local fisheries. In general, as beach fill redistributes, increased suspended sediment loads could physiologically stress resident fishes by reducing the efficiency of visual predation (LaSalle et al 1991), and the burial of hard-bottom as beach fill potentially redistributes could remove habitat structure that is critical to the fish communities in this area. Short-term changes in fish communities and fish diets have been identified in response to turbidity plume associated with beach nourishment activities (Wilber et al 2003). Here we propose to characterize shorter (seasonal) and longer-term (2 years) changes in benthic fish communities associated with nourishment activities adjacent to nearshore hard-bottom areas.

Blackfish traps (Collins 1990) will be deployed at each of the same four reef areas being monitored for changes in overall hard-bottom habitat and benthic invertebrate recruitment (nearshore proximal, nearshore distal, offshore proximal and offshore distal). Cages will be deployed for 2-4 hours during day time. At least 12 traps will be deployed in each area over a period of 2 days during each of March-April, June-July, September-October, and December-January. Prior to deployment, traps will be baited with clupeids. Following retrieval, all fish will be identified to species, enumerated and measured to the nearest mm total length (TL). Otoliths, reproductive tissue, and stomach contents will be removed form 10 fish from each 1 cm size class for each species. Differences in fish abundance, and community structure will be statistically tested 1) with proximity to the nourishment, 2) before and after nourishment (6-month periods only), 3) along gradients of sedimentation as determined by side scan sonar surveys, and 4) among seasons.

Objective 3: Document the impacts on and recovery of native bathymetry, sediment characteristics, and benthic infaunal communities in sand borrow areas.

Bathymetry (Gayes)

Detailed bathymetric surveys of the borrow site areas are proposed to be used to assess the change in seafloor condition associated with dredging at each site. One pre-dredging survey is proposed to establish the condition of the seafloor at the borrow sites planned for use in the upcoming renourishment and also to establish any subsequent infilling of the previously used borrow locations since the last survey of the borrow areas in the late 1990's. This is proposed to be completed in August-September 2007 for the Surfside Garden City area and shortly before initiation of dredging operations in the Myrtle Beach and North Myrtle Beach areas.

Additional surveys are proposed immediately following dredging at each borrow site to document the volumes removed and establish the conditions of the sea floor after dredging. Surveys will also be completed one and two years following dredging to monitor potential infilling and change.

This aspect of the study of the initial nourishment project was hampered by unresolvable problems associated with one pre-dredge survey provided by an outside contractor for the Corps and a relatively coarse survey grid adopted from historical surveys for these purposes. This proposal will modify those methods to better resolve and quantify changes in the dredged areas and utilize one system for pre-post surveys as well as assessing subsequent change.

Bathymetric surveys will be completed using a grid of standard single beam survey grade-fathometer lines (SC BERM program protocols). The BERM system utilizes real-time kinematic DGPS for positioning and establishing vertical control and corrects fathometer output for Heave/Pitch/Roll, sound velocity and water level elevation (tides) during the survey. In addition, a side scan sonar mosaic of the borrow site will be completed during each bathymetric survey to assist efforts to characterize the spatial homogeneity of change in sediment characteristics associated with the dredging and subsequent infilling of the pit.

Survey lines will be completed at 75-meter spacings and extend at least 200 meters beyond the edges of the dredged area to reduce edge effects in the gridding of the

data. In addition, tie lies will be completed on 150 meter spacings and support the side scan sonar surveys to assess the changes in spatial homogeneity of sediment textures infilling the pit over time. These proposed geophysical survey work will coincide and integrate with SC DNR efforts focused on biological impacts of the projects.
The effects of offshore dredging in sand borrow sites is a major environmental concern due to the long-term impacts that have been observed at borrow areas used for previous nourishment projects (Van Dolah *et al*. 1992, Jutte and Van Dolah 1999, 2000), and in several other studies of beach nourishment projects (e.g. Naqvi and Pullen, 1983, Nelson 1985, Jutte *et al.* 2002).

Sediment Characteristics and Infauna (Bergquist and Van Dolah)

Dredging necessarily impacts benthic environments because it removes sediments and their associated communities. As a result, the primary open question associated with beach fill borrow areas is the time required for sediment characteristics and benthic communities to recover from dredging. Monitoring of borrow sites used in previous nourishment projects in South Carolina have suggested that the depth of the dredge pit and the proximity of the borrow area to tidal inlets can have significant consequences for the recovery of benthic ecosystems (Van Dolah et al 1994; Jutte et al 1999; Jutte and Van Dolah. 2000). These same characteristics can also greatly influence the ability of future nourishment projects to re-use a borrow are as deep pits and close proximity to tidal inlets increases the likelihood that dredge pits will re-fill with sediments incompatible with beach sands (Van Dolah et al 1998). SCDNR has been examing benthic recovery in sand borrow areas since the late 80's and has developed one of the strongest databases for this type of disturbance in the southeast US. This database has proven invaluable for improving borrow site selection and management practicies to minimize impact, but the total number of nourishment projects monitored is still too low to allow statistically robust analyses. Here we propose to continue building onto this database by monitoring sediment characteristics and infaunal communities at two of the three borrow sites.

In each of the two borrow areas (Cane North/South and Cherry Grove) and one reference area (located between the borrow areas, ten randomly selected stations will be located using a global positioning system (GPS) and sampled. One benthic grab sample will be collected at each of the ten stations within each borrow area using a 0.04 m^2 Young grab, and each grab sample will be sub-sampled for analysis of sediment characteristics (percent sand, silt, clay, $CaCO_3$, organic matter content, and sand grain size distribution). Benthic organisms will be identified to the lowest possible taxonomic level and enumerated by experienced taxonomists. Previous studies have indicated that ten samples per sampling site and date are sufficient to characterize the dominant benthic taxa (e.g. Van Dolah *et al.* 1994, Jutte *et al.* 1999a).

Samples will be collected at three time points preceeding nourishment (12-month, 6-month and immediately pre-nourishment) to allow the characterization of pre-dredging conditions at the borrow sites relative to the control area. Following the completion of dredging at each borrow site, immediate post-nourishment, and 6-month and 12-month post-dredging samples will also be collected.

Table 3. Timeline for sampling sediment and benthic community monitoring at borrow areas.

Borrow Area	Pre-nourishment			Post Nourishment		
	12-month	6-month	Immediate	Immediate	6-month	12-month
Cane North/South	3-4/2007	8-9/2007	2-3/2008	8-9/2008	3/2009	9/2009
Cherry Grove	8-9/2007	2-3/2008	8-9/2008	12/2008	6/2009	12/2009

Sediment characteristics and infaunal density data at the borrow sites (as a function of those at the control sites) will be analyzed using general linear models. Community-level infauna data will be examined using canonical correspondence analysis (CANOCO software) to test the null hypothesis that borrow and control area communities respond the same over time. By incorporating bathymetric data obtained from the sonar surveys, changes in sediment characteristics and infaunal communities within each borrow area will also be examined as a function of changes in bottom topography.

PROJECT TIMELINE:

TIMELINE

Project Component	Fiscal Year: 2007 to 9/07	2008 10/07-9/08	2009 10/08-9/09	2010 10/09-9/10
Beach				
Beach Profile				
MB swash	--	pre	post + 1 yr post	*
MB BERM	--	pre	post + 1 yr post	*
MB Aerials/Beachcam	pre	pre + post	1 yr post	*
SB/GC Biological survey	pre	post	1 yr post	*
Borrow				
Bathymetry				
SB/GC	pre	post	1 yr post	*
MB	--	pre + post	1 yr post	*
NMB	--	pre	post	1 yr post
Sediment and Infauna				
MB	1yr pre + 6mo pre	pre + post	6 mo post + 1 yr post	*
NMB	1 yr pre	6 mo pre + pre	post + 6 mo post	1 yr post
Reef				
Physical Habitat	--	pre	1 yr post	*
Invertebrate Recruitment	pre	post + 6 mo post	1 yr post + 18 mo post	*
Fish Communities	pre	pre + post	post	*
Report				
CCU	--	pre	post + 1 yr post	
SCDNR	--	--	--	Beach + Reef + Borrow

*--further monitoring may be recommended as part of long-term monitoring plan

SB/GC--Surfside Beach/Garden City; MB--Myrtle Beach or Cane North/South; NMB--North Myrtle Beach or Cherry Grove

STUDY PARTICIPANTS:

The proposed monitoring program will be conducted by scientists from the South Carolina Department of Natural Resources Marine Resources Research Institute (MRRI) and Coastal Carolina University (CCU). MRRI and CCU staff have extensive experience in conducting ecological assessments of beach nourishment projects, including monitoring of the previous nourishment project performed at Myrtle Beach (Jutte *et al.* 1999a, b; Jutte *et al.* 2002; Ojeda *et al* 2001).

STUDY COSTS:

This scope of work represents all pre- and post-nourishment monitoring efforts on the beach, around nearshore reefs and in borrow sites. For brevity, we have combined the Scopes of Work for the MRRI (PI's: Bergquist and Van Dolah) and CCU (PI: Gayes), but separate budgets have been included for each participant. The two institutions, if funded, will bill separately. Estimates include partial support for a graduate student to conduct portions of the research (reef fish surveys). Estimated costs include preparation of a final report summarizing all findings.

At the request of the Corps, the budget has been divided into fiscal years 2007-2008 and fiscal years 2009-2010. Only funds for fiscal years 2007 and 2008 are requested here (Current Budget Requests, below). Funds for activities in fiscal years 2009-2010 are not yet available and will be requested during 2008 (Future Funding Requests, below).

References Cited:

Brown, A.C., and A. McLachlan. 1990. *Ecology of Sandy Shores*. Amsterdam: Elsevier, 328 pp.

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Golbuu, Y., S. Victor, E Wolanski, RH Richmond. 2003. Trapping of fine sediment in a semi-enclosed bay, Palau, Micronesia. **Estuarine, Coastal and Shelf Science** 57:941-949.

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Layman, C.A. 2000. Fish assemblage structure of the shallow ocean surfzone on the eastern shore of Virginia barrier islands. **Estuarine, Coastal and Shelf Science** 51:201-213.

Miller, D.C., C.L. Muir, O.A. Hauser. 2002. Detrimental effects of sedimentation on marine benthos: what can be learned from natural processes and rates? **Ecological Engineering** 19:211-232.

Naqvi, S. and E. Pullen. 1982. Effects of beach nourishment and borrowing on marine organisms. Misc. Rept. No. 82-14. U.S. Army Corps of Engineers Coastal Engineering Research Center, Fort Belvoir, Va.

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Ojeda, GY, PT Gayes, AL Sapp, PC Jutte, and RF Van Dolah. 2001. Habitat mapping and sea bottom change detection on the shoreface and inner shelf adjacent to the Grand Strand beach nourishment project. Final Report prepared for the US Army Corps opf Engineers, Charleston District.

Peterson, C.H., H.M. D.H.M. Hickerson, and G.G. Johnson. 2000. Short-term consequences of nourishment and bulldozing on the dominant large invertebrates of a sandy beach. **Journal of Coastal Research**. 16(2), 368-378.

Sedberry, G.R., R.F. Van Dolah 1984. Demersal fish assemblages associated with hardbottom habitat in the South Atlantic Bight of the USA. **Envir. Biol. Fish.** 4:241-258.

Van Dolah, R.F., R.M. Martore, A.E. Lynch, M.V. Levisen, P.H. Wendt, D.J. Whitaker, and W.D. Anderson. 1994. Environmental Evaluation of the Folly Beach Nourishment Project. Final Report. U.S. Army Corps of Engineers, Charleston District, and the Marine Resources Division, South Carolina Department of Natural Resources. 155 pp.

Van Dolah, R.F., B.J. Digre, P.T. Gayes, P. Donovan-Ealy, M.W. Dowd. 1998. An evaluation of physical recovery rates in sand borrow sites used for beach nourishment projects in South Carolina. Final Report. Submitted to The South Carolina Task Force on Offshore Resources and The Minerals Management Service, Office of International Activities and Marine Minerals. 76 pp.

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Wilber, D.H., D.G. Clark, G.L. Ray, M. Burlas. 2003. Response of surf zone fish to beach nourishment operations on the northern coast of New Jersey, USA. **Marine Ecology Progress Series** 250:231-246.

Wolcott, T.G. 1978. Ecological role of ghost crabs, *Ocypode quadrata*, on an ocean beach: scavengers or predators? **Journal of Experimental Marine Biology and Ecology**. 31, 67-82.

Only funds for activities occurring in fiscal years 2007 and 2008 are being requested at this time. If funded we request that South Carolina Department of Natural Resources and Coastal Carolina University be funded separately as shown below.

SCDNR Current Funding Request

To be funded directly to:
South Carolina Department of Natural Resources

Study Component	FY 2007 *to 9/07*	FY 2008 *10/07-9/08*	TOTALS
Beach	$4,122	$6,143	***$10,265***
Borrow Areas	$32,507	$31,402	***$63,909***
Nearshore Reefs	$26,120	$48,687	***$74,807***
Final Report	$0	$0	***$0***
TOTALS	$62,749	$86,232	***$148,981***

CCU Current Funding Request

To be funded directly to:
Coastal Carolina University

Study Component	FY 2007 *to 9/07*	FY 2008 *10/07-9/08*	TOTALS
Beach	$24,814	$38,303	***$63,117***
Borrow Areas	$10,090	$43,625	***$53,715***
Nearshore Reefs	$0	$40,501	***$40,501***
Final Report	$0	$0	***$0***
TOTALS	***$34,904***	***$122,429***	**$157,333**

Fiscal years 2009 and 2010 funds are not yet available. During 2008, the following expected requests will be made to complete the project described above.

SCDNR Future Funding Request

To be funded directly to:
South Carolina Department of Natural Resources

Study Component	FY 2009 *10/08-9/09*	FY 2010 *10/09-9/10*	TOTALS
Beach	$6,429	$0	***$6,429***
Borrow Areas	$66,654	$13,319	***$79,973***
Nearshore Reefs	$56,308	$0	***$56,308***
Final Report	$0	$34,933	***$34,933***
TOTALS	$129,391	$48,252	***$177,643***

CCU Future Funding Request

To be funded directly to:
Coastal Carolina University

Study Component	FY 2009 *10/08-9/09*	FY 2010 *10/09-9/10*	TOTALS
Beach	$35,000	$0	***$35,000***
Borrow Areas	$30,750	$10,250	***$41,000***
Nearshore Reefs	$40,000	$0	***$40,000***
Final Report	$0	$7,000	***$7,000***
TOTALS	$105,750	$17,250	***$123,000***

State And Local Department/Agency
Indirect Cost Negotiation Agreement

EINs: 57-0882454 (Marine Division)
57-6000286 (Other DNR)

Organization:

State of South Carolina
Department of Natural Resources
c/o State Budget and Control Board
Office of State Budget
1201 Main Street, Suite 870
Columbia, South Carolina 29201

Date: February 5, 2007

Report No(s).: 07-A-254

Filing Ref.:
Last Negotiation Agreement
dated June 20, 2005

The indirect cost rates contained herein are for use on grants, contracts, and other agreements with the Federal Government to which Office of Management and Budget Circular A-87 applies, subject to the limitations in Section II.A. of this agreement. The rates were negotiated by the U.S. Department of the Interior, National Business Center, and the subject organization in accordance with the authority contained in the Circular.

Section I: Rates

Type	Effective Period From	Effective Period To	Rate*	Locations	Applicable To
Fixed Carryforward	07/01/06	06/30/07	22.68%	All	PR/DJ
Fixed Carryforward	07/01/06	06/30/07	22.60%	All	All Other

*Base: Total direct salaries and wages, excluding fringe benefits.

Treatment of fringe benefits: Fringe benefits applicable to direct salaries and wages are treated as direct costs; fringe benefits applicable to indirect salaries and wages are treated as indirect costs.

Section II: General

A. **Limitations:** Use of the rates contained in this agreement is subject to any applicable statutory limitations. Acceptance of the rates agreed to herein is predicated upon these conditions: (1) no costs other than those incurred by the subject organization were included in its indirect cost rate proposal, (2) all such costs are the legal obligations of the grantee/contractor, (3) similar types of costs have been accorded consistent treatment, and (4) the same costs that have been treated as indirect costs have not been claimed as direct costs (for example, supplies can be charged directly to a program or activity as long as these costs are not part of the supply costs included in the indirect cost pool for central administration).

B. **Audit:** All costs (direct and indirect, federal and non-federal) are subject to audit. Adjustments to amounts resulting from audit of the cost allocation plan or indirect cost rate proposal upon which the negotiation of this agreement was based will be compensated for in a subsequent negotiation.

C. **Changes:** The rates contained in this agreement are based on the organizational structure and the accounting system in effect at the time the proposal was submitted. Changes in organizational structure, or changes in the method of accounting for costs which affect the amount of reimbursement resulting from use of the rates in this agreement, require the prior approval of the responsible negotiation agency. Failure to obtain such approval may result in subsequent audit disallowance.

D. **Fixed Carryforward Rate:** The fixed carryforward rate is based on an estimate of the costs that will be incurred during the period for which the rate applies. When the actual costs for such period have been determined, an adjustment will be made to the rate for a future period, if necessary, to compensate for the difference between the costs used to establish the fixed rate and the actual costs.

E. **Agency Notification:** Copies of this document may be provided to other federal offices as a means of notifying them of the agreement contained herein.

F. **Record Keeping:** Organizations must maintain accounting records that demonstrate that each type of cost has been treated consistently either as a direct cost or an indirect cost. Records pertaining to the costs of program administration, such as salaries, travel, and related costs, should be kept on an annual basis.

G. **Reimbursement Ceilings:** Grantee/contractor program agreements providing for ceilings on indirect cost rates or reimbursement amounts are subject to the ceilings stipulated in the contract or grant agreements. If the ceiling rate is higher than the negotiated rate in Section I of this agreement, the negotiated rate will be used to determine the maximum allowable indirect cost.

H. **Use of Other Rates:** If any federal programs are reimbursing indirect costs to this grantee/contractor by a measure other than the approved rates in this agreement, the grantee/contractor should credit such costs to the affected programs and the approved rates should be used to identify the maximum amount of indirect cost allocable to these programs.

I. **Central Service Costs:** Where central service costs are estimated for the calculation of indirect cost rates, adjustments will be made to reflect the difference between provisional and final amounts.

J. **Other:**

1. The purpose of an indirect cost rate is to facilitate the allocation and billing of indirect costs. Approval of the indirect cost rates does not mean that an organization can recover more than the actual costs of a particular program or activity.

2. Programs received or initiated by the organization subsequent to the negotiation of this agreement are subject to the approved indirect cost rate if the programs receive administrative support from the indirect cost pool. It should be noted that this could result in an adjustment to a future rate.

3. New indirect cost proposals are necessary to obtain approved indirect cost rates for future fiscal or calendar years. The proposals are due in our office 6 months prior to the beginning of the year to which the proposed rates will apply.

Section III: Acceptance

Listed below are the signatures of acceptance for this agreement:

By the State Department/Agency:

Carole Collins /s/

CAROLE COLLINS
Name (Type or Print)

DEPUTY DIRECTOR
Title

29 JAN 07
Date

By the Cognizant Federal Government Agency:

Deborah A. Moberly /s/

Deborah A. Moberly
Name

Indirect Cost Coordinator
Indirect Cost Services
Title

U.S. Department of the Interior
National Business Center
Agency

Date **February 5, 2007**

Negotiated by Steve Dallosta
Telephone (916) 566-7111

FINANCIAL AUDIT INFORMATION

Please complete and return with your application:

Date of your organization's financial audit: March 2006

Period covered by audit: July 2004 – June 2005

Findings

No Material Findings: XX

If there were negative findings, explain how they have been resolved (if additional space is needed, please attach pages):

Next scheduled audit: March 2007

Period to be covered by scheduled audit: July 2005 – June 2006

DO NOT SEND A COPY OF YOUR FINANCIAL STATEMENT!

Charles Myers, Jr., South Carolina Department of Natural Resources
Fiscal Officer's Name and Signature
Charles Myers Jr
Fiscal Officer's Phone Number: (803) 734-6191
Internet Address: myersc@dnr.sc.gov

STUDY COSTS:

This scope of work represents all pre- and post-nourishment monitoring efforts on the beach, around nearshore reefs and in borrow sites. For brevity, we have combined the Scopes of Work for the MRRI (PI's: Bergquist and Van Dolah) and CCU (PI: Gayes), but separate budgets have been included for each participant. The two institutions, if funded, will bill separately. Estimates include partial support for a graduate student to conduct portions of the research (reef fish surveys). Estimated costs include preparation of a final report summarizing all findings.

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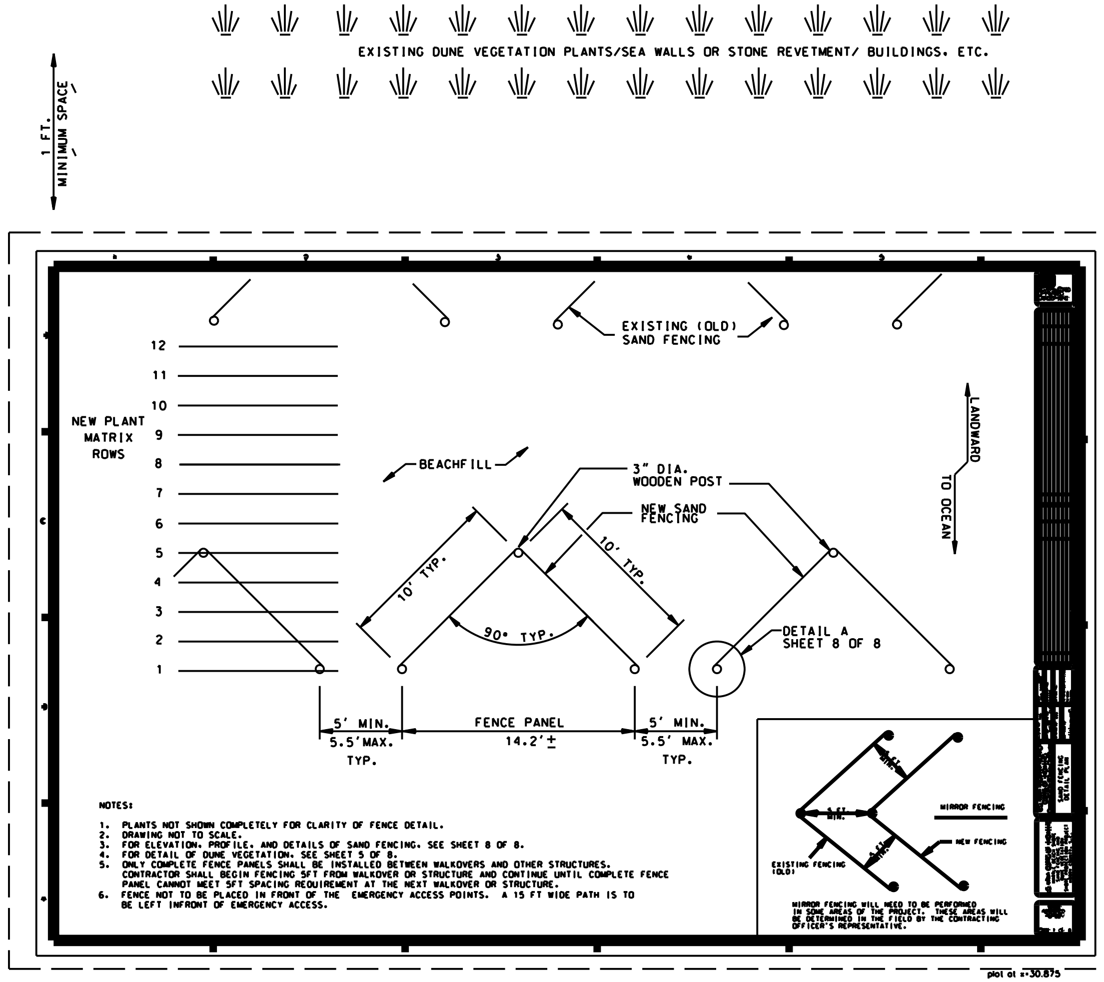
Appendix 10

Sand Fencing Design Drawings

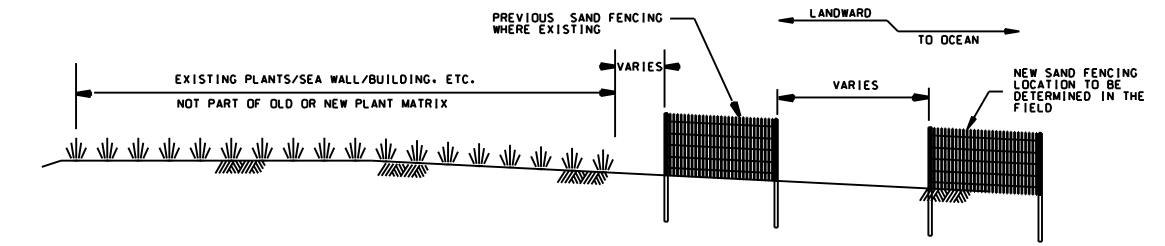
NOTES:
1. DRAWING NOT TO SCALE.
2. FOR ELEVATION, PROFILE, AND DETAILS OF SAND FENCING, SEE SHEET 8.
3. FOR DETAIL OF DUNE VEGETATION, SEE SHEET 5.
4. OCEAN SIDE POST SHALL NOT BE PLACED FENCE WITHIN 5 FT OF PUBLIC OR PRIVATE WALKOVER OR STRUCTURES WHERE TURTLES COULD BE TRAPPED BY FENCING TRYING TO RETURN TO THE OCEAN.
5. ONLY COMPLETE FENCE PANELS ARE TO BE USED. WHERE FENCING IS TO BE PLACED BETWEEN WALKOVERS OR STRUCTURES, CONTRACTOR SHALL START FENCING 5.5 FT FROM WALKOVER OR STRUCTURE AND CONTINUE UNTIL COMPLETE FENCE PANEL CANNOT MEET 5.5' SPACING FROM WALKOVE

3

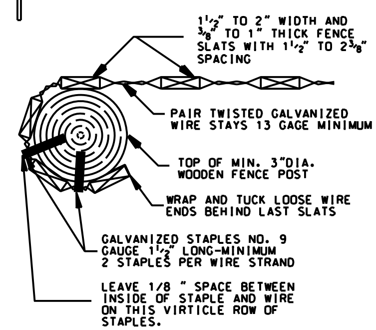


NOTES:
1. PLANTS NOT SHOWN COMPLETELY FOR CLARITY OF FENCE DETAIL.
2. DRAWING NOT TO SCALE.
3. FOR ELEVATION, PROFILE, AND DETAILS OF SAND FENCING, SEE SHEET 4.
4. FOR DETAIL OF DUNE VEGETATION, SEE SHEET 2.
5. ONLY COMPLETE FENCE PANELS SHALL BE INSTALLED BETWEEN WALKOVERS AND OTHER STRUCTURES. CONTRACTOR SHALL BEGIN FENCING 5FT FROM WALKOVER OR STRUCTURE AND CONTINUE UNTIL COMPLETE FENCE PANEL CANNOT MEET 5FT SPACING REQUIREMENT AT THE NEXT WALKOVER OR STRUCTURE.

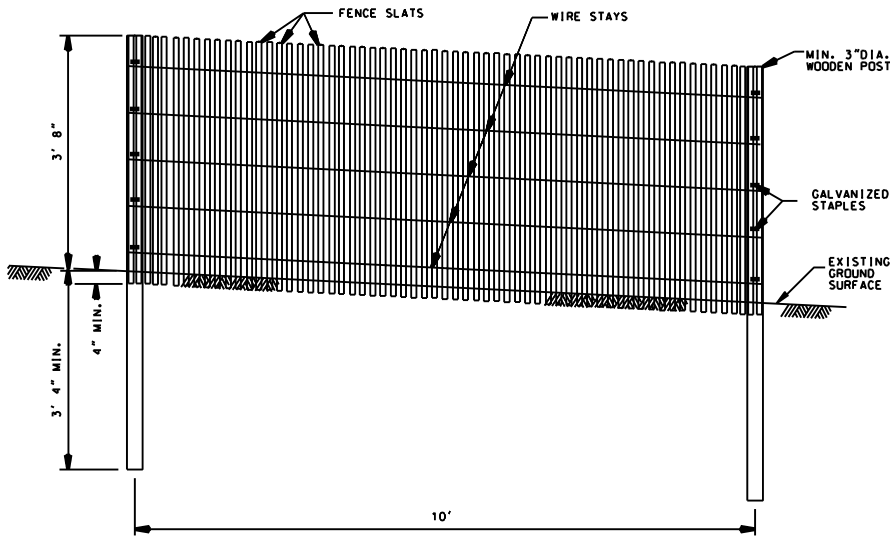
NOTE: SPACING BETWEEN FENCE PANELS CHANGED FROM 5.5FT TO 7.5FT.



FENCING AND BEACH GRASS
NO SCALE



DETAIL A
FENCE POST (TYP.)
NO SCALE



ELEVATION -- FENCE PANEL
NO SCALE

NOTE:

1. NEW PLANT MATRIX NOT SHOWN FOR CLARITY.
2. A MINIMUM OF 5 PAIRS OF GALVANIZED WIRES SHALL BE PROVIDED.
3. SAND FENCE SHALL BE PLACED IN 4" DEEP TRENCH. SAND SHALL BE PLACED BACK IN TRENCH AND COMPACTED TO EXISTING GROUND SURFACE.
4. USE 1 STAPLE PER WIRE STRAND ON MIDDLE POST.
5. ANY FENCE MATERIAL IN THE ESTIMATED QUANITY THAT IS NOT INSTALLED WILL BE TURNED OVER TO THE SPONSOR. FENCE MATERIAL WILL BE DELIVERED TO STORAGE AREA LOCATED BY THE SPONSOR.
6. DO NOT HAMMER STAPLES HARD AGAINST WIRE.
7. PROPERTY EASEMENT, CONSTRUCTION LIMITS, EXISTING FENCE POST, SWASHES, DRAIN PIPES, EMERGENCY LANE IN (REACH 2) OR EXISTING DUNE WILL DETERMINED NEW FENCE LOCATION WHICH WILL BE DETERMINED IN THE FIELD.

SAND FENCING DETAILS

MYRTLE BEACH
SAND FENCING AND
DUNE VEGETATION
SHORE PROTECTION PROJECT
HORRY COUNTY, SC

07 MB fendetail-8.dgn
plot at x=30.875

Appendix 11

Scoping Letters and Other Public Comment

DEPARTMENT OF THE ARMY
CHARLESTON DISTRICT, CORPS OF ENGINEERS
69A HAGOOD AVENUE
CHARLESTON, SOUTH CAROLINA 29403-5107

REPLY TO
ATTENTION OF

April 4, 2006

Planning Branch

Dear Ms.

The purpose of this letter is to inform you that the U.S. Army Corps of Engineers, Charleston District is planning a renourishment of an existing storm protection project along the “Grand Strand” in the vicinity of Myrtle Beach, South Carolina. This planning effort, as well as the potential, subsequent renourishment is being performed under the authority of Public Law 84-99, which allows the Corps of Engineers to perform repairs to Federally-authorized shore protection works that have been damaged by coastal storms. In addition, due to the cycle of nourishment originally calculated during authorization of this project, there is a potential that the volume of sand placed will be greater than what is authorized strictly under P.L. 84-99.

The 2005 hurricane season was unusually intense and destructive. Analysis is currently being conducted to determine whether Hurricane Ophelia caused significant erosion along the length of the federal project. If the analysis finds that significant erosion has occurred and the project meets all of the requirements of P.L. 84-99, the beach profile will be returned to the pre-storm condition. If approved for construction, it is expected that this work will be performed around September 2006.

The Charleston District prepared an Environmental Impact Statement (EIS) which was finalized in January 1993 and issued a Record of Decision in October of 1993. The planned PL 84-99 effort is the same project and should result in the same impacts to human health and the environment. The original EIS can be viewed or obtained by download from the internet at “http://www.sac.usace.army.mil/ea/”, or you can request a copy by contacting Mr. Shawn Boone by phone ((843) 329-8158), or email (shawn.a.boone@usace.army.mil). It is assumed that previous coordination regarding this project is still valid unless otherwise notified.

We want to give you the opportunity to comment on the proposed P.L. 84-99 renourishment and to provide any data that you think should be considered and incorporated. If you have any questions or require additional information, please contact Mr. Shawn Boone, as noted above. Please provide any comments by April 21, 2006.

Respectfully,

Joseph A. Jones
Chief, Planning Branch

Ms. Carolyn Boltin
Office of Ocean and Coastal Resource Management
SC Dept. of Health and Env. Control
1362 McMIllan Avenue Suite 400
Charleston, SC 29405

Dr. Rodger Stroup, Director
SHPO, SC Department of Archives
8301 Parklane Road
Columbia, SC 29223

Mr. Pace Wilber
National Marine Fisheries Services
219 Fort Johnson Road
Charleston, SC 29412-9110

Dr. Gerald Miller
EPA - Region IV
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Atlanta, GA 30303

Mr. Tim Hall-Field Supervisor
US Fish and Wildlife Service
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Charleston, SC 29407

Ms. Sally Murphy
SC Dept. of Natural Resources
PO Box 12559
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Mr. Quinton Epps, Manager
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SC Dept of Health and Env. Control
2600 Bull Street
Columbia, SC 29201

Mr. Ed Duncan
Environmental Programs Director
SC Dept. of Natural Resources
PO Box 12559
Charleston, SC 29422-2559

DEPARTMENT OF THE ARMY
CHARLESTON DISTRICT, CORPS OF ENGINEERS
69A HAGOOD AVENUE
CHARLESTON, SOUTH CAROLINA 29403-5107

REPLY TO
ATTENTION OF

April 5, 2006

Planning Branch

Dear Mr.

The purpose of this letter is to inform you that the U.S. Army Corps of Engineers, Charleston District is planning a renourishment of an existing storm protection project along the “Grand Strand” in the vicinity of Myrtle Beach, South Carolina. This planning effort, as well as the potential, subsequent renourishment is being performed under the authority of Public Law 84-99, which allows the Corps of Engineers to perform repairs to Federally-authorized shore protection works that have been damaged by coastal storms. In addition, due to the cycle of nourishment originally calculated during authorization of this project, there is a potential that the volume of sand placed will be greater than what is authorized strictly under P.L. 84-99.

The 2005 hurricane season was unusually intense and destructive. Analysis is currently being conducted to determine whether Hurricane Ophelia caused significant erosion along the length of the federal project. If the analysis finds that significant erosion has occurred and the project meets all of the requirements of P.L. 84-99, the beach profile will be returned to the pre-storm condition. If approved for construction, it is expected that this work will be performed around September 2006.

The Charleston District prepared an Environmental Impact Statement (EIS) which was finalized in January 1993 and issued a Record of Decision in October of 1993. The planned PL 84-99 effort is the same project and should result in the same impacts to human health and the environment. The original EIS can be viewed or obtained by download from the internet at “http://www.sac.usace.army.mil/ea/”, or you can request a copy by contacting Mr. Shawn Boone by phone ((843) 329-8158), or email (shawn.a.boone@usace.army.mil). It is assumed that previous coordination regarding this project is still valid unless otherwise notified.

We want to give you the opportunity to comment on the proposed PL 84-99 renourishment and to provide any data that you think should be considered and incorporated. If you have any questions or require additional information, please contact Mr. Shawn Boone, as noted above. Please provide any comments by April 21, 2006.

Respectfully,

Joseph A. Jones
Chief, Planning Branch

Mr. Nick Smith
Section 106 Coordinator
Shawnee Tribe
P.O. Box 189
Miami, OK 74355

Ms. Rebecca Hawkins
Section 106 Coordinator
Shawnee Tribe
P.O. Box 189
Miami, OK 74355

Mr. Willard Steele, THPO
Ah-Tah-Thi-Ki Museum
Seminole Tribe of Florida
HC-62, Box 21-A
Clewiston, FL 33440

Mr. Russell Townsend
Tribal Historic Preservation Office
The Eastern Band of the Cherokee Nation
P.O. Box 455
Cherokee, NC 28719

Mr. Tyler Howe
Tribal Historic Preservation Specialist
The Eastern Band of the Cherokee Nation
P.O. Box 455
Cherokee, NC 28719

Mr. Charles Enyart, Chief
Eastern Shawnee Tribe
P.O. Box 350
Seneca, MO 64865

Ms. Delores Herrod
Environmental Director
Kialegee Tribal Town
P.O. Box 332
Wetumka, OK 74883

Mr. Robert Thrower
Tribal Historic Preservation Officer
Poarch Band of Creek Indians
5811 Jack Springs Road
Atmore, AL 36502

Ms. Lisa Stopp
Tribal Historic Preservation Officer
United Keetoowah Band of Cherokee Indians
P.O. Box 746
Tahlequah, OK 74465

Mr. Leo Henry, Chief
Tuscarora Nation
2235 Mount Hope Road
Sanborn, NY 14132

Mr. Richard Hill, Chairperson
Haudenosaunee Standing Committee on Burial Rules and Regulations
Tuscarora Nation
2235 Mt. Hope Road
Sanborn, NY 14132

Mr. Charles Coleman
Tribal Historic Preservation Officer
Thlopthlocco Tribal Town
Rt. 1, Box 190-A
Weleetka, OK 74880

Mr.Louis McGertt, Mekko
Thlopthlocco Tribal Town
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Okemah, OK 74859

Ms. Lillie Strange
Environmental Director
Jena Band of Choctaw Indians
P.O. Box 14
Jena, LA 71342-0014

Ms. Joyce Bear
Tribal Historic Preservation Officer
Muscogee (Creek) Nation
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Okmulgee, OK 74447

Mr. Scott Miller
Section 106 Coordinator
Absentee-Shawnee Tribe of Indians of Oklahoma
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Shawnee, OK 74801-9381

Ms. Josephine Yargee
Section 106 Coordinator
Alabama-Quassarte Tribe
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Wetumka, OK 74883

Dr. Wenonah G. Haire
Tribal Historic Preservation Officer
Catawba Indian Nation
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Rock Hill, SC 29731

Dr. Richard Allen
Section 106 and NAGPRA Consultant
Cherokee Nation
P.O. 948
Tahlequah, OK 74465-0948

Ms. Virginia Nail, Chickasaw Nation Historic Preservation Officer
Chickasaw Nation
Arlington at Mississippi
P.O. Box 1548
Ada, OK 74821

Mr. Terry D. Cole
Tribal Historic Preservation Officer
Choctaw Nation of Oklahoma
P.O. Drawer 1210, 16th & Locust Street
Durant, OK 74702-1201

South Carolina Department of
Natural Resources

John E. Frampton
Director

D. Breck Carmichael, Jr.
Deputy Director for
Wildlife and Freshwater Fisheries

February 7, 2007

Mr. Joseph A. Jones
Planning Branch
U.S. Army Corps of Engineers
69 Hagood Avenue
Charleston, SC 29403-5107

Attn: Shawn Boone

Re: Myrtle Beach Storm Damage Reduction Project
Georgetown and Horry Counties
FWS Log No. 2007-F0041

Dear Mr. Jones,

This letter is to provide recommendations for the scheduled Myrtle Beach Storm Damage Reduction project as it relates to sea turtle mortality in coastal waters off the counties of Horry and Georgetown. This project is proposing the use of a hopper dredge in the three borrow sites for the entire duration of the project (15 months from onset of project). Sea turtles, especially loggerheads (threatened) and leatherbacks (endangered) are abundant in waters off of Horry and Georgetown counties April through November.

While the USFWS Biological Opinion (BO) adequately addresses concerns for sea turtles while they are on the beach, the Biological Assessment (BA) provided by the USACE (2006) and the BO provided by the NMFS (1997) do not adequately address concerns for sea turtles in the water. Also, SCDHEC/OCRM Critical Area Permit regulations state that "dredging in borrow areas shall not be in conflict with spawning seasons or migratory movements of significant estuarine or **marine species** [Section 30-13. N. 2 (c)]. In addition, SCDNR and USACE have a written agreement that hopper dredges will only be used December through March in South Carolina waters (see enclosure).

According to the Endangered Species Act of 1973, Sec. 4.(a), there are five factors (A-E) that are probable cause for a species to become endangered or threatened. They are as follows:

(A) the present or threatened destruction, modification, or curtailment of its habitat or range;
(B) over utilization for commercial, recreational, scientific, or educational purposes;
(C) disease or predation;
(D) the inadequacy of existing regulatory mechanisms;
(E) other natural or manmade factors affecting its continued existence.

By adhering to the seasonal hopper dredge window previously agreed upon between the SCDNR and USACE, three (A, D, E) of these five factors can be avoided.

A hopper dredge should only be used from December 1 – March 31 because:

1. Loggerheads and leatherbacks are abundant in waters off Georgetown and Horry Counties from April through November.
2. The USACE BA and NMFS BO do not contain recent, available data on the spatial/temporal abundance and distribution of loggerheads and leatherbacks in South Carolina offshore waters. These data support the fact that waters in the action area are high-risk areas and dredging should only be scheduled from December through March ("cold water periods") as stated in the NMFS BO (1997).
3. Contrary to the NMFS BO, leatherback sea turtles are likely to be adversely affected by hopper dredge activities.
4. A hopper dredge was used for the initial Myrtle Beach Storm Reduction project and five loggerheads were killed while using deflecting dragheads.
5. Using a hopper dredge is in violation of SCDHEC/OCRM Section 30-13.N.2(c) because it interferes with the reproductive migration of loggerheads and the seasonal migration of leatherbacks.

The SCDNR and USACE spent a considerable amount of time in 1991 to come to an agreement concerning the temporal window within which hopper dredges are allowed in South Carolina waters. It would be in our best interests, and that of sea turtle recovery, if we would continue to abide by this agreement. This should be of interest especially to the USACE since the Hopper Dredge Protocol for the Atlantic Coast states that three "takes" ceases operations and five "takes" terminates the project. Additionally, two "takes" of an endangered species will also suspend the project, resulting in considerable lost time and expense, not to mention the loss of sea turtles to the species.

We thank you for your consideration of our recommendations and look forward to working with you on future projects. Your interest in protecting threatened and endangered species is appreciated.

Sincerely,

DuBose B. Griffin

DuBose B. Griffin, Biologist
SC Sea Turtle Program Coordinator

Cc: Melissa Bimbi
Derrell Shipes
Susan Davis
Ed Duncan
Charlotte Hope
Breck Carmichael
Robert Chappel
Alan Shirey
Robert Boyles
David Whitaker
Robert Van Dolah
Sandy MacPherson
Barbara Schroeder
David Bernhardt
Barbara Neale

Enclosures:

Letter from Lt. Colonel Mark E. Vincent to Dr. James A. Timmerman, Jr. dated September 16, 1991.

Loggerhead aerial observations (n = 286) from 2001 through 2006 during April, May and June in the action area (SCDNR, unpublished data).

Leatherback aerial observations (n = 208) from 1993 through 2006 during April, May and June in the action area (SCDNR, unpublished data).

DEPARTMENT OF THE ARMY
CHARLESTON DISTRICT, CORPS OF ENGINEERS
P.O. BOX 919
CHARLESTON, S.C. 29402-0919

REPLY TO
ATTENTION OF

9/16/91
Copy:
Paul Sandifer
Ed Duncan
Buford Mabry
Jim Quinn
Tom Kohlsaat

September 16, 1991

Programs and Project Management
Division

Dr. James A. Timmerman, Jr.
Executive Director
S.C. Wildlife and Marine Resources
Department
Post Office Box 167
Columbia, South Carolina 29202

Dear Dr. Timmerman:

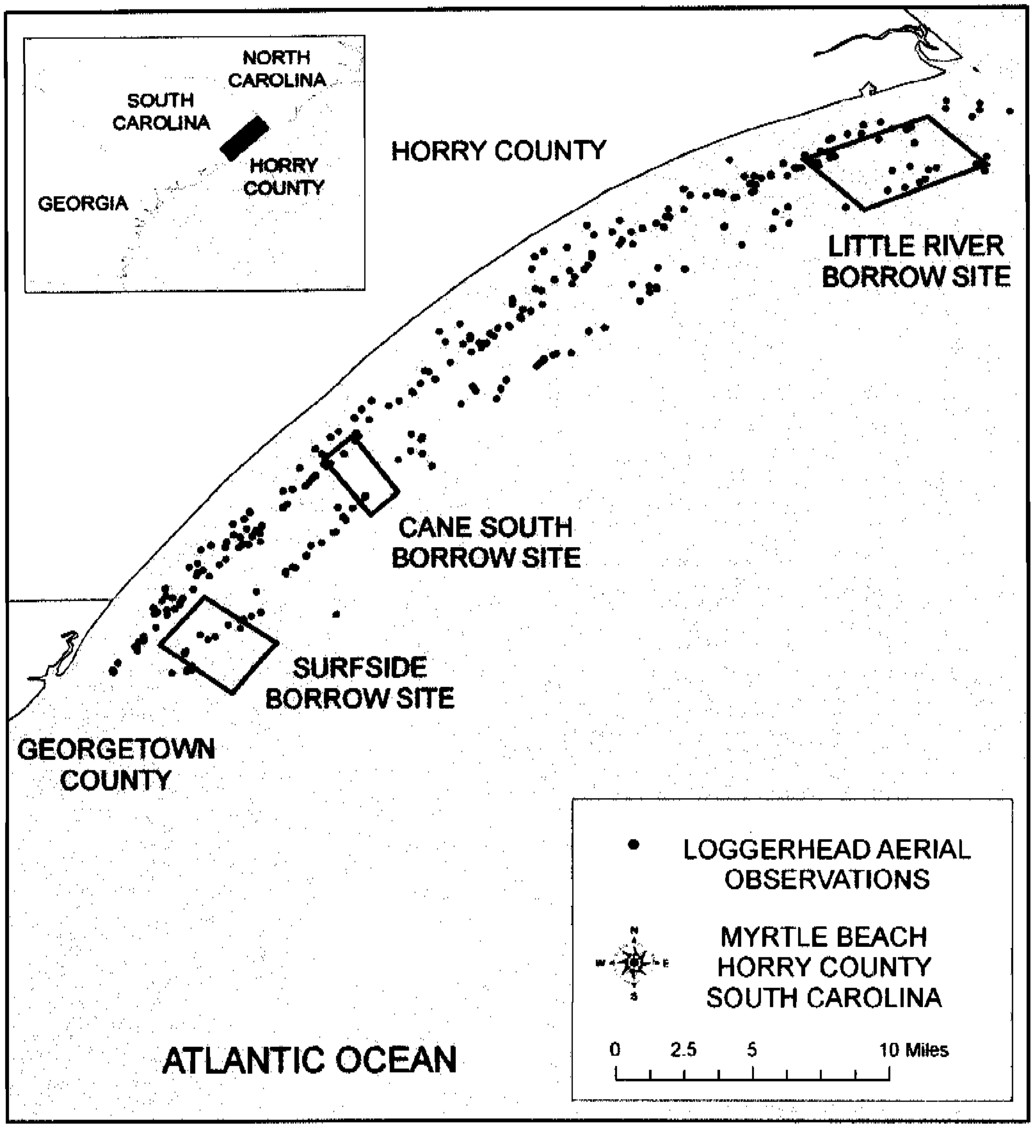
This is to inform you that the Corps of Engineers, in consultation with the South Carolina State Ports Authority, has decided not to proceed with hopper dredging in South Carolina waters until December 1, 1991. This decision should resolve the issues raised in your recent letters regarding the Charleston Harbor project.

We have concluded that the overall public interest is best served by voluntarily restricting the use of hopper dredges in state waters to the 1 December to 31 March time frame as you and your staff have recommended. Unfortunately, this suspension of hopper dredging will add significant cost and time for completing the work. However, our actions afford threatened and endangered sea turtles an added measure of protection that is warranted under the circumstances.

All of us at the Charleston District office appreciate the very professional manner in which you and your staff have dealt with this complex and sensitive matter. We look forward to working closely with you in the future to bring this vital project to a successful conclusion.

Sincerely,

for Donald W. Alexander
MARK E. VINCENT
LTC, Corps of Engineers
District Engineer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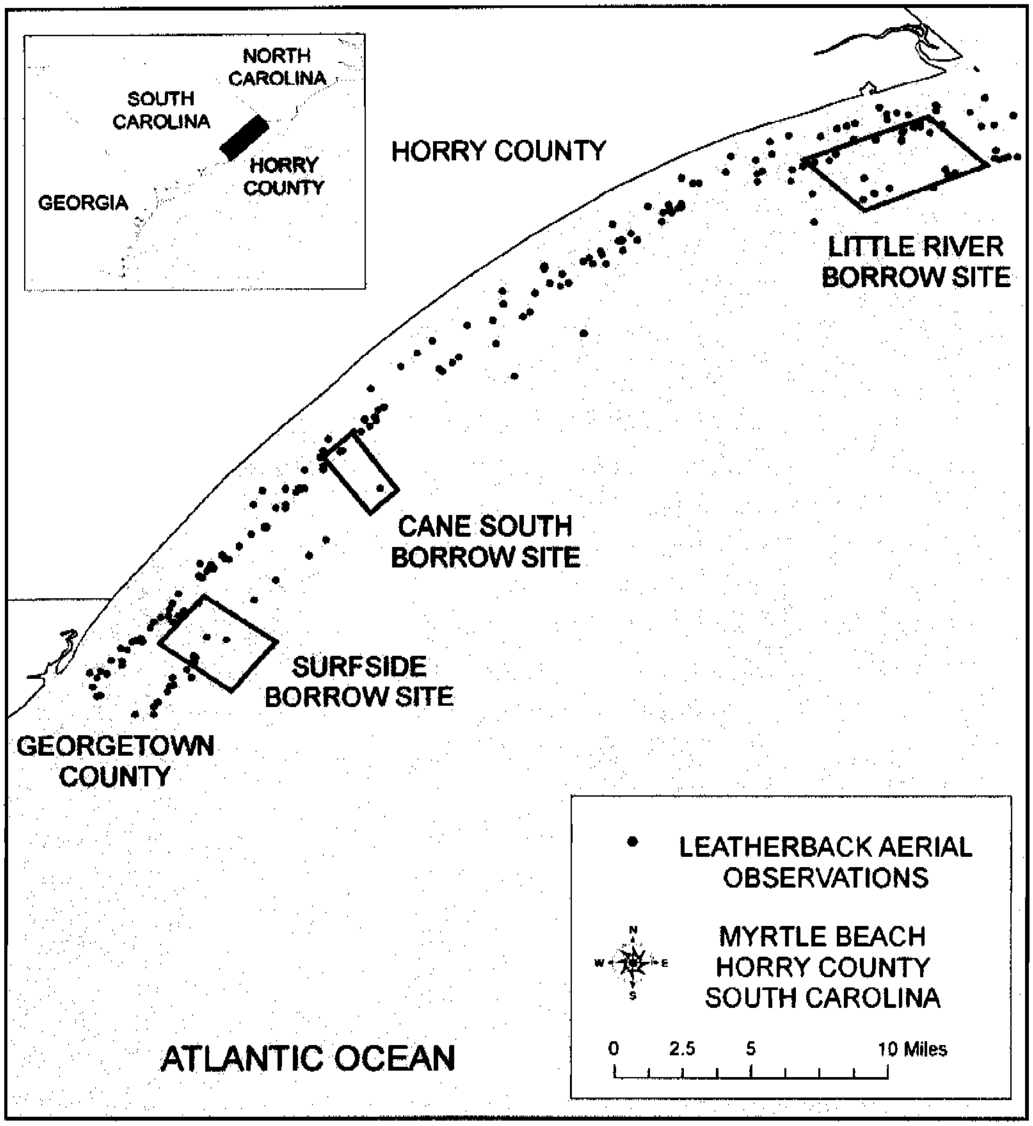
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DEPARTMENT OF THE ARMY
CHARLESTON DISTRICT, CORPS OF ENGINEERS
69A HAGOOD AVENUE
CHARLESTON, SOUTH CAROLINA 29403-5107

REPLY TO
ATTENTION OF

June 14, 2007

Planning Branch

Ms. DuBose B. Griffin
Sea Turtle Program Coordinator
SC Department of Natural Resources
Post Office Box 12559
Charleston, SC 29422

Dear Ms. Griffin:

The purpose of this communication is to respond to your letter dated February 7, 2007 regarding the Myrtle Beach Storm Damage Reduction Project. It is understood that the potential use of a hopper dredge, between and including the months of April and November, to perform the upcoming nourishment of the project is not preferred by the South Carolina Department of Natural Resources (SCDNR). This letter will state the reasons for considering the hopper method of dredging and address other concerns stated in the referenced letter.

The U.S. Army Corps of Engineers (USACE) makes every effort to comply with any and all legal requirements. While some may find existing Biological Opinions unsupported, outdated or otherwise wanting, they are the documents used to guide the use of specific construction devices. This policy is in accordance with the Endangered Species Act. In addition, guidelines for the granting of state permits relevant to erosion control and areas of consideration to be taken into account by the permit grantors are of concern to the Charleston District. However, the final determination in South Carolina is made by the Office of Coastal Resource Management (OCRM). OCRM has granted and reaffirmed for the pending nourishment a statement of coastal consistency.

With regard to the September 1991 letter referenced in your correspondence, there are some critical differences in the situations surrounding the operations taking place fifteen years ago and the current effort. First and foremost, the agreement pertained to dredging operations taking place in the harbor while the Grand Strand project will be nourished using an offshore borrow source. Prohibitions against hopper dredge use in the harbor, outside of the time between December 1 and March 31 continues to be enforced. Secondly, the geologic environment within the harbor is significantly different from the offshore borrow areas. Borrow sites for the Grand Strand's protection are relatively shallow sand lenses and difficult to mine by other means than a hopper dredge.

With regard to hopper dredging, there have been a number of improvements in data collection, equipment configuration and awareness education since the initial construction of the Horry and Georgetown County protective beaches. A few of these improvements are:

- Silent Inspector – allows real time monitoring and storage of drag-head movements resulting in increased accountability.
- Deflector Plate Modification
- Training and Documentation Requirements

USACE, Charleston District is very aware that "takes" of endangered and threatened species result in lost time and consequently money. Viewed in isolation, the potential of a take would be enough to deter a prudent person from pursuing the use of a hopper dredge. However, given the lengthy estimated time of construction for this project (16 months), working only within the specified window of time would result in no fewer than four starts and stops. One of the major cost elements associated with dredging operations is the mobilization and de-mobilization of equipment and crew. For this effort, the estimated costs for this element are $2.5 million. Delaying construction operations also has the effect of complicating the planning of future nourishments and impairing the function of the protective berm which could result in loss of structures.

Preservation of the environment and of endangered species is a serious concern of the Corps of Engineers. It is recognized that endeavors undertaken within the authority of the Corps of Engineers' purview have an effect on natural resources. However, the complexities of the stakeholder's interests in the project area, the State of South Carolina and the United States as they pertain to the Grand Strand Storm Damage Reduction Project are significant. The Corps prides itself on being a learning organization and is willing to listen to arguments, discuss findings and work towards solutions to complex problems.

Respectfully,

Joseph A. Jones
Chief, Planning Branch

Appendix 12

Coordination Between the Minerals Management Service and the Charleston District, Army Corps of Engineers

DEPARTMENT OF THE ARMY
CHARLESTON DISTRICT, CORPS OF ENGINEERS
69A HAGOOD AVENUE
CHARLESTON, SOUTH CAROLINA 29403-5107

REPLY TO
ATTENTION OF

June 29, 2006

Planning Branch

Ms. Renee Orr
Minerals Management Service
381 Elden Street
Mail Stop 4010
Herndon, VA 20170

Dear Ms. Orr:

The U.S. Army Corps of Engineers, Charleston District is currently involved in the planning phase of a beach re-nourishment effort in the Grand Strand (Myrtle Beach) of Horry County, South Carolina. This endeavor is under the auspices of a congressional appropriation for the Emergency Flood Control Funds Act (Public Law 84-99) to repair damage done to Federal projects by Hurricane Ophelia during the 2005 hurricane season.

It is requested that this letter represent a formal request to initiate coordination for the purpose of entering into a Memorandum of Agreement (MOA) for the use of outer continental shelf resources, pursuant to the provisions of Section 8(k)(2)(D) of the Outer Continental Shelf Lands Act (OCSLA) (43 U.S.C. 1337(k)(2)(D), as amended by P.L. 103-4261. The estimated volume of material needed is a total of 1.5 million cubic yards of beach compatible sand.

Enclosed is a copy of the previous MOA entered into for the initial construction of the project and a map indicating the project location as well as the proposed borrow areas.

It is the goal of the Charleston District to start construction as soon as possible and anticipate an October 2006 commencement. However, this timeframe is an estimate and is subject to a number of variables including contractor availability, weather and environmental factors.

For specific information regarding this project, please contact Shawn Boone, of my staff, by phone at (843) 329-8158 or by email at shawn.a.boone@usace.army.mil .

Respectfully,

Lt Col Edward R. Fleming
Commander, Charleston District

Enclosures

United States Department of the Interior

MINERALS MANAGEMENT SERVICE
Washington, DC 20240

Mr. Thomas E. Leath
City Manager
City of Myrtle Beach
P.O. Box 2468
Myrtle Beach, South Carolina 29578

NOV 2 2 2006

Re: Storm Damage Reduction Project, Myrtle Beach, South Carolina

Dear Mr. Leath:

The Minerals Management Service (MMS) received your October 4, 2006, request for a negotiated lease for approximately 1,442,500 cubic yards of beach compatible sand from the Cane South Borrow Area which lies partially in Federal waters. The sand will be used to restore Reach Two of the Myrtle Beach-Horry County Storm Damage Reduction Project scheduled to begin in the spring or summer of 2007.

After review of the information you and the U.S. Army Corps of Engineers provided, we have determined that the City of Myrtle Beach qualifies for a negotiated lease agreement for the identified sand sources for the proposed project. This determination is based on the public accessibility of the project and that it will be funded from local, State, and Federal monies.

There are certain requirements that will need to be completed prior to the issuance of a negotiated lease to fulfill our National Environmental Policy Act (NEPA) responsibilities. We are presently cooperating with the U.S. Army Corps of Engineers (Corps) in the preparation of an Environmental Analysis (EA) for the project which includes use of the sand from the borrow areas under our jurisdiction. As part of the NEPA process the Corps is conducting the required Essential Fish Habitat consultation, with NOAA Fisheries as well as the Section 7 endangered species consultations with the Fish and Wildlife Service and NOAA Fisheries; some of the information from these consultations will likely become terms and conditions attached to the lease document. Once the draft EA is prepared, we will provide you and the Corps with a copy for review. A schedule for review and approval of the requested negotiated agreement is attached.

In addition to the above, we also have to consider seabed hazards and protection of any archaeological resources that might lie within the boundary of the borrow areas. It is our understanding, from talking to the Corps representative, that these surveys are now underway and that a report with the data and findings will be available for review by our staff archaeologist prior to issuance of the lease.

TAKE PRIDE IN AMERICA

RECEIVED
NOV 2 7 2006
CITY MANAGER'S OFFICE

We look forward to working with you on this project. If you have any questions, please do not hesitate to call me at (703) 787-1215, or Roger Amato of my staff at (703) 787-1282.

Sincerely,

L. Renee Orr
Chief, Leasing Division

Attachment

Tentative Schedule for Completion of an MOA and Negotiated Lease Agreement with Horry County and the Cities of Myrtle Beach and North Myrtle Beach, South Carolina

MILESTONE	TARGET DATE
Requests for OCS sand received from Horry County And Cities of Myrtle Beach and North Myrtle Beach	October 9, 2006
Initiate Informal EFH and Section 7 Consultations with NOAA Fisheries and the Fish and Wildlife Service (USACE)	underway
Complete MOA with USACE	December 4, 2006
Conduct Air Quality Conformity Determination	December 29, 2006
Receive Biological Opinions and Conservation Recommendations from NOAA and the F&WS	January 15, 2007
MMS Completes Archaeological Review	January 21, 2007
Complete Draft EA (USACE)	January 30, 2007
MMS completes review of EA	February 15, 2007
MMS Incorporates Opinions and Recommendations As terms and Conditions of the Lease	February 15, 2007
MMS Sends Draft Lease to USACE, Horry County, and Cities of Myrtle Beach and North Myrtle Beach	February 21, 2007
MMS receives Comments on Draft Lease	March 7, 2007
MMS Sends Final Lease Agreements to Horry County and Cities of Myrtle Beach and North Myrtle Beach	March 15, 2007
MMS Sends Letter to Congressional Committees	March 31, 2007
USACE Begins Sand dredging Operations	June 2007
MMS Receives Post-Dredging Surveys from USACE	30 days after completion of project

MEMORANDUM OF AGREEMENT
BETWEEN
THE MINERALS MANAGEMENT SERVICE
OF THE DEPARTMENT OF THE INTERIOR
AND THE CORPS OF ENGINEERS
OF THE DEPARTMENT OF THE ARMY

Title I. Purpose and Authority

A. Under the authority of Section 8(k)(2)(A)(i) of the Outer Continental Shelf Lands Act (OCSLA) (43 U.S.C. §§ 1331–1356a, Pub.L. No. 95-372, as amended by Pub.L. No. 103-426), the Department of the Interior's (DOI) Minerals Management Service (MMS) and the Department of the Army's Corps of Engineers (USACE), enter into this Memorandum of Agreement (MOA) for the use of Federal sand resources on the Outer Continental Shelf (OCS) for the Myrtle Beach Storm Damage Reduction Project, herein referred to as the "Project," for Horry County and the cities of Myrtle Beach and North Myrtle Beach, South Carolina.

B. The purpose of this MOA is to establish procedures to ensure timely coordination and cooperation between MMS and the USACE as each carries out its specific responsibilities related to the use of Federal OCS sand resources for the Project.

C. The MMS, under the authority delegated by the Secretary of the Interior, is authorized, pursuant to Section 8(k)(2)(D) of the OCSLA (43 U.S.C. § 1337 (k) (2)(D)) to enter into an MOA with any Federal agency that proposes to make use of certain specified minerals (including sand), subject to the provisions of the OCSLA.

The MMS has determined that the Project meets the requirements of Section 8(k) (2) (A) (i) of the OCSLA. Therefore, in accordance with Section 8(k)(2)(D), the MMS authorizes the use, and establishes the terms and conditions for any use, of Federal OCS sand resources identified for the construction of the Project.

Nothing in this MOA is intended to abrogate or diminish the Secretary of the Interior's authority under the OCSLA to oversee and regulate the removal of Federal sand resources from the OCS.

Title II. Project Description

A. The USACE is undertaking this project under Section 101 of the Water Resources Development Act of 1990 (Pub. L. No. 101-640) and Emergency Flood Control Funds Act (Pub. L. No. 84-99) appropriations to repair damage done to Federal projects by Hurricane Ophelia during the 2005 hurricane season.

B. The USACE Charleston District anticipates placing approximately 3 million cubic yards of sand along 3 reaches of the beach to restore them to the Project design specifications. The sand for the Project will come from 3 borrow areas that straddle the 3-nautical mile line from the shore. These are the Surfside, Cane South, and Little River borrow areas (see chart below).

Northing	Easting	Lat. (Degrees)	Long. 83 (Degrees)	Lat. (Decimal)	Long. (Decimal)	Borrow Area
639.246	2623.249	33 34 24.0708	78 57 12.0636	33.573353	78.953351	Surfside
630.581	2635.071	33 32 56.0076	78 54 54.5076	33.548891	78.915141	Surfside
620.845	2628.043	33 31 21.0828	78 56 19.7448	33.522523	78.938818	Surfside
629.232	2616.232	33 32 53.3796	78 58 37.1496	33.548161	78.976986	Surfside
670.935	2646.540	33 39 32.9173	78 52 29.0976	33.659144	78.874749	Cane South
660.021	2654.062	33 37 43.0477	78 51 02.7967	33.628624	78.850777	Cane South
655.536	2649.791	33 36 59.9141	78 51 54.4014	33.616643	78.865112	Cane South
666.291	2641.959	33 38 47.9036	78 53 24.4137	33.646640	78.890115	Cane South
734.282	2738.026	33 49 39.6189	78 34 09.2403	33.827672	78.569233	Little River
725.110	2747.711	33 48 06.6224	78 32 17.0394	33.801840	78.538067	Little River
715.809	2726.152	33 46 39.6245	78 36 35.0437	33.777673	78.609734	Little River
725.633	2718.229	33 48 18.6076	78 38 06.2349	33.805169	78.635065	Little River

Title III. Provisions

A. This MOA applies only to the initial construction of the Project described above. It is acknowledged that there is a potential need for future Federal OCS sand for periodic nourishment. It is intended that USACE and the MMS enter into subsequent MOAs, as required in the future, and consistent with the responsibilities of the Secretary of the Interior under the OCSLA and other Federal laws, for the continued use of Federal OCS sand for such periodic nourishment.

B. The MMS and USACE recognize that planning and coordination between the two agencies will ensure that responsibilities under the OCSLA, other Federal laws, and this Congressionally-authorized Project are carried out and accommodated in an efficient and timely manner so that the project schedule will not be unnecessarily delayed or compromised. Both parties also recognize that the MMS, as a bureau in the DOI, has certain stewardship responsibilities for the orderly, timely, and efficient recovery of OCS minerals using the best available technology while ensuring environmental compliance. To that end, with respect to the Project, USACE and the MMS agree to the following:

1. Notification of OCS Activity near the Borrow Areas

The MMS will notify the USACE in a timely manner of any OCS activity within the jurisdiction of the DOI that may adversely affect the USACE's ability to use the Federal OCS sand resources for the Project.

2. Environmental Compliance and Studies

The USACE will provide the MMS with all non-privileged documents which contain environmental information and analyses with respect to the Project.

All the requirements of the National Environmental Policy Act (NEPA) will be met relative to DOI's stewardship responsibilities for mineral resources under its jurisdiction and its specific responsibilities under Section 20 of the OCSLA (43 U.S.C. § 1346). This will include a National Oil and Hazardous Substances Pollution Contingency Plan, completion of an archeological survey and report, and all consultations for endangered and threatened species and essential fish habitat. All environmental studies for the commencement of this Project will have been completed within the required time.

3. Pre- and Post-Bathymetry Surveys

The USACE will provide the MMS with pre- and post-bathymetric surveys of the designated borrow areas. This data will be submitted to the MMS within thirty (30) days after the post-project survey is completed. The recommended delivery format for submission is ArcGIS geodatabase. All geospatial data should be submitted in North American Datum 1983 Geographic and Universal Transverse Mercator grid. The data are to be accompanied by complete metadata documentation in the Federal Geospatial Data Committee Content Standard for Digital Geospatial Metadata format, which can be found on the Internet at http://fgdc.er.usgs.gov/. The data shall be collected in such a manner that the post-dredging bathymetry survey is compatible with the pre-dredging bathymetric survey data to enable the latter to be subtracted from the former to calculate the volume of sand removed and the shape of the excavation.

4. Electronic Positioning System

In order to ensure the accuracy of the dredge relative to the borrow area specified in the lease agreement, the USACE will ensure that the dredge is equipped with an onboard differential global positioning system (DGPS) capable of maintaining and recording the location of the dredge within an accuracy range of no more than plus or minus 3 meters during all phases of the project. The DGPS will be approved by the MMS prior to the conduct of any dredging within the borrow area.

5. Ordinance Reporting Requirement Plan

If any ordinance is encountered while conducting sand dredging activities within the Project area, the USACE will report the discovery in a timely manner to Ms. Renee Orr, Chief, MMS Leasing Division, at (703) 787-1300.

6. Submittal of Production and Volume Information

Following completion of all activities authorized under this MOA, the USACE, in cooperation with the dredge operator, shall submit to MMS a certified copy of the complete operational data set (dredge head tracklines, cut slope angles, cut depth, etc.), outlining any deviations from the original operational design plan. This report should be sent to Ms. Renee Orr, Chief, MMS Leasing Division, 381 Elden Street, MS 4010, Herndon, Virginia 20170. The report shall be submitted within 120 days following completion of the activities authorized under this MOA.

7. Project Completion Report to the MMS

Upon final completion of the activities authorized under this MOA, the USACE will submit to the Minerals Management Service, Chief, Marine Minerals Branch, 381 Elden Street, MS 4010, Herndon, Virginia 20170, 1 paper copy and 1 electronic copy of a project completion report. The report shall contain, at a minimum, the following information:

- the names and titles of the project managers overseeing the effort (both for USACE and the dredging/engineering firm), including contact information (phone numbers, mailing addresses, and email addresses);
- the location and description of the Project, including the final total volume of material extracted from the borrow areas and the volume of material actually placed on the beach or shoreline (including a description of the volume calculation method used to determine these volumes);
- a narrative describing the final, as-built features, boundaries, and acreage, including the restored beach width and length;
- a table, an example of which is illustrated below, showing the various key project cost elements;

	Project Cost Estimate ($)	Cost Incurred as of Construction Completion ($)
Construction		
Engineering and Design		
Inspections/Contract Administration		
Total		

- a table, an example of which is illustrated below, showing the various items of work construction, final quantities, and monetary amounts;

Item No.	Item	Estimated Quantity	Unit	Unit Price	Estimated Amount	Final Quantity	Bid Unit Price	Final Amount	% Over/ Under
1	Mobilization and Demobilization								
2	Beach Fill								
3	Any beach or offshore hard structure placed or removed								

- a listing of construction and construction oversight information, including the prime and subcontractors, contract costs, etc.;
- a list of all major equipment used to construct the Project;
- a narrative discussing the construction sequences and activities, and, if applicable, any problems encountered and solutions;
- a list and description of any construction change orders issued, if applicable;
- a list of any pipelines or other oil/gas-related infrastructure in the Project area, the owners, and any contacts made;
- a list and description of any safety-related issues or accidents reported during the life of the Project;
- a narrative and any appropriate tables describing any environmental surveys or efforts associated with the Project and costs associated with these surveys or efforts;
- a table listing significant construction dates beginning with bid opening and ending with final acceptance of the Project by Horry County and the cities of Myrtle Beach and North Myrtle Beach;
- an appendix containing the as-built drawings, beach-fill cross-sections, and survey data;
- any additional pertinent comments.

The report shall be submitted within 120 days after completion of the activities authorized under this MOA.

8. Sharing of Information

Consistent with the purpose stipulated by both agencies in Title I, Part B., the USACE and the MMS agree to: (1) share all information needed for or generated from the Project, including the sharing of implementation and other applicable schedules; (2) provide such information to the requesting agency as expeditiously as possible; and (3) work collaboratively to ensure that all required completion report information is received.

9. Resolution of Disputes

In the case of a substantial disagreement between USACE and the MMS with respect to any aspect of or decision to implement the Project, the undersigned will designate a senior management official in their respective agencies to determine an appropriate course of action, including a firm and expeditious schedule, to resolve such disagreement.

10. Effective Date

This MOA will become effective when signed by the Chief, Leasing Division of the MMS and the Assistant Secretary of the Army (Civil Works). This MOA my be amended or revoked at any time by mutual agreement between the agencies, and expires upon completion of the project.

L. Renee Orr
Chief, Leasing Division
Minerals Management Service
Department of the Interior

Date: 1/30/07

Edward R. Fleming
Lieutenant Colonel, U.S. Army
District Commander
Corps of Engineers

Date: 19 January 2007