FINAL
Feasibility Report And Environmental Impact Statement On Hurricane Protection And Beach Erosion Control

DARE COUNTY BEACHES
(BODIE ISLAND PORTION)

Dare County, North Carolina

SYLLABUS

The purpose of this study is to investigate shore protection needs for Dare County beaches (Bodie Island Portion) and develop the most suitable plan of protection for this area. Dare County beaches are located on the northeastern North Carolina coast. The primary study area for this report includes the communities of Nags Head, Kill Devil Hills, and Kitty Hawk. The study of Pea Island, Hatteras Island, and Ocracoke Island to investigate shore protection needs for North Carolina Highway 12, will be addressed in a separate interim report as requested by the North Carolina Department of Transportation (NCDOT).

This study discloses that the most practicable plan of protection for the primary study area is a berm and dune project (with terminal transitions) extending along approximately 14.2 miles of the oceanfront at Nags Head, Kill Devil Hills and Kitty Hawk. The south project area includes 10.1 miles along Nags Head. The north project area includes 4.1 miles along Kill Devil Hills and Kitty Hawk. These are the only two project areas within the 20-mile-long primary study area where there is a Federal interest and improvements are economically justified.

The recommended plan of improvement consists of a sand dune constructed to an elevation of 13 feet above the National Geodetic Vertical Datum (NGVD), fronted by a 50-foot wide beach berm constructed to an elevation of 7 feet above NGVD. The south berm and dune project extends along a reach of 53,340 feet. This length includes 47,490 feet for the main fill and 3,000 feet for a transition fill at the north end of the project and 2,850 feet for a transition at the south end of the project. The north berm and dune project extends along a reach of 21,900 feet. This length includes 15,900 feet for the main fill and 3,000 feet for a transition fill at each end of the project.

The principal project purpose is the reduction of damages associated with hurricane and storm events and beach erosion. In addition, the project will enhance the beach strand available for recreation use.

First costs of the south project are currently estimated at $48,961,000. Expected annual costs are estimated at $10,922,000. With expected annual benefits estimated at $26,092,000, the south project benefit-cost ratio is 2.4. First costs of the north project are currently estimated at $22,713,000. Expected annual costs are estimated at $7,313,000. With expected annual benefits estimated at $9,310,000, the north project benefit-cost ratio is 1.3. First costs of the total project are currently estimated at $71,674,000. Expected annual costs are estimated at $18,235,000. With expected annual benefits estimated at 35,402,000, the total project benefit-cost ratio is 1.9.

The recommended plan of improvement is the National Economic Development Plan (NED). Under Federal planning guidelines, the NED Plan is the plan, which, among the available alternatives, produces the maximum net economic

benefits. Unless there are overriding considerations that favor another plan, the NED plan will be the plan recommended for implementation. The local sponsor, Dare County, supports the recommended plan of improvement, but has requested further investigation of the northern 2 miles of Kitty Hawk. This area will be further investigated during the design phase, and if it proves feasible, will be documented in a post authorization change report and supplemental EIS.

The recommended plan of improvement is considered to be environmentally acceptable. However, piping plover were documented to feed along the primary study area. This species is most common as a winter resident of the State and frequently uses the surf zone. The project may affect piping plover foraging distribution on the beach since beach food resources may be affected by beachfill operations. The green sea turtle, loggerhead sea turtle, Kemp's ridley sea turtle, and leatherback sea turtle are known to nest in North Carolina and could nest in the project area. For this reason, they could be affected by initial project construction and periodic nourishment. These sea turtles occur in offshore waters and may also be affected if hopper dredges are used. Initial construction will occur during the sea turtle nesting season. Periodic nourishment activities will be timed, to the extent practicable, to avoid the sea turtle nesting season. When fill placement overlaps the sea turtle nesting season a nest monitoring and relocation program will be implemented. The project Environmental Impact Statement will include a biological assessment of project impacts. The U.S. Fish and Wildlife Service and the National Marine Fisheries will review this biological assessment.

This report was prepared in partial compliance with the congressional resolution that pertains to Dare County beaches. As stated previously, an interim report will be prepared at a later date to address shore protection needs for NC 12 along Pea Island, Hatteras Island and Ocracoke Island.

It should be noted that the Administration's position on funding support for hurricane and storm damage reduction projects is as follows: "The Office of Management and Budget advises that while the Water Resources Development Act of 1999 (WRDA 99) changed the cost-sharing formula for the long-term sand renourishment component of certain future shore protection projects, these changes did not go far enough considering the long-term cost of most of these projects. Further, because WRDA 99 delayed the effect of the change in cost sharing for up to a decade or more, it did not address current constraints on Federal spending. The Administration intends to work with Congress to address these problems. However, until these issues are satisfactorily resolved, the Administration will not support authorization of new shore protection projects that involve significant long-term Federal investments beyond the initial construction of these projects, and will give new shore protection projects that are already authorized low priority for funding."

As stated above, the Administration has expressed concern about significant long-term Federal investments associated with hurricane and storm damage reduction projects. Clearly, substantial long-term Federal investments would be

required to implement the current project proposal. The Administration's projections of future inflation are 3.2 percent annually. Based on these data, the total inflation adjusted (fully funded) project costs are estimated to be $1,662,000,000 over the 50-year period of Federal participation for the recommended plan of improvement. The Federal share of the fully funded project costs is currently estimated at $843,300,000. The non-Federal share of the fully funded costs is currently estimated at $818,700,000. As stated on the first page of this syllabus, the total project benefit-cost ratio is 1.9, which means that for every dollar spent for the project there is one dollar and ninety cents realized in National Economic Development (NED) benefits from the project.

FINAL FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT ON HURRICANE PROTECTION AND BEACH EROSION CONTROL

DARE COUNTY BEACHES, NORTH CAROLINA (BODIE ISLAND PORTION)

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FINAL FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT ON HURRICANE PROTECTION AND BEACH EROSION CONTROL

DARE COUNTY BEACHES, NORTH CAROLINA (BODIE ISLAND PORTION)

SECTION I - INTRODUCTION

The purpose of this study is to investigate hurricane protection and beach erosion control needs along a portion of Dare County beaches and develop the optimum plan of protection for this area. Dare County beaches are located on the northeastern North Carolina Coast. The beachfront in Dare County that the local sponsor requested to be investigated for shore protection needs includes the resort communities of Nags Head, Kill Devil Hills, and Kitty Hawk. A significant portion of this 20-mile-long shoreline reach is rapidly eroding. Numerous structures in this area have been damaged by storm action. Also, with an eroded dune system, this area is highly vulnerable to future storm action. Based on analyses conducted during this study, the most practicable improvement for shore protection is a berm and dune project (with transitions) along the southern 10.1 miles of Nags Head and along 4.1 miles of Kill Devil Hills and Kitty Hawk. These are the only two reaches of the 20-mile-long shoreline of Nags Head, Kill Devil Hills and Kitty Hawk where Federal improvements were determined to be economically justified. In addition the North Carolina Department of Transportation (NCDOT) has requested an interim study of Dare County beaches along Pea Island and Hatteras Island as well as Ocracoke Island in Hyde County, to investigate shore protection needs for North Carolina Highway 12. This study will be completed at a later date.

STUDY AUTHORITY

This study was conducted pursuant to a congressional resolution pertaining to Dare County beaches. The primary study emphasis was directed toward shore protection measures at Nags Head, Kill Devil Hills, and Kitty Hawk. The text of the authorizing resolution is:

RESOLUTION ADOPTED 1 AUGUST 1990 BY THE UNITED STATES HOUSE OF REPRESENTATIVES:

Resolved by the Committee on Public Works and Transportation of the United States House of Representatives, That the Secretary of the Army, in accordance

with section 110 of the River and Harbor Act of 1962, is requested to make, under the direction of the Chief of Engineers, studies of the Dare County beaches, Dare County, North Carolina, in the interest of beach erosion control, hurricane protection, storm damage reduction needs, and related purposes.

Based on the authority contained in the above congressional resolution, the scope of this study is limited to developing solutions to problems associated with ocean shoreline erosion and damage caused by ocean storms and their related impacts. This study does not address problems that may result from storms acting over the sounds west of the barrier island.

SCOPE OF STUDY

This report presents the results of studies conducted to address the needs for shore protection for Dare County beaches. The authorized study area is shown on figure 1. Study emphasis was placed on shore protection measures for the 20-mile-long primary study area as requested by the local sponsor. This area includes the resort communities of Nags Head, Kill Devil Hills, and Kitty Hawk. This report is submitted in partial compliance with the resolution quoted in the "Study Authority" section of this document. The Dare County Beaches (Hatteras and Ocracoke Islands Portion) study will investigate the shore protection needs for NC 12 between Oregon Inlet and Ocracoke Inlet (Pea Island is included). This study will be conducted as a separate study and reported later. NCDOT has indicated a willingness to be the non-Federal sponsor for this study. The project reported herein has independent utility, that is the Federal Government would recommend this project whether or not a Federal project is recommended for the protection of NC 12 between Oregon Inlet and Ocracoke Inlet. Also, the project recommended herein assures adequate opportunity for the consideration of alternatives, both for this project and for the later project.

PRIOR STUDIES

There have been several prior studies in the study area and adjacent waters by the Wilmington District. These studies, listed below, include three shoreline studies, five flood insurance studies, and one navigation study.

House Document No.763, "North Carolina Shoreline, Beach Erosion Study." This report, approved by Congress in 1948, presents the results of an investigation of beach erosion along the North Carolina shoreline conducted as part of a comprehensive study of shore protection needs for the North Carolina shoreline.

House Document No. 476, "Outer Banks Between Virginia State Line and Hatteras Inlet, North, Carolina." This report, approved by Congress in 1966, presents the results of an investigation of beach erosion as part of a comprehensive study of shore protection needs for the North Carolina shoreline between Virginia and Hatteras Inlet.

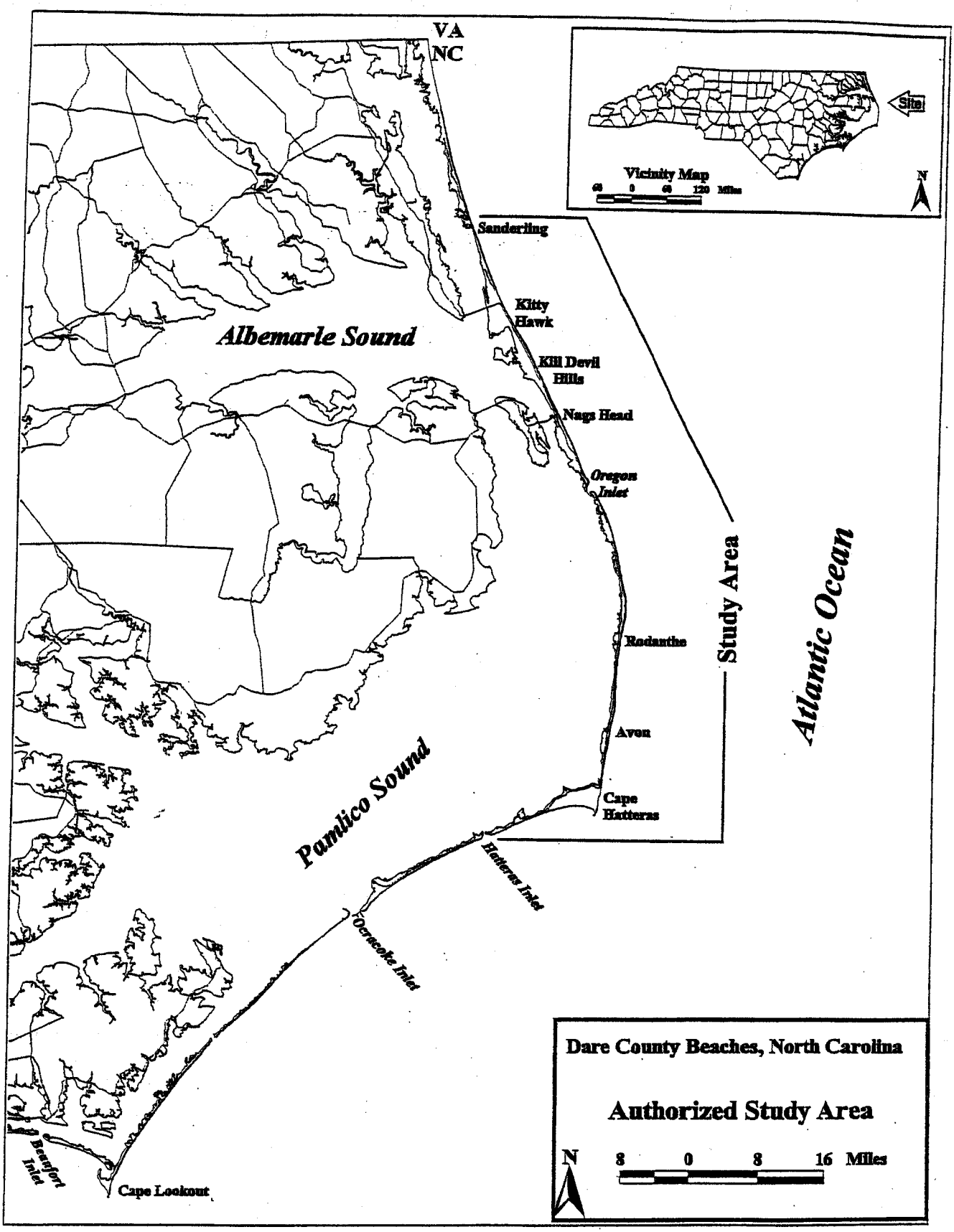

VA
NC
Vicinity Map
Site
N
Sanderling
Kitty Hawk
Albemarle Sound
Kill Devil Hills
Nags Head
Oregon Inlet
Study Area
Atlantic Ocean
Rodanthe
Avon
Pamlico Sound
Cape Hatteras
Hatteras Inlet
Ocracoke Inlet
Beaufort Inlet
Cape Lookout
Dare County Beaches, North Carolina
Authorized Study Area
N
8 0 8 16 Miles

Figure 1

House Document No. 93-121, "National Shoreline Study." This report, approved by Congress in 1970, presents the results of an investigation of the nations' shorelines as part of a comprehensive study to address shoreline conditions including shoreline ownership, property values, and shoreline changes (eroding, stable, or accreting).

Flood Insurance Studies for Nags Head, Kill Devil Hills, Kitty Hawk, Southern Shores, and Unincorporated Areas of Dare County." These reports dated 1986 for Nags Head, 1986 for Kill Devil Hills, 1986 for Kitty Hawk, 1987 for Southern Shores, and 1986 for unincorporated areas of Dare County, were prepared for flood insurance purposes.

Manteo (Shallowbag) Bay, North Carolina, Supplement No. 2, General Design Memorandum - The General Design Memorandum, dated January 1999, has been devoted to navigation improvements (jetties at Oregon Inlet), which is located in Dare County (see figure 2).

EXISTING FEDERAL PROJECTS

There are no active Federal hurricane and storm damage reduction projects in the study area. There is an active navigation project that includes the maintenance of a channel through Oregon Inlet. This project, known as the Manteo (Shallowbag) Bay project, provides for a 400-foot wide channel at 14 feet below mean low water across the ocean bar of Oregon Inlet that connects with a 100-foot wide channel at 12 feet deep from the inlet to the commercial fishing harbor at Wanchese, located on the southern end of Roanoke Island. Previous maintenance operations for the inlet channel has deposited material along the north end of Pea Island either directly on the beach or nearshore in water depths of between 10 and 15 feet. These disposal operations are intended to keep the dredged material in the littoral system and prevent project induced erosion. The amount of material place on the beach or in the nearshore region varies depending on the channel maintenance requirements.

STUDY PARTICIPANTS AND COORDINATION

This study has been coordinated with various Federal, State, and local agencies and the public having concerns about shore protection and the environmental impacts of proposed improvements. A DEIS was circulated for review and comment in June 2000. Comments received on that document are included in the FEIS. Required coordination has been conducted with the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFs). The draft Fish and Wildlife Service's Final Coordination Act Report (CAR) is attached as appendix B.

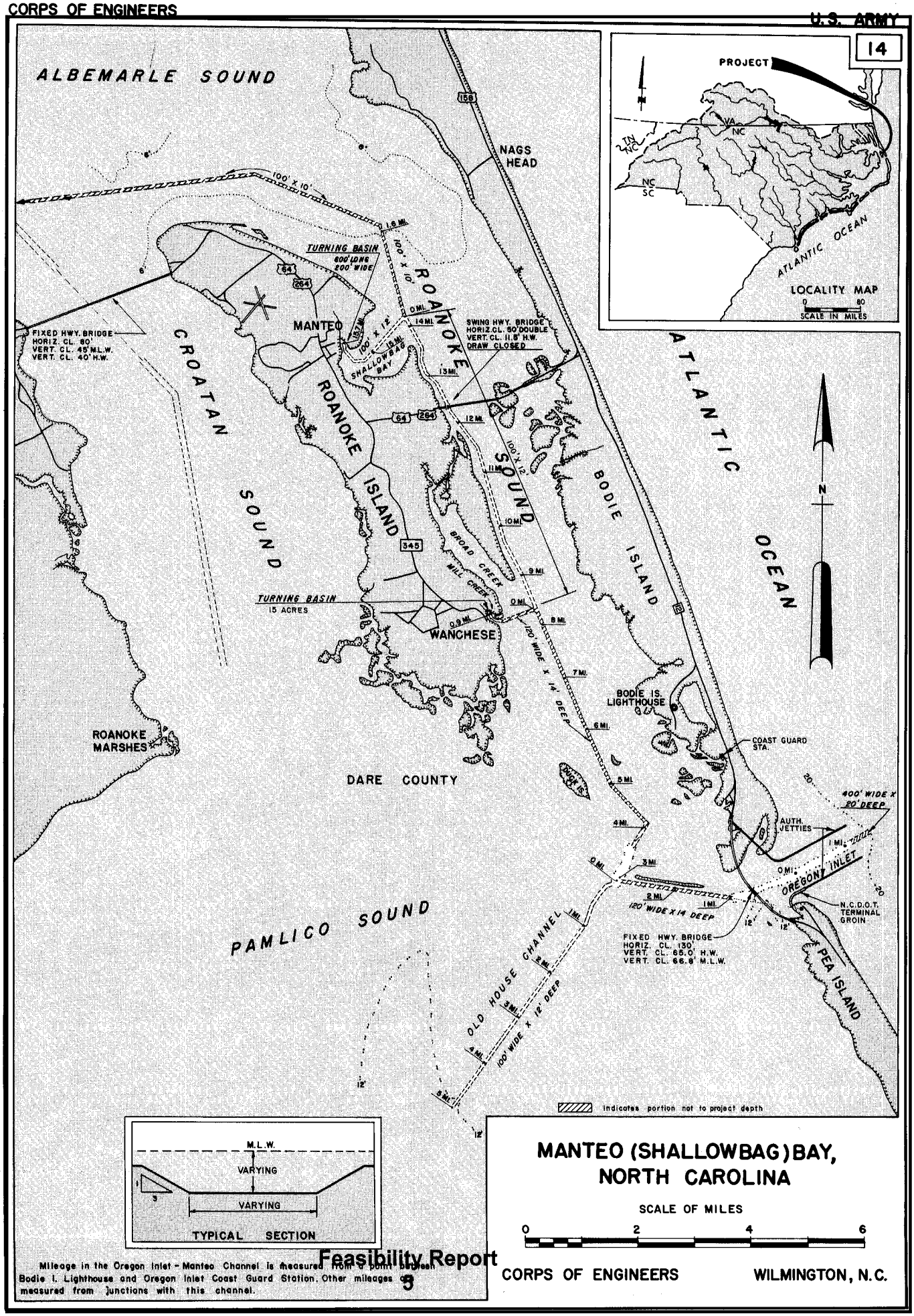

14
PROJECT
LOCALITY MAP
SCALE IN MILES
ALBEMARLE SOUND
NAGS HEAD
ROANOKE SOUND
MANTEO
SHALLOWBAG BAY
CROATAN SOUND
ROANOKE ISLAND
BODIE ISLAND
ATLANTIC OCEAN
BROAD CREEK
MILL CREEK
TURNING BASIN
15 ACRES
WANCHESE
ROANOKE MARSHES
DARE COUNTY
BODIE IS. LIGHTHOUSE
COAST GUARD STA.
AUTH. JETTIES
OREGON INLET
N.C.D.O.T. TERMINAL GROIN
PEA ISLAND
OLD HOUSE CHANNEL
PAMLICO SOUND
FIXED HWY. BRIDGE HORIZ. CL. 80' VERT. CL. 45' M.L.W. VERT. CL. 40' H.W.
SWING HWY. BRIDGE HORIZ. CL. 50' DOUBLE VERT. CL. 11.5' H.W. DRAW CLOSED
FIXED HWY. BRIDGE HORIZ. CL. 130' VERT. CL. 65.0' H.W. VERT. CL. 66.6' M.L.W.
100' X 10'
100' X 12'
120' WIDE X 14' DEEP
400' WIDE X 20' DEEP
100' WIDE X 12' DEEP
TURNING BASIN 600' LONG 200' WIDE
Indicates portion not to project depth
M.L.W.
VARYING
TYPICAL SECTION
MANTEO (SHALLOWBAG) BAY, NORTH CAROLINA
SCALE OF MILES
0 2 4 6
CORPS OF ENGINEERS WILMINGTON, N.C.
Mileage in the Oregon Inlet - Manteo Channel is measured from a point between Bodie I. Lighthouse and Oregon Inlet Coast Guard Station. Other mileages are measured from junctions with this channel.

Figure 2

AREAS OF CONTROVERSY

The following issues are considered areas of particular concern regarding impacts of the proposed project or the adequacy of the DEIS. The FEIS contains additional discussion on each of these topics. A copy of the letters and correspondence received on the DEIS for the Hurricane Protection and Beach Erosion Control, Dare County Beaches are in appendix A – Pertinent Correspondence. And, the Corps' response to each comment is included in Attachment C of the FEIS.

- Public Policy on Federal Involvement in Beach Nourishment.
- Validation of GRANDUC Model
- Evaluation of Nonstructural Alternative
- Cumulative Impacts Analysis
- Monitoring Needs and Timing of Project Initiation
- Sand Compatibility in N1 Borrow Area
- Impacts of Turbidity and Dredging on Important Fisheries
- Consideration of Barrier Island Transmigration and Sea Level Rise
- Impacts of Sediment Transport to Oregon Inlet

The local sponsor, Dare County, supports the recommended plan of improvement. This plan is the National Economic Development (NED) plan that maximizes net average annual benefits for the project.

SECTION II - PROBLEM IDENTIFICATION

The purpose of this report section is to identify problems, needs and opportunities in the study area in accordance with the authorizing resolution. This report section includes the following: (1) description of the study area; (2) an analysis of public concerns, which presents the concerns of local interests, Federal agencies, and others having interests in the study; (3) a statement of the National Objective, which outlines the criteria for Federal participation in water resources developments; (4) an assessment of Federal interest, which identifies concerns in the study area which the Federal government can address under this objective; and (5) specification of Problems, Needs, and Opportunities..

STUDY AREA

The "Authorized Study Area" includes Dare County beaches, which is shown on figure 1. Dare County covers an area of 1,200 square miles, consisting of Bodie Island, Pea Island, Hatteras Island, Roanoke Island, some smaller islands, a mainland portion, and over 800 square miles of water. The Cape Hatteras National Seashore, Pea Island National Wildlife Refuge, and Alligator River National Wildlife Refuge occupy the major portion of the land area in Dare County. Other smaller holdings are in the control of the Federal, State, and local governments. Only about 15 percent of the land area in Dare County is in private ownership and, therefore, part of the tax base. Manteo, located on Roanoke Island, is the county seat. Dare County had a year-round permanent population of 28,140 in 1998. The county's seasonal population is estimated to exceed 250,000 which is approximately 9 times the year-round population. Most of these visitors stay in the first two rows of oceanfront development .

The study area is part of an island complex popularly known as the Outer Banks. The Outer Banks extends from southern Virginia to Beaufort Inlet, North Carolina. The area includes several different shoreline orientations, ranging from northeast facing to south facing. Reports of historic storms often list damages for the Outer Banks or the "banks area"; without specifically identifying the island affected.

Hurricanes, northeasters and progressive erosion have always occurred in the study area. Increasing development in Dare County over the last several years has raised the potential for damages considerably. Development in the study area consists of single family houses, multi-unit apartment and condominium buildings, hotels, motels, cottage courts, and commercial buildings of various sorts, all covering a wide range of values and susceptibility to storm damages. Long-term erosion rates and elevations also vary over the study area. Because of substantial variations in every factor that will affect storm damages, it is impossible to select any small areas or reaches that could be considered representative of the study area as a whole.

In the summer months, a large portion of the homes in Nags Head, Kill Devil Hills and Kitty Hawk are available as summer rentals to vacationers from all over the United States. Almost 2 million people, including those residing in the Tidewater area of Virginia, live within a two-hour drive of these beaches. More than 4 million people live within a three-hour drive radius, which includes Richmond, Virginia and Raleigh, North Carolina. During the summer months, the population of Dare County is estimated to exceed 250,000 people. In the off-season months, it drops to 28,140, which includes about 2,241 permanent residents in Nags Head (1998), 5,429 in Kill Devil Hills, and 2,490 in Kitty Hawk.

North Carolina Highway 12 (NC 12) which is also referred to as the Virginia Dare Trail, is located within the project area just inland from the coast from Whalebone Junction in Nags Head north through Kitty Hawk. U.S. Highway 158 parallels NC 12 along this stretch of coastline and serves as the main route for hurricane evacuation. NC 12 through Kitty Hawk is vulnerable to storm overwash and long term erosion.

NC 12 is the only traffic artery from Whalebone Junction south to Ocracoke Island. Therefore, NC 12 is the land evacuation route for Hatteras Island and Ocracoke Island. NCDOT is concerned about six "hot spots" along NC 12 (two on Pea Island, three on Hatteras Island, and one on Ocracoke Island). These areas are overwashed during storms, leaving the road impassable until it can be cleared by NCDOT crews. NCDOT has used sandbags to protect sections of the highway, but the sandbags can only be used as a temporary measure. On Hatteras Island three sections of NC 12 have been relocated, but will again become vulnerable to overwash and undercutting because of progressive erosion. Therefore, NCDOT has requested an interim study by the Corps, under the Dare County beaches congressional authority, to investigate shore protection needs for NC 12 on Pea Island and Hatteras Island. An additional congressional authority will allow this interim study to also include an investigation of the "hot spot" on Ocracoke Island. This interim study will be completed at a later date. Therefore, this study will not be discussed any further in this report.

PUBLIC CONCERNS

Local interests have expressed a need for beach erosion control and hurricane protection measures for the 20-mile-long reach which includes the resort communities of Nags Head, Kill Devil Hills, and Kitty Hawk. In addition, agencies and individuals with interests related to environmental quality have expressed concerns that any plan of improvement be implemented in a manner which avoids or minimizes environmental impacts. Public concerns are summarized below; detailed discussion of these concerns will be presented in subsequent report sections.

BEACH EROSION CONTROL AND HURRICANE AND STORM DAMAGE REDUCTION

The concerns of local interests, as expressed by their elected representatives, are reflected in the authorizing resolution which is the basis for this study. Beach erosion and hurricane and storm damage have been persistent public concerns in the communities of Nags Head, Kill Devil Hills, and Kitty Hawk. A severe erosion problem exists in much of this area and there is a high potential for hurricane and storm damage to structures in the areas where the protective dune system has been weakened or lost due to erosion.

ENVIRONMENTAL QUALITY CONCERNS

Environmental concerns identified during coordination of the Draft Environmental Impact Statement and Feasibility Report, referred to previously, are discussed in detail in the attached Final Environmental Impact Statement (FEIS). Specific concerns addressed in the FEIS are cumulative impacts of shore protection measures, turbidity impacts, and impacts to near shore and surf zone organisms.

CONSISTENCY WITH STATE COASTAL MANAGEMENT PROGRAM

As will be discussed in subsequent report sections, the plan of improvement recommended is considered to be consistent with the State's Coastal Management Program.

THE FEDERAL OBJECTIVE

The Federal Objective in water resources planning is to contribute to the National Economic Development in a manner consistent with protection of the nation's environment. If shore protection measures at Nags Head, Kill Devil Hills, and Kitty Hawk are economically feasible (benefits exceed costs) and environmentally acceptable, construction of a Federal project for this purpose would contribute to this objective.

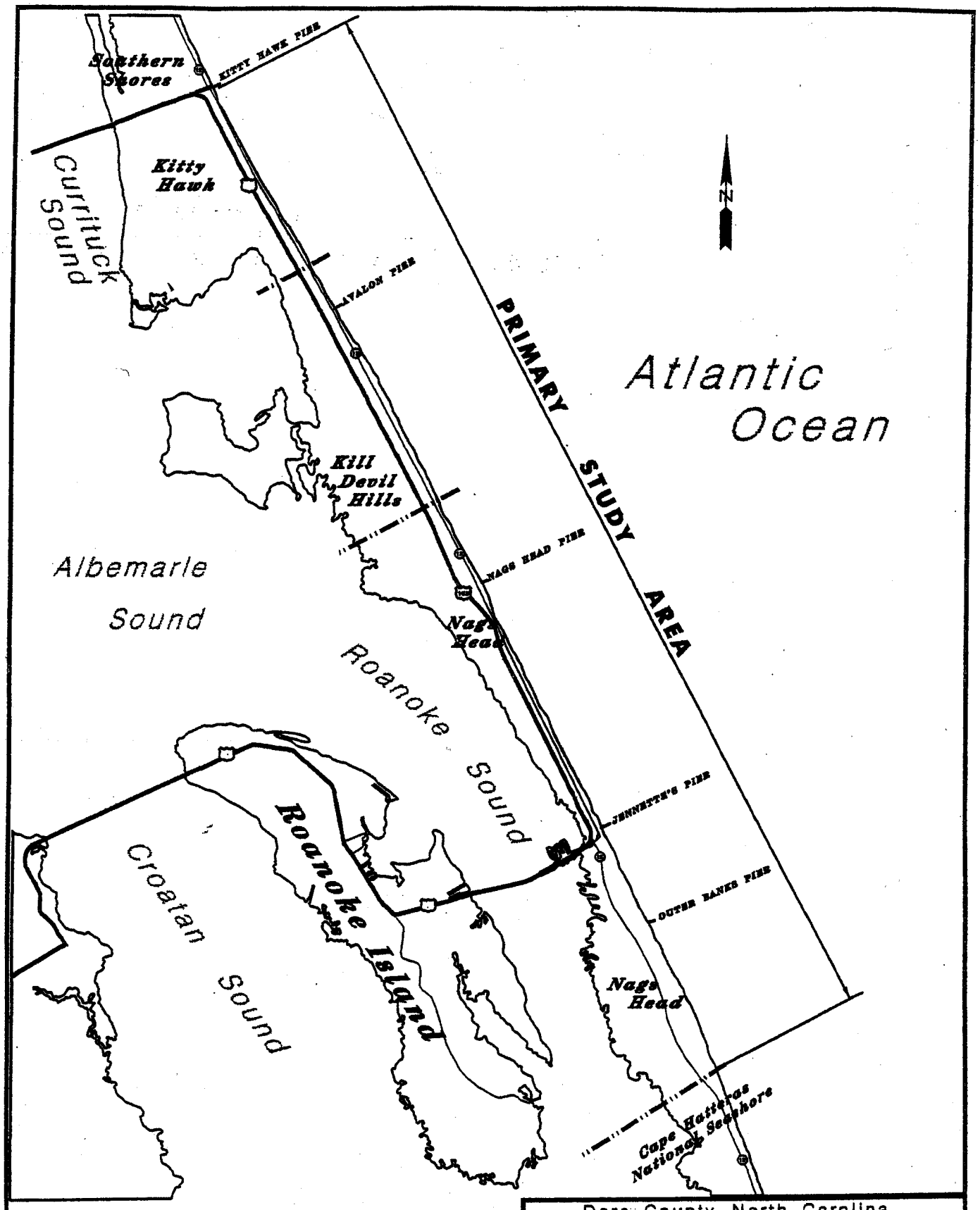
FEDERAL INTEREST

In accord with the Federal Objective any plan of improvement to be recommended for Federal implementation must produce benefits that exceed costs. "Also, the area must be open and accessible to the general public on an equal basis." Therefore, detailed studies were directed toward those areas included in the 20-mile-long reach of shoreline that includes the communities of Nags Head, Kill Devil Hills, and Kitty Hawk and this reach will be referred to as the "Primary Study Area", see figure 3. In these areas, damages due to hurricane-storm action and beach erosion were of a magnitude consistent with the costs of the available engineering solutions. The only technically feasible solutions identified in this study consisted of berm and dune construction to arrest erosion and protect against wave

action. These measures will be discussed in detail in the subsequent report section on "Plan Formulation".

While the potential for hurricane and storm damages and beach erosion exists at other shoreline reaches within the town limits of Kill Devil Hills and Kitty Hawk, Federal improvements at these areas are not practicable, due to accreting shorelines and economic constraints. The shoreline reach at Nags Head from 200-feet north of the Nags Head Pier (Mile Post 11.7) to 500-feet south of First Street (Mile Post 7.3) is considered to be accreting, and potential benefits for hurricane and storm protection were not considered sufficient to merit a Federal project. The shoreline reach at Kitty Hawk from Kitty Hawk Road (Mile Post 4.) to the northern town limit is eroding, however, potential benefits for shore protection were not considered sufficient to merit a Federal project. The Town of Kitty Hawk again expressed interest in including this area within the Federal project during the comment period for the draft report. If this project is authorized the Wilmington District will review this area again during the pre-construction, engineering and design (PED) phase.

The two shoreline reaches within the Primary Study Area where a Federal project was determined to be economically feasible and environmentally acceptable are as follows. The southern shoreline reach extends 47,490 feet from 800 feet south of Altoona Street (MP 20.7) to a point 200 feet north of the Nags Head Pier (MP 11.7) in Nags Head. The northern shoreline reach extends 15,900 feet from a point 500 feet south of First Street (MP 7.3) in Kill Devil Hills to the Kitty Hawk Road (MP 4.3) in Kitty Hawk. The project main fill reaches mentioned above will include an additional 3,000 feet for transitions on each end of the main fill sections except for the south transition of the south project which includes 2,850 feet. These two project areas are shown on plate 1 and will be referred to as the "South Project Area" and the North Project Area" in subsequent report sections.



Dare County, North Carolina
Dare County Beaches

Primary Study Area

Figure 3

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Table 1

Dare County - Project Limits

SOUTH PROJECT AREA

Main Fill (MF), Transition (T)

Township	(MF) Main Fill Begins	(MF) Main Fill Ends	Proj Station	(MF+T) Proj Length (ft)	(MF) Proj Length (mi)	(MF+T) Proj Length (mi)
Nags Head (N)			491+60 T			
				(3,000) T		
Nags Head (N)	200' North of Nags Head Pier (MP 11.7)		521+60 MF			
				25,940	4.9	5.5
Whalebone Junction			781+00 MF			
				21,550	4.1	4.6
Nags Head (S)	800' South of Altoona St. (MP 20.7)		996+50 MF			
				(2,850) T		
Nags Head S. Town Limit			1025+00 T			
South Project Totals (Main Fill)				47,490	9.0	
South Project Totals (Main Fill + Transitions)				53,340		10.1

Table 1 (continued)

Dare County - Project Limits

NORTH PROJECT AREA

Main Fill (MF), Transition (T)

Township	(MF) Main Fill Begins	(MF) Main Fill Ends	Proj Station	(MF+T) Proj Length (ft)	(MF) Proj Length (mi)	(MF+T) Proj Length (mi)
Kitty Hawk			108+30 T			
				(3,000) T		
	Kitty Hawk Rd (MP 4.3)		138+30 MF			
Kitty Hawk				5,070	1.0	1.5
(Town Limits)			189+00 MF			
Kill Devil Hills		500' South of 1st Street (MP 7.3)		10,830	2.0	2.6
			297+30 MF			
				(3,000) T		
Kill Devil Hills			327+30 T			
North Project Totals (Main Fill)				15,900	3.0	
North Project Totals (Main Fill + Transitions)				21,900		4.1
Total Project Area (Main Fill)				63,390	12.0	
Total Project Area (Main Fill + Transitions)				75,240		14.2

PROBLEMS, NEEDS, AND OPPORTUNITIES

The primary public concerns identified in the study area are the loss of land and structures due to progressive beach erosion and damages to structures due to hurricane and storm action. These concerns are discussed below, and protective solutions are identified. These solutions will be discussed in detail in subsequent report sections.

BEACH EROSION CONTROL NEEDS

"Beach erosion" as used in this report section refers to long-term shore processes. These processes can be documented based on shoreline history, and projected to estimate future conditions. Erosion in this sense differs from erosion during storms, which, although devastating to development, is generally of a temporary nature. Following storms, the coastline tends to reshape itself into its former configuration, as sand displaced from the beach is returned by wave action. The beach shape then conforms to the prevailing wave climate and littoral processes. However, land losses due to progressive erosion are essentially permanent, as documented by the shoreline history along the Primary Study Area. Analyses of coastal processes conducted during this study indicate that historical erosion trends along the Primary Study Area can be expected to continue if no action is taken to stabilize erosion-prone areas. Past and projected future shoreline positions for the Primary Study Area are discussed below.

Past Shoreline Positions, Primary Study Area. Shoreline changes for beach segments along the 20-mile-long Primary Study Area are shown on figure 4 and table 2. As shown, the peak erosion has occurred along the South Project Area and the North Project Area. Erosion has resulted in the loss of much of the protective dune system and threatens structures located just upland of the shoreline. Many of the seaward most buildings have been damaged by storm wave action due to the loss of the dune system. Also, the width and quality of the beach available for recreation have diminished.

Dare County Beaches - Primary Study Area
North Carolina Division of Coastal Management
Long Term Erosion Rates (Time Period 1945 - 1995)

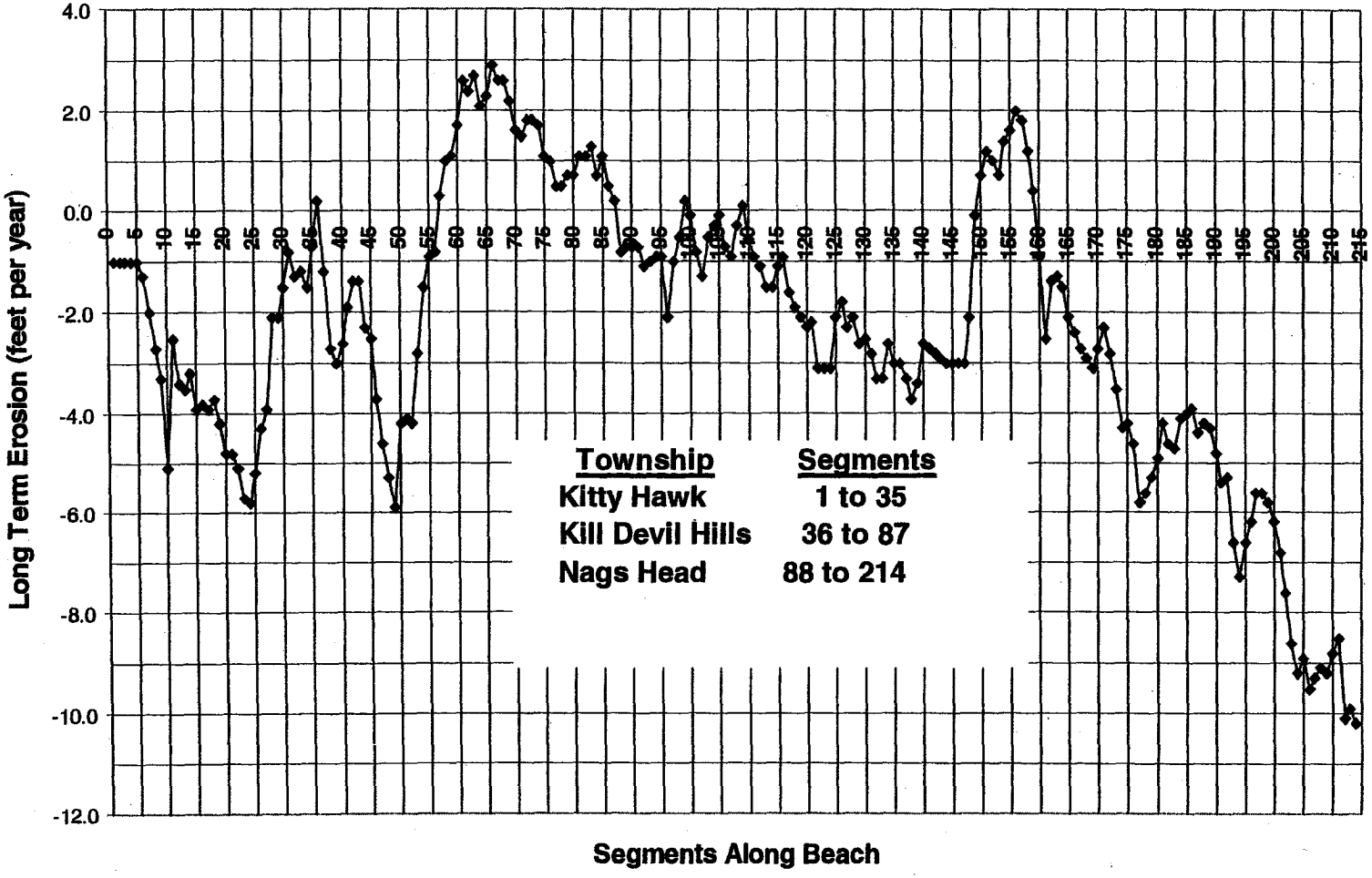


Figure 4

Table 2

Shoreline Changes - 20-mile-long Primary Study Area

N.C. Erosion Rates Change (+ Accretion - Erosion)			Future Shoreline Positions Linear Distance (+ Accretion - Erosion)				
Seg	Seg L (ft)	Rate (ft/yr)	10-Yrs 2014 (ft)	20-Yrs 2024 (ft)	30-Yrs 2034 (ft)	40-Yrs 2044 (ft)	50-Yrs 2054 (ft)
KH							
01	664	-1.0	-10	-20	-30	-40	-50
02	632	-1.0	-10	-20	-30	-40	-50
03	414	-1.0	-10	-20	-30	-40	-50
04	307	-1.0	-10	-20	-30	-40	-50
05	310	-1.0	-10	-20	-30	-40	-50
06	415	-1.3	-13	-26	-39	-52	-65
07	652	-2.0	-20	-40	-60	-80	-100
08	429	-2.7	-27	-54	-81	-108	-135
09	700	-3.3	-33	-66	-99	-132	-165
10	829	-5.1	-51	-102	-153	-204	-255
11	405	-2.5	-25	-50	-75	-100	-125
12	345	-3.4	-34	-68	-102	-136	-170
13	468	-3.5	-35	-70	-105	-140	-175
14	410	-3.2	-32	-64	-96	-128	-160
15	510	-3.9	-39	-78	-117	-156	- 195
16	760	-3.8	-38	-76	-114	-152	-190
17	729	-3.9	-39	-78	-117	-156	-195
18	640	-3.7	-37	-74	-111	-148	-185
19	413	-4.2	-42	-84	-126	-168	-210
20	459	-4.8	-48	-96	-144	-192	-240
21	278	-4.8	-48	-96	-144	-192	-240
22	614	-5.1	-51	-102	-153	-204	-255
23	1021	-5.7	-57	-114	-171	-228	-285
24	295	-5.8	-58	-116	-174	-232	-290
25	533	-5.2	-52	-104	-156	-208	-260
26	310	-4.3	-43	-86	-129	-172	-215
27	695	-3.9	-39	-78	-117	-156	-195
28	1177	-2.1	-21	-42	-63	-84	-105
29	574	-2.1	-21	-42	-63	-84	-105
30	184	-1.5	-15	-30	-45	-60	-75
31	976	-0.8	- 8	-16	-24	-32	-40
32	181	-1.3	-13	-26	-39	-52	-65
33	479	-1.2	-12	-24	-36	-48	-60
34	390	-1.5	-15	-30	-45	-60	-75

Table 2 (continued)

Shoreline Changes - 20-mile-long Primary Study Area

Seg	Seg L (ft)	N.C. Erosion Rates Change (+ Accretion - Erosion) Rate (ft/yr)	Future Shoreline Positions Linear Distance (+ Accretion - Erosion) 10-Yrs 2014 (ft)	20-Yrs 2024 (ft)	30-Yrs 2034 (ft)	40-Yrs 2044 (ft)	50-Yrs 2054 (ft)
35	388	-0.7	- 7	-14	-21	-28	-35
KH							
KDH							
36	364	+0.2	+ 2	+ 4	+ 6	+ 8	+ 10
37	652	-1.2	-12	-24	-36	-48	-60
38	471	-2.7	-27	-54	-81	-108	-135
39	620	-3.0	-30	-60	-90	-120	-150
40	660	-2.6	-26	-52	-78	-104	-130
41	522	-1.9	-19	-38	-57	-76	-95
42	400	-1.4	-14	-28	-42	-56	-70
43	853	-1.4	-14	-28	-42	-56	-70
44	740	-2.3	-23	-46	-69	-92	-115
45	594	-2.5	-25	-50	-75	-100	-125
46	669	-3.7	-37	-74	-111	-148	-185
47	299	-4.6	-46	-92	-138	-184	-230
48	440	-5.3	-53	-106	-159	-212	-265
49	390	-5.9	-59	-118	-167	-236	-295
50	451	-4.2	-42	-84	-126	-168	-210
51	421	-4.1	-41	-82	-123	-164	-205
52	511	-4.2	-42	-84	-126	-168	-210
53	612	-2.5	-25	-50	-75	-100	-125
54	620	-1.5	-15	-30	-45	-60	-75
55	342	-0.9	- 9	-18	-27	-36	-45
56	388	-0.8	- 8	-16	-24	-32	-40
57	658	+0.3	+ 3	+ 6	+ 9	+12	+15
58	413	+1.0	+10	+20	+30	+40	+50
59	300	+1.1	+11	+22	+33	+44	+55
60	742	+1.7	+17	+34	+51	+68	+85
61	561	+2.6	+26	+52	+78	+104	+130
62	685	+2.4	+24	+48	+72	+96	+120
63	487	+2.7	+27	+54	+81	+108	+135
64	591	+2.1	+21	+42	+63	+84	+105
65	468	+2.3	+23	+46	+69	+92	+115
66	600	+2.9	+29	+58	+87	+116	+145

Table 2 (continued)

Shoreline Changes - 20-mile-long Primary Study Area

	N.C. Erosion Rates Change (+ Accretion - Erosion)		Future Shoreline Positions Linear Distance (+ Accretion - Erosion)				
Seg	Seg L (ft)	Rate (ft/yr)	10-Yrs 2014 (ft)	20-Yrs 2024 (ft)	30-Yrs 2034 (ft)	40-Yrs 2044 (ft)	50-Yrs 2054 (ft)
KDH							
67	516	+2.6	+26	+52	+78	+104	+130
68	283	+2.6	+26	+52	+78	+104	+130
69	557	+2.2	+22	+44	+66	+88	+110
70	321	+1.6	+16	+32	+48	+64	+80
71	463	+1.5	+15	+30	+45	+60	+75
72	249	+1.8	+18	+36	+54	+72	+90
73	509	+1.8	+18	+36	+54	+72	+90
74	421	+1.7	+17	+34	+51	+68	+85
75	484	+1.1	+11	+22	+33	+44	+55
76	255	+1.0	+10	+20	+30	+40	+50
77	250	+0.5	+ 5	+10	+15	+20	+25
78	320	+0.5	+ 5	+10	+15	+20	+25
79	430	+0.7	+ 7	+14	+21	+28	+35
80	248	+0.7	+ 7	+14	+21	+28	+35
81	607	+1.1	+11	+22	+33	+44	+55
82	208	+1.1	+11	+22	+33	+44	+55
83	649	+1.3	+13	+26	+39	+52	+65
84	624	+0.7	+ 7	+14	+21	+28	+35
85	360	+1.1	+11	+22	+33	+44	+55
86	436	+0.5	+ 5	+10	+15	+20	+25
87	330	+0.2	+ 2	+ 4	+ 6	+8	+10
KDH NH							
88	429	-0.8	- 8	-16	-24	-32	-40
89	360	-0.7	- 7	-14	-21	-28	-35
90	219	-0.7	- 7	-14	-21	-28	-35
91	420	-0.7	- 7	-14	-21	-28	-35
92	580	-1.1	-11	-22	-33	-44	-55
93	359	-1.0	-10	-20	-30	-40	-50
94	640	-0.9	- 9	-18	-27	-36	-45
95	360	-0.9	- 9	-18	-27	-36	-45
96	388	-2.1	-21	-42	-63	-84	-105
97	664	-1.0	-10	-20	-30	-40	-50
98	460	-0.5	- 5	-10	-15	-20	-25

Table 2 (continued)

Shoreline Changes - 20-mile-long Primary Study Area

		N.C. Erosion Rates Change (+ Accretion - Erosion)	Future Shoreline Positions Linear Distance (+ Accretion - Erosion)				
Seg	Seg L (ft)	Rate (ft/yr)	10-Yrs 2014 (ft)	20-Yrs 2024 (ft)	30-Yrs 2034 (ft)	40-Yrs 2044 (ft)	50-Yrs 2054 (ft)
NH							
99	314	+0.2	+ 2	+ 4	+ 6	+ 8	+10
100	288	-0.1	- 1	- 2	- 3	- 4	- 5
101	314	-0.8	- 8	-16	-24	-32	-40
102	272	-1.3	-13	-26	-39	-52	-65
103	469	-0.5	- 5	-10	-15	-20	-25
104	490	-0.3	- 3	- 6	- 9	-12	-15
105	370	-0.1	- 1	- 2	- 3	- 4	- 5
106	290	-0.7	- 7	-14	-21	-28	-35
107	350	-0.9	- 9	-18	-27	-36	-45
108	528	-0.3	- 3	- 6	- 9	-12	-15
109	568	+0.1	+ 1	+ 2	+ 3	+ 4	+ 5
110	258	-0.6	- 6	-12	-18	-24	-30
111	340	-0.9	- 9	-18	-27	-36	-45
112	405	-1.1	-11	-22	-33	-44	-55
113	300	-1.5	-15	-30	-45	-60	-75
114	400	-1.5	-15	-30	-45	-60	-75
115	300	-1.1	-11	-22	-33	-44	-55
116	792	-0.9	- 9	-18	-27	-36	-45
117	650	-1.6	-16	-32	-48	-64	-80
118	374	-1.9	-19	-38	-57	-76	-95
119	750	-2.1	-21	-42	-63	-84	-105
120	708	-2.3	-23	-46	-69	-92	-115
121	311	-2.2	-22	-44	-66	-88	-110
122	450	-3.1	-31	-62	-93	-124	-155
123	619	-3.1	-31	-62	-93	-124	-155
124	640	-3.1	-31	-62	-93	-124	-155
125	295	-2.1	-21	-42	-63	-84	-105
126	440	-1.8	-18	-36	-54	-72	-90
127	450	-2.3	-23	-46	-69	-92	-115
128	500	-2.1	-21	-42	-63	-84	-105
129	446	-2.6	-26	-52	-78	-104	-130
130	725	-2.5	-25	-50	-75	-100	-125
131	524	-2.8	-28	-56	-84	-112	-140

Table 2 (continued)

Shoreline Changes - 20-mile-long Primary Study Area

N.C. Erosion Rates Change (+ Accretion - Erosion)			Future Shoreline Positions Linear Distance (+ Accretion - Erosion)				
Seg	Seg L (ft)	Rate (ft/yr)	10-Yrs 2014 (ft)	20-Yrs 2024 (ft)	30-Yrs 2034 (ft)	40-Yrs 2044 (ft)	50-Yrs 2054 (ft)
NH							
132	297	-3.3	-33	-66	-99	-132	-165
133	578	-3.3	-33	-66	-99	-132	-165
134	350	-2.6	-26	-52	-78	-104	-130
135	270	-3.0	-30	-60	-90	-120	-150
136	444	-3.0	-30	-60	-90	-120	-150
137	703	-3.3	-33	-66	-99	-132	-165
138	424	-3.7	-37	-74	-111	-148	-185
139	518	-3.4	-34	-68	-102	-136	-170
140	300	-2.6	-26	-52	-78	-104	-130
141	462	-2.7	-27	-54	-81	-108	-135
142	367	-2.8	-28	-56	-84	-112	-140
143	429	-2.9	-29	-58	-87	-116	-145
144	460	-3.0	-30	-60	-90	-120	-150
145	530	-3.0	-30	-60	-90	-120	-150
146	492	-3.0	-30	-60	-90	-120	-150
147	547	-3.0	-30	-60	-90	-120	-150
148	548	-2.1	-21	-42	-63	-84	-105
149	270	-0.1	- 1	- 2	- 3	- 4	- 5
150	374	+0.7	+ 7	+14	+21	+28	+35
151	607	+1.2	+12	+24	+36	+48	+60
152	480	+1.0	+10	+20	+30	+40	+50
153	405	+0.7	+ 7	+14	+21	+28	+35
154	420	+1.4	+14	+28	+42	+56	+70
155	361	+1.6	+16	+32	+48	+64	+80
156	538	+2.0	+20	+40	+60	+80	+100
157	630	+1.8	+18	+36	+54	+72	+90
158	345	+1.2	+12	+24	+36	+48	+60
159	320	+0.4	+ 4	+ 8	+12	+16	+20
160	600	+0.9	+ 9	+18	+27	+36	+45
161	400	-2.5	-25	-50	-75	-100	-125
162	260	-1.4	-14	-28	-42	-56	-70
163	461	-1.3	-13	-26	-39	-52	-65
164	410	-1.5	-15	-30	-45	-60	-75

Table 2 (continued)

Shoreline Changes - 20-mile-long Primary Study Area

N.C. Erosion Rates Change (+ Accretion - Erosion)			Future Shoreline Positions Linear Distance (+ Accretion - Erosion)				
Seg	Seg L (ft)	Rate (ft/yr)	10-Yrs 2014 (ft)	20-Yrs 2024 (ft)	30-Yrs 2034 (ft)	40-Yrs 2044 (ft)	50-Yrs 2054 (ft)
NH							
165	687	-2.4	-24	-48	-72	-96	-120
166	570	-2.7	-27	-54	-81	-108	-135
167	670	-2.9	-29	-58	-87	-116	-145
168	442	-3.1	-31	-62	-93	-124	-155
169	478	-2.7	-27	-54	-81	-108	-135
170	469	-2.3	-23	-46	-69	-92	-115
171	497	-2.8	-28	-56	-84	-112	-140
172	448	-3.5	-35	-70	-105	-140	-175
173	380	-4.3	-43	-86	-129	-172	-215
174	540	-4.2	-42	-84	-126	-168	-210
175	800	-4.6	-46	-92	-138	-184	-230
176	364	-5.8	-58	-116	-174	-232	-290
177	460	-5.6	-56	-112	-168	-224	-280
178	600	-5.3	-53	-106	-159	-212	-265
179	410	-4.9	-49	-98	-147	-196	-245
180	630	-4.2	-42	-84	-126	-168	-210
181	240	-4.6	-46	-92	-138	-184	-230
182	750	-4.7	-47	-94	-141	-188	-235
183	597	-4.1	-41	-82	-123	-164	-205
184	293	-4.0	-40	-80	-120	-160	-200
185	342	-3.9	-39	-78	-117	-156	-195
186	240	-4.4	-44	-88	-132	-176	-220
187	585	-4.2	-42	-84	-126	-168	-210
188	767	-4.3	-43	-86	-129	-172	-215
189	612	-4.8	-48	-96	-144	-192	-240
190	540	-5.4	-54	-108	-162	-216	-270
191	260	-5.3	-53	-106	-159	-212	-265
192	422	-6.6	-66	-132	-198	-264	-330
193	515	-7.3	-73	-146	-219	-292	-365
194	720	-6.6	-66	-132	-198	-264	-330
195	348	-6.2	-62	-124	-186	-248	-310
196	302	-5.6	-56	-112	-168	-224	-280
197	468	-5.6	-56	-112	-168	-224	-280
198	520	-5.8	-58	-116	-174	-232	-290

Table 2 (continued)

Shoreline Changes - 20-mile-long Primary Study Area

N.C. Erosion Rates Change (+ Accretion - Erosion)			Future Shoreline Positions Linear Distance (+ Accretion - Erosion)				
Seg	Seg L (ft)	Rate (ft/yr)	10-Yrs 2014 (ft)	20-Yrs 2024 (ft)	30-Yrs 2034 (ft)	40-Yrs 2044 (ft)	50-Yrs 2054 (ft)
NH							
199	441	-6.2	-62	-124	-186	-248	-310
200	439	-6.8	-68	-136	-204	-272	-340
201	790	-7.6	-76	-152	-228	-304	-380
202	400	-8.6	-86	-172	-258	-344	-430
203	430	-9.2	-92	-184	-276	-368	-460
204	450	-8.9	-89	-178	-267	-356	-445
205	390	-9.5	-95	-190	-285	-380	-475
206	642	-9.3	-93	-186	-279	-372	-465
207	650	-9.1	-91	-182	-273	-364	-455
208	265	-9.2	-92	-184	-276	-368	-460
209	405	-8.8	-88	-176	-264	-352	-440
210	425	-8.5	-85	-170	-255	-340	-425
211	330	-10.1	-101	-202	-303	-404	-505
212	660	-9.9	-99	-198	-297	-396	-495
213	780	-10.2	-102	-204	-306	-408	-510
NH							

Estimated Future Shoreline Conditions, Primary Study Area. The discussion below presents an estimate of the future shoreline. Again, emphasis is placed on the 20-mile-long reach along the shorelines of Nags Head, Kill Devil Hills, and Kitty Hawk, which is the Primary Study Area. This estimated future condition will form the basis for evaluating potential economic benefits for beach erosion control and developing plans to address these needs. For purposes of this discussion, it is assumed that no Federal project will be constructed before 2004. The year 2004 is referred to as the "base year" in subsequent report sections. (It should be noted that a Federal project could be implemented before or after 2004; however, this base year is assumed for purposes of economic analysis.)

Table 2 shows the estimated shoreline positions 10, 20, 30, 40, and 50 years from the base year (2004). These projections were developed based on historic rates of erosion and shoreline adjustments, and do not take into account any erosion-control measures that might be undertaken during the periods of analysis.

By the year 2054, progressive long-term erosion is expected to have claimed more than 1,000 structures along the Primary Study Area and to have also washed out NC 12 in Kitty Hawk. This state highway is the seaward most road in Kitty Hawk. U.S. Highway 158, which is the primary route for hurricane evacuation, parallels NC 12. If NC 12 is washed out along this segment in Kitty Hawk; traffic would be disrupted and would have to be rerouted around the washed out segments of roadway. Access to the buildings located along this area would also be disrupted. Access would have to be gained from side streets perpendicular to US 158.

The future shoreline positions discussed above and shown on table 2 are based on continuation of uniform historic rates of shoreline change. However, considering the value of property along the Primary Study Area (Nags Head, Kill Devil Hills, and Kitty Hawk) relative to the cost of erosion control measures, it is likely that local interests will undertake temporary measures to protect against progressive erosion.

At present, the three towns bulldoze the beaches to create artificial dunes in the areas where erosion is most acute. Also, property owners have placed sandbags along their property for temporary protection. These sandbag projects have to be approved by the NC Division of Coastal Management. For beach communities that are not actively pursuing a beach nourishment project, permitted sandbag structures are only allowed to remain in place for 2 years for small buildings and 5 years for large buildings. If a community is actively pursuing a beach nourishment project, sandbag structures that are in compliance with the State's size restrictions may remain in place until May 1, 2008. At the present level of activity, these measures are not sufficient to prevent erosion from proceeding landward, as shown in table 2. Therefore, unless more effective beach erosion control measures are undertaken, erosion is expected to progress landward.

Thus, the "most likely future" scenario along the Primary Study Area is that erosion control measures by local and state interests are not expected to provide significant protection against the erosion and flooding associated with hurricane and storm events.

HURRICANE AND STORM DAMAGE REDUCTION NEEDS

"Hurricane and storm damages," as used in this report, refer to flooding by wave overwash during hurricanes and northeasters, as well as short-term erosion which occurs during these events. When the island is under hurricane and storm attack, the full force of the waves is felt along the immediate ocean shoreline; as the waves break and spill over the ocean edge of the island, development in upland areas is subject to the force of the waves. As noted in the discussion of "beach erosion" problems above, erosion is threatening much of the dune system along the shoreline within the Primary Study Area. These segments of the island could be overtopped by a category 2-storm event. With the smaller storms, such as a category 1-storm event, the principal damages would be associated with the battering and loosening of the pilings, which support beachfront structures, and the loss of decks and other structures. With the larger storms, such as the Ash Wednesday storm in 1962 and the Halloween storm in 1991, entire structures can be swept away. Past hurricanes and northeasters and their damage potential are discussed below.

Past Hurricanes and Northeasters. Devastating hurricanes and northeasters periodically strike the study area. Storms occur in cycles with the recent years being fairly active. The following list is intended to present some of the worst storms that have been experienced in the study area. Hurricane season runs from 1 June through 30 November; while the northeaster season extends from 15 October to 10 April. Dollar estimates of the extent of the damages were not available for every storm and sometimes the available estimate covered a wider area than the scope of this study. Where any damage figures are given for storms in previous decades, it should be kept in mind that the damages would of course be far worse if a similar storm occurred today due to the surge in development during recent years.

2 September 1913 - The center of this storm passed inland 20 miles south of Hatteras, continued westward and southwest. Extensive damage was reported on the south end of Hatteras Island. Total property loss in the State was between $4,000,000 and $5,000,000 and five deaths were associated with the storm.

25 August 1924 - The center of the storm passed about 30 miles east of Hatteras, moving north-northeast. Extensive damage was reported. The Weather Bureau at Hatteras rated this as one of the greatest hurricanes, both in intensity and extent, ever experienced off the Atlantic Coast.

22 August 1933 - The center of the storm passed about 30 miles east of Hatteras moving northwest. The storm moved inland. Considerable damage was reported.

16 September 1933 - The center passed about 25 miles east of Hatteras, moving north-northeast. This storm was blamed for 21 deaths and over $3,000,000 in property damage in North Carolina. The storm was very severe and caused much damage in the banks area.

7 September 1934 - The center of this storm passed about 10 miles east of Hatteras, moving north-northeast. This storm and the damages it caused were severe along the banks area.

18 September 1936 - The center passed inland south of Oregon Inlet. This was a very severe storm that caused much damage and 2 deaths in the banks area.

14 September 1944 - This storm is known as the Great Atlantic Hurricane. Its center passed over Hatteras, moving north, then north-northeast. This storm was very severe and caused much damage along the Outer Banks. Barometer readings at Hatteras were the lowest in 70 years. Damages in the study area were estimated to be about $75,000. Total damage in the State was estimated at $1,500,000.

24 August 1949 - The center passed about 40 miles east of Hatteras moving north-northeast. The storm caused 1 death in Buxton and some damage in that area.

During the years 1954 and 1955, three extremely severe and devastating storms struck the North Carolina coast. Fortunately, in the study area, damages were relatively light. These hurricanes are important because similar storms do have the potential to occur in the study area. Hurricane Hazel, which pounded the coast from 5 to 18 October 1954, was the most destructive storm to strike North Carolina in 50 years. Every fishing pier along 170 miles of coast was destroyed. Between the North Carolina-South Carolina State line and Cape Fear, grass covered dunes, some 20 feet high, and a line of beach houses behind the dunes simply disappeared. Nineteen people were killed and 200 were injured. Damages throughout the State were estimated at $125,309,000, of which $31,190,300 occurred in the coastal and tidal areas. Hurricane Hazel did not reach the study area until 15 October 1954 and the storm passed about 145 miles west of Hatteras. Hurricane Hazel caused less than $10,000 in damages in the study area. Hurricane Connie caused tremendous beach erosion between 3 and 14 August 1955. The damage throughout the State was thought to be about $50,000,000, but before damages could be fully assessed, Hurricane Diane followed, and between 7 and 21 August, caused about $40,000,000 more in

damages. Hurricane Diane caused over $20,000 in damages in the study area. Hurricane Connie reached the study area on 12 August 1955, passing 10 miles west of Hatteras, and Hurricane Diane followed on 17 August 1955. The storm had moved far inland before it traveled as far north as the study area.

19 September 1955 - Hurricane Ione. The center passed about 50 miles west of Hatteras, moving north-northeast. Considerable damage was done to the north section of the banks area. Total damages throughout the State were estimated at $88,000,000, with an estimated $22,317,200 in damages occurring in the tidal area. Most of the damage resulted from flooding. Over $40,000 in damages occurred in the study area.

27 September 1958 - Hurricane Helene. The center passed about 30 miles east of Hatteras, moving northeast. The storm caused moderate damage in the south section of the banks area.

12 September 1960 - Hurricane Donna. The center passed about 30 miles east of Washington, NC, moving northeast and into the Atlantic near Caffey Inlet. Much damage was caused by high water north of Oregon Inlet and there were 3 deaths at Nags Head. The damage in the study area totaled about $60,000.

7 March 1962 - Ash Wednesday Storm. This storm was not a hurricane, but a late winter northeaster. Until 1991, it was the unquestioned storm of record for the study area. The northeaster was part of a very severe and widespread weather system that blanketed North Carolina and other states with snow. Unfortunately, the storm coincided with the spring tides, the highest tides of the year. In addition to damages in this study area, there was widespread destruction over hundreds of miles of coastline from Cape Hatteras northward. Over 60 buildings were destroyed in the study area and about 1,300 others were significantly damaged, for a total of nearly $2,000,000. No lives were lost in the study area. Altogether the Ash Wednesday Storm caused $200,000,000 in property damage and 33 deaths.

17 February 1973 - Another winter storm affected the coastal areas of the State. According to the Raleigh News and Observer, "The wind-whipped sea toppled large buildings in resort communities on the Outer Banks, nearly bisected at least two offshore islands, ripped up highways, filled roadbeds with sand and carved away large chunks of sandy beach. The worst of the storms fury was directed at Buxton, Kitty Hawk, and Nags Head, but severe erosion and some property damage occurred at the more southerly resort communities at Wrightsville Beach, Carolina Beach, and Topsail Beach."

31 October 1991 - Halloween Storm. This unusual storm caused erosion and flooding over a few days in the study area, but the peak of the storm

came on 31 October. Hurricane Grace was moving toward the Outer Banks from Bermuda. As Hurricane Grace weakened, another storm that originated in Canada began to move in, gaining strength from Grace's moisture and adding to the winds already generated by the hurricane. The storm stayed out to sea, unlike the Ash Wednesday storm. Weather in the damage area was fair, although huge waves breached and overwashed the dunes, spreading debris and large amounts of sand over open areas and flooding buildings and streets. In many places there appeared to have been some accretion, although the excess sand was not deposited on the beach. In Kitty Hawk, Kill Devil Hills, and Nags Head, over 500 buildings were damaged to some degree, 5 of those being destroyed. Residents had been urged to evacuate. There were no damages in Southern Shores or Duck. An accumulation of 4 or 5 feet of sand blocked NC 12 on Pea Island. NC 12 was flooded at other locations on Hatteras Island and Bodie Island. The damages on Bodie Island amounted to $4,125,000. The storm resulted in considerable damages from Florida to Maine.

In April, after the Halloween Storm, the Wilmington Morning Star reported that two University of Virginia professors, Dolan and Davis, had developed the first ranking system for northeasters. They had collected data on 1,347 northeasters that occurred between 1943 and 1984. The system rates storms from Class 1 (weak) to Class 5 (extreme) based on wave heights and duration. The Halloween storm was the most intense recorded, with wave heights of 37 feet and a duration of 114 hours. The Halloween Storm and the Ash Wednesday Storm were both Class 5 storms; only 5 of the other storms were rated as Class 5. About half were rated Class 1. While the Halloween storm is now the storm of record for the study area based on duration and wave heights, the Ash Wednesday Storm is still the record holder for damages. The Halloween Storm was not accompanied by the flooding and winds present during the Ash Wednesday Storm because the storm itself was not over the study area as the Ash Wednesday Storm was.

(Recent Hurricane History - Bertha, Fran, Bonnie, Dennis, Floyd, Irene)

12 July 1996 - Hurricane Bertha. The center moved over the North Carolina coast near Wilmington on 12 July with sustained winds of approximately 105 mph and gusts reported as high as 144 mph at Topsail Beach. The category 2 hurricane was an early season Cape Verde Hurricane. Damages were estimated to exceed $60 million for homes and structures and over $10 million for agriculture. Corn, tobacco, and other crops received severe damage from the storm. Rainfall totals of over 5 inches were common in eastern North Carolina.

6 September 1996 - Hurricane Fran. The center moved over the Cape Fear area around 0030 on 6 September and was moving northward near 15 knots.

When it made landfall, Hurricane Fran was a category three hurricane resulting in significant storm surge flooding on the North Carolina coast and widespread wind damage over North Carolina. At landfall, the minimum central pressure was estimated at 954 mb and the maximum sustained surface winds were estimated at 100 knots. Twenty-one died in North Carolina alone. Rainfall totals exceeding six inches were common near the path of Fran. Extensive flooding spread well inland from the Carolinas. Storm surge on the North Carolina coast destroyed or seriously damaged numerous beachfront houses. Widespread wind damage to trees and roofs, as well as downed power lines, occurred as Fran moved inland over North Carolina. Extensive flooding was responsible for additional damage in the Carolinas. Nearly a half-million tourists and residents were ordered to evacuate the coast in North and South Carolina. Press reports from Reuters News Service stated that 4.5 million people in the Carolinas and Virginia were left without power. The Property Claim Services Division of the American Insurance Services Group reported that Fran caused an estimated $1.6 billion dollars in insured property damage to the United States. This estimate includes $1.275 billion in North Carolina, $20 million in South Carolina, $175 million in Virginia, $50 million in Maryland, $20 million in West Virginia, $40 million in Pennsylvania and $20 million in Ohio. A conservative ratio between total damage and insured property damage, compared to past landfalling hurricanes, is two to one. Therefore, the total U.S.damage estimate is $3.2 billion.

26 August 1998 - Hurricane Bonnie. The center drifted along the coast, with the western part of the eye moving across extreme southeast Brunswick County and over eastern New Hanover County. The center officially came onshore a short distance northeast of Wilmington during the late evening of the 26th and early morning of the 27th. Bonnie then moved slowly over extreme eastern North Carolina, emerging off the Outer Banks near Kitty Hawk early on the 28th. After being downgraded to a tropical storm while over land, Bonnie re-strengthened into a hurricane with 75-mph winds as it moved back into the Atlantic. Early estimates of storm tides are as follows. Brunswick coast: 7 to 9 feet above normal, 2 feet of overwash at Bald Head and eastern end of other islands. New Hanover and Pender County coasts: 9 to 10 feet above normal, 2 to 3 feet overwash at the north end of Carolina Beach. There was less overwash on the south end of Topsail Island.

30 August 1999 - Hurricane Dennis. The hurricane lashed the Carolina coast on the 30th and part of the 31st with sustained tropical storm force winds, gusts to hurricane force, large waves, and high surf. The hurricane turned northeast away from the coast on the morning of the 30th and began to accelerate later that day while moving to the east-northeast. Dennis stalled about 150 miles east of Cape Hatteras on the morning of the 31st and then began to drift westward and weaken. During the first couple of days of September, Dennis continued to weaken and was downgraded to a tropical

storm as it drifted slowly to the southwest along the lower Outer Banks. The storm turned to the northwest on the 4th and made landfall over the Outer Banks between Cape Lookout and Ocracoke as a tropical storm. NC 12 was washed out north of Buxton.

16 September 1999 - Hurricane Floyd. The center made landfall near Cape Fear North Carolina as a category two hurricane around 0230 EDT September 16. The hurricane moved over the eastern part of the state and accelerated north-northeast up the coast, weakening to a tropical storm before moving into New England and losing its tropical characteristics early on the 17th. Floyd is responsible for massive inland flooding over portions of the eastern United States, particularly in North Carolina. The death toll from Floyd was 51 and makes this the deadliest United States tropical cyclone since Agnes of 1972. Many ocean front homes were heavily damaged.

18 October 1999 - Hurricane Irene. The center passed just east of the Outer Banks early on the 18th. After passing the Outer Banks, Irene rapidly intensified and reached a peak intensity of 105 mph on the 18th. Irene continued northeast and was absorbed by an extra-tropical low on the 19th.

Hurricane and Storm Damage Potential. The Primary Study Area is heavily developed and the potential for hurricane-wave damage is obvious given the weakened dune system in this area. Unlike long-term erosion which can be predicted, to some extent, based on past trends and observed shore processes, damages from hurricane-wave attack can occur in any year, and can be predicted only as a mathematical probability. Based on these probabilities, average annual damages were computed for hurricane and storm events, and will be discussed in Section III of this report, "Potential Economic Benefits".

CONDITIONS IF NO FEDERAL ACTION IS TAKEN

Development at Nags Head, Kill Devil Hills, and Kitty Hawk is expected to continue, with or without a Federal project. However, if no Federal action is taken this development will continue to be threatened by hurricanes and storm damage and long-term erosion. Basic assumptions are as follows:

(1) Most development seaward of NC 12 is expected to still be in place by year 2004, the year in which it is assumed that a Federal project could be implemented along the Primary Study Area. Local interests are expected to take short-term actions (bulldozing and sandbagging) to protect their property, however erosion will eventually take their structures.

(2) Local measures are not considered likely to provide significant protection against hurricane and storm damage, including wave overwash and flooding.

(3) Likewise, State measures are not considered likely to provide significant protection against a washout of NC 12 in Kitty Hawk.

SUMMARY OF PROBLEMS, NEEDS, AND OPPORTUNITIES

The principal water-resources problems identified along the Primary Study Area are progressive beach erosion, due to long-term shore processes, and the threat of hurricane and storm overwash. The need for action to address these problems is particularly acute along two reaches. The south reach extends from 3,000 feet north of the southern town limits of Nags Head to a point 200-feet North of Nags Head Pier (MP 11.7) in Nags Head. The north reach extends from a point 500-feet south of First Street (MP 7.3) in Kill Devil Hills to Kitty Hawk Road (MP 4.3) in Kitty Hawk.

SECTION III - POTENTIAL ECONOMIC BENEFITS

The purpose of this analysis is to estimate the potential economic benefits that could be realized with elimination of all preventable damages due to beach erosion and hurricane and storm action in the Primary Study Area. As discussed previously, the Primary Study Area includes the 20-mile-long reach of shoreline, which includes the resort communities of Nags Head, Kill Devil Hills, and Kitty Hawk. This is the only area along Dare County beaches north of Oregon Inlet where potential benefits are of significant magnitude to merit detailed study of a Federal project. Reduction of these damages, along with benefits for enhanced recreational use of the area, constitutes the economic justification for the plans of improvement that will be discussed in subsequent report sections.

METHODOLOGY AND ASSUMPTIONS

The analysis of potential economic benefits which follows is based on the assumption that no effective action will be taken to reduce hurricane and storm damages along the Primary Study Area. However, efforts by local and state interests will include sandbagging and beach scraping.

The interest rate for the analysis is 6-5/8 percent and a 50-year period of analysis is used. October 1999 price levels are applied. The "base year" used for the economic analysis is 2004.

The structural database used for this analysis was compiled by field surveying every structure in the primary study area. Each structure was assigned a reasonable estimate of its depreciated replacement value. Factors such as age, condition, quality of materials, and type and quality of construction enter into this value determination. Tax values were used for the sake of comparison, since the Dare County tax appraisers also strive to measure replacement value less depreciation.

Estimates of values of contents of commercial structures in the primary study area are based on interviews with business owners and insurance agents familiar with the Dare County oceanfront, as well as empirical data collected for past studies. Each type of business has a unique content factor applied to its structural value. Motels comprise most of the commercial base in the primary study area and 50 percent of the structural value was used for their content value. For estimating the value of household contents of residential structures in the study area, again 50 percent of the structural value is used. This is based on site-specific responses from Dare County officials, insurance agents, realtors, and home owners familiar with the development along this section of oceanfront.

POTENTIAL BENEFITS FOR HURRICANE AND STORM DAMAGE REDUCTION

This analysis includes 4,991 structures that occupy the Primary Study Area. Of this total, there are 2,221 structures in Nags Head, 1,843 structures in Kill Devil Hills, and 927 structures in Kitty Hawk.

Expected annual hurricane and storm damages for the Primary Study Area were computed using Wilmington District computer programs (see appendix F). These programs are used to compute damages for various storms based on their probability of occurrence. These damages are then estimated at an expected annual amount. Expected annual hurricane and storm damages for the Primary Study Area were estimated at $37,860,000, which includes $26,850,000 for Nags Head, $6,380,000 for Kill Devil Hills, and $4,630,000 for Kitty Hawk. This expected annual damage figure includes damages to structures and contents due to inundation and undermining by erosion during hurricanes and northeasters. The expected annual damage figure includes damages to structures and contents associated with inundation, wave impacts, and storm induced erosion.

POTENTIAL BENEFITS FOR EMERGENCY COSTS AND OTHER DAMAGE REDUCTION

Emergency costs prevented refer to expected annual expenditures that residents and local and state governments are experiencing under the without project condition that a Federal project would preclude. Other damages prevented include storm damages that are not covered under the National Flood Insurance Program, but represent financial impacts on public and private storm victims that a Federal project could prevent. The categories for this benefit include: (1) beach scraping and pushing; (2) sandbagging; (3) emergency costs incurred by the North Carolina Department of Transportation (NCDOT); (4) damages to public property (water and electric utility distribution systems and access walkways); (5) damages to private property such as walkways, driveways, and cleanup costs; and post-storm recovery expenses and storm related expenses such as police patrolling, inspections, and permits. Expected annual emergency costs and other damage reduction benefits for the Primary Study Area were estimated at $721,000, which includes $406,000 for Nags Head, $147,000 for Kill Devil Hills, and $168,000 for Kitty Hawk.

POTENTIAL BENEFITS FOR RECREATION

As discussed previously, local interests are expected to bulldoze sand after storm events and place sandbags along the shoreline fronting their structures in an attempt to protect their structures for as long as possible. The recreational beach that remains by 2004 is expected to be very narrow or nonexistent at high tides. Potential recreation benefits for the Primary Study Area were computed by estimating the unit day value of the recreational experience available with and

without a Federal project. The term "unit day value" represents the economic value that is assigned to a day of recreational experience (see appendix H).

A unit day value of $3.87 was assigned for the "without project" condition (see appendix H). The unit day value will be higher if a Federal project is implemented to restore and stabilize the beach strand. Assuming that any Federal project that is constructed will include a beach width of at least 50 feet and is regularly nourished, then a unit day value of $5.17 is considered appropriate. This increase of $1.30 per unit day multiplied by estimated annual visitation represents the potential economic benefits for a restored and stabilized beach along the Primary Study Area. Estimated visitation is discussed below.

Beach use along the Primary Study Area is estimated at a daily peak of 103,600 persons, based on data from the Towns of Nags Head, Kill Devil Hills, and Kitty Hawk and the Dare County Tourist Bureau. This represents 4,882,000 beach users annually. This total represents an annual visitation of 1,744,000 for Nags Head, 2,257,000 for Kill Devil Hills, and 881,000 for Kitty Hawk. Therefore, potential recreational benefits for the Primary Study Area are estimated at an expected annual amount of $6,346,000 (4,882,000 visitor days x $1.30 increase in unit day value). The $6,346,000 includes $2,267,000 for Nags Head, $2,934,000 for Kill Devil Hills, and $1,145,000 for Kitty Hawk.

POTENTIAL REGIONAL BENEFITS

Although Regional Economic Development (RED) benefits can not be included as part of the NED benefit computations, they are extremely important to the non-Federal sponsor (Dare County). In this case, one of the factors that Dare County can use in gaining local support for the project is the multiplier effect as a portion of the project cost is returned to the local economy. This information is provided in appendix H.

SUMMARY OF POTENTIAL ECONOMIC BENEFITS

The total potential expected annual benefits for shore protection along the 20-mile-long Primary Study Area that includes the resort towns of Nags Head, Kill Devil Hills, and Kitty Hawk, are summarized in table 3. As shown, potential economic benefits include three categories: (1) Hurricane and Storm Damage Reduction Benefits - Potential benefits in this category are based on damages due to long-term beach erosion and short-term storm erosion and wave overwash during hurricanes and northeasters; (2) Emergency Costs and Other Damage Reduction - Potential benefits in this category are based on storm related expenditures that are not covered by the National Flood Insurance Program; and (3) Recreation - Potential benefits in this category are based on increases in the value of the recreation experience for beachgoers with implementation of a Federal project within the Primary Study Area. Regional benefits are not allowed as National Economic

Development (NED) benefits, however at the request of the non-Federal sponsor, they were computed and the results are summarized in appendix H.

Table 3

Potential Economic Benefits for the Primary Study Area
(Nags Head, Kill Devil Hills, and Kitty Hawk)

Benefit Category	Nags Head Potential Expected Annual Benefits	Kill Devil Hills Potential Expected Annual Benefits	Kitty Hawk Potential Expected Annual Benefits	Primary Study Area Potential Expected Annual Benefits
Hurricane and Storm Damage Reduction	$26,850,000	$6,380,000	$4,630,000	$37,860,000
Emergency	406,000	147,000	168,000	721,000
Recreation	2,267,000	2,934,000	1,145,000	6,346,000
Total Potential Benefits	$29,523,000	$9,461,000	$5,943,000	$44,927,000

As shown in table 3, total potential expected annual benefits for the Primary Study Area are estimated at $41,727,000 which includes $27,253,000 for Nags Head, $8,921,000 for Kill Devil Hills, and $5,553,000 for Kitty Hawk. In accord with the National Objective stated previously, the expected annual cost of any Federal improvement recommended must be less than the expected annual benefits. In addition, any plan of improvement to be recommended must be shown to be environmentally acceptable. Environmental resources in the Primary Study Area are discussed in the following report sections.

SECTION IV - ENVIRONMENTAL CONSIDERATIONS IN PROJECT PLANNING

The purposes of this report section are (1) to identify significant environmental resources which might be affected by a Federal project along the Primary Study Area; and (2) to identify criteria which should be followed in planning and designing a project to minimize impacts on those resources. Significant, or potentially significant, resources are discussed below.

SIGNIFICANT RESOURCES

Generally, the upland areas in the Primary Study Area have limited natural values, due to the intensity of development. However, the estuaries, inlets, beaches, and shallow ocean bottom surrounding the Primary Study Area have significant values, as discussed below.

BIOLOGICAL RESOURCES

Marine waters in the vicinity of the beachfill sites and the offshore borrow sites provide habitat for a variety of ocean 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 for from boats, or the surf and local piers. Studies conducted by the U.S. Fish and Wildlife Service (1993) indicated that nearshore ocean waters from Cape Lookout, North Carolina to Cape Charles, Virginia, are the wintering grounds for the Atlantic Coast migratory striped bass population. Off shore marine waters serve as habitat for the spawning of many estuarine dependent species. These species, according to the National Marine Fisheries Service, "compose approximately 75 percent of commercially and recreationally important catch of fish and invertebrates in North Carolina". The surf zone serves as a nursery area for juvenile kingfish during the summer. Nearshore waters also accumulate juvenile, ocean spawning, estuarine dependent fish and invertebrates in the late winter and early spring prior to their transport through Oregon Inlet to the Pamlico and Albemarle Sound estuary.

Although developed areas in the Primary Study Area have limited habitat value, portions of the barrier island beaches within the Primary Study Area are important nesting areas used by colonies of least terns, common terns, gull-billed terns, and black skimmers during the spring and early summer. Potential project areas were surveyed during this study to determine potential use of these areas by the species mentioned above and the results are presented in the attached FEIS.

A man-made dune system is present along the Primary Study Area, however, this dune system is being severely eroded. These dunes are vegetated primarily with grasses, sea oats, and salt meadow hay, which provide habitat for some wildlife species including birds and small mammals. Dunes serve an important function as a barrier to storm tides, protecting barrier island development. Dune vegetation such

as sea oats is important as a dune builder and helps to protect against erosion. It is expected that the recommended plan will result in reestablishing and protecting the dune system along the project area.

There is one site within the Primary Study Area that is in the Coastal Barrier System and therefore protected under the Coastal Barrier Improvement Act of 1990 (USFWS 1990). The site is Nags Head Woods and is located in Kill Devil Hills and Nags Head. This site does not include beachfront areas and therefore would not be affected by the recommended plan.

More detailed descriptions of the landforms and fish and wildlife resources of the study area are presented in the attached FEIS and appendix B. Appendix B contains the "Dare County Beaches, Final Fish and Wildlife Coordination Act Report," prepared by the U.S. Fish and Wildlife Service.

ENDANGERED AND THREATENED SPECIES

Coordination with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service has been conducted to identify endangered and threatened species that might be present in the vicinity of the Primary Study Area. Species that are currently Federally listed as endangered or threatened, which may or do occur in the Primary Study Area, and which may be subject to impacts from beach nourishment are listed in table 4.

Table 4
Federally Listed Endangered or Threatened Species

MAMMALS	Finback whale Humpback whale Right whale Sei whale Sperm whale Blue Whale
BIRDS	Piping plover Roseate tern
REPTILES	Loggerhead sea turtle Kemp's ridley turtle Green sea turtle Hawksbill sea turtle Leatherback sea turtle
FISH	Shortnose sturgeon
PLANT	Seabeach amaranth

Potential project-related impacts have been addressed for each of these species and are presented in the attached FEIS. Of primary concern are the impacts of beachfill on the nests of loggerhead and green sea turtles.

WATER QUALITY

Within the Primary Study Area the North Carolina Division of Environmental Management has designated area waters as SB for the Atlantic Ocean. SB waters are suitable for fish and wildlife propagation, primary and secondary recreation, and other uses requiring water of lower quality.

CULTURAL RESOURCES

The Dare County Beaches Primary Study Area, is known to have a high potential for containing historic resources, primarily shipwreck sites. A summary statement regarding the presence of shipwrecks, prehistoric sites, and architectural-historical archeological sites is presented below. A list of known sites is included in the attached FEIS.

A primary source for shipwreck data is Newton et al. (1971:16, 24-29, Wreck Chart No. 3) An Oceanographic Atlas of the Carolina Margin. Of the nearly 1,200 wrecks identified for the coastline between Dare and New Hanover Counties, the atlas lists nearly 372 vessel losses in the Cape Hatteras vicinity. This area includes Diamond Shoals and waters of Dare County to approximately 30 miles off shore, and the beaches off Dare County from Hatteras Inlet to approximately ten miles north of Oregon Inlet. A majority of these wrecks appear as a virtually unbroken string along the shoreline of Dare County (Newton et al. 1971:Wreck Chart No. 3). All or a portion of these wrecks may be represented in the site files of the North Carolina Division of Archives and History, Underwater Archeology Unit. Based on an examination of the Underwater Archeology Unit site files, 15 wrecks have been reported on the beaches within the study area. Investigations conducted during this feasibility study indicated that there were no known shipwrecks that would be impacted by the recommended project (see the attached FEIS).

No prehistoric sites on or near the Primary Study Area were identified during this feasibility study. No archaeological sites are listed for the Primary Study Area in the North Carolina Division of Archives and History site file. Archeological surveys of proposed offshore borrow areas and shoreline nourishment areas have been conducted during this feasibility study and no significant resources were encountered. These surveys consisted of a magnetic survey over upland (beach) areas and magnetometer and side-scan sonar surveys over the offshore borrow areas.

AESTHETIC RESOURCES

The Dare County beach communities of Nags Head, Kill Devil Hills and Kitty Hawk, that are located in the Primary Study Area, provide a vacation area for millions of visitors each year. The beaches within the Primary Study Area are used extensively for recreation. This includes sunbathing, swimming, surf fishing, jogging, bird watching and sightseeing. Public access with parking is available along the Primary Study Area. There are five ocean fishing piers within the Primary Study Area (see plate 1).

ENVIRONMENTAL CRITERIA AND CONSTRAINTS

No environmental constraints were identified which would preclude implementation of a Federal project at Nags Head, Kill Devil Hills, and Kitty Hawk. However, any plan of improvement should be designed and implemented, to the extent practicable, to avoid impacts on the threatened species known to occur along the Primary Study Area (see table 4).

Generally, any plan of improvement should be designed to avoid adverse impacts on water quality and biological resources. Also, the timing of initial project construction and periodic nourishment should be adjusted as practicable to avoid periods of high biological productivity.

As noted above, the aesthetic qualities of the beach strand at Nags Head, Kill Devil Hills and Kitty Hawk will probably continue to be degraded as erosion encroaches on development. Therefore, there is an opportunity to enhance this aspect of the island's aesthetic quality by restoration and periodic nourishment of the beachfront.

SECTION V - PLAN FORMULATION

This report section describes the procedures by which alternative plans were developed and the recommended plan of improvement was ultimately selected. Plans discussed herein provide protection for the project areas within the Primary Study Area shown on figure 3. The South Project Area, including approximately 10.1 miles of beachfront and the North Project Area, including approximately 4.1 miles of beachfront (see plate 1), are the two project areas that have been identified within the Primary Study Area, and correspond to the areas described previously. The total length of beachfront for the North and South Project Areas is approximately 14.2 miles and this combined project area is referred to herein as the Total Project Area. It should be noted that the project areas include transitions.

PLAN FORMULATION RATIONALE

Typical alternatives for shore protection include offshore breakwaters, groin fields, bulkheads, beach nourishment and relocation. Offshore breakwaters and a hardened shoreline alternative such as groins or bulkheads were not considered because of coastal management policies that prohibit hardened structures due to their impact on adjacent beaches. A beach nourishment project would consist of (1) a beach berm project to control erosion; or (2) a beach berm and dune project to control erosion and reduce wave overwash during storms. "Nonstructural" measures were also considered as required by Federal planning regulations. These measures usually include relocation, evacuation, elevating, or waterproofing of buildings to reduce damageability. The only nonstructural measures that would substantially reduce damages in the project areas are structure relocation and evacuation. While relocation would reduce damage to structures, it would not prevent loss of property, associated tax values or emergency costs. Given the high costs of structures, loss of benefits, and the impracticality of moving thousands of structures, these non-structural measures are economically infeasible. An evaluation of the non-structural alternative is included in Appendix H.

ALTERNATIVE PLANS

The alternative plans evaluated in detail were beach berm plans, referred to herein as "Beach Erosion Control Plans," and berm and dune plans, referred to herein as "Hurricane Protection and Beach Erosion Control Plans." Within each of these categories, various levels of protection were evaluated for comparison of benefits to costs. In all cases, the areas protected extend along the same project areas within the Primary Study Area, as shown on plate 1. These project areas were evaluated for all alternative plans since: (1) these areas have consistent development and erosion has weakened the protective dune; and (2) there are no significant environmental constraints associated with these reaches.

BEACH EROSION CONTROL PLANS

Alternatives in this category are referred to herein as "beach berm" plans. These plans would consist of constructing a sand berm along the oceanfront at an elevation of 7 feet above NGVD, which is approximately the existing berm elevation in the Primary Study Area. As will be discussed in this report section, widths of 50, 100, and 150 feet were considered for the beach berm alternatives. As shown on plate 1, the South Project Area to be protected by the beach berm extends from 800 feet south of the Altoona Street (MP 20.7) in Nags Head to 200 feet north of Nags Head Fishing Pier (Mile Post 11.7) in Nags Head. The North Project Area to be protected extends from 500 feet south of First Street (Mile Post 7.3) in Kill Devil Hills to Kitty Hawk Road (Mile Post 4.3) in Kitty Hawk. The total length of the South Project main fill is 47,490 feet and 15,900 feet for the North Project main fill. These plans would provide protection against long-term erosion.

As shown on plate 1, the beach berm alternatives were evaluated with transition zones at both ends of the main fill. Since the fill will cause the shoreline to protrude seaward, the north and south ends of the fill will erode rapidly unless measures are taken to terminate the fill with a gradual transition. The transition zones at the north and south ends of the fill are 3,000 feet long except for the south transition of the south project which is 2,850 feet long. Based on coastal engineering analyses conducted during this study, these transition lengths provide the most cost-effective means for terminating the ends of the fill, regardless of the width of the beachfill. The transition fills will taper into the existing system. While some economic benefits will be realized due to the protection provided to development behind the transition fills, protection of these areas is not a primary project purpose. The total length of the South Project Area with transitions is 53,340 feet and 21,900 feet for the North Project Area

All shore protection plans considered would be constructed and maintained by hydraulic dredges (pipeline and hopper with pump out capability) using the borrow areas shown on plate 1. In each case, material would be pumped from the offshore borrow areas to the beach and shaped by earth moving equipment. Widths of 50, 100, and 150 feet were considered for the beach berm. In each case, the beach berm would be constructed at an elevation of +7-feet NGVD, the elevation of the existing beach berm along the project reaches. Construction methodology is explained in appendix D. Benefits and costs discussions for each of these beach berm alternatives follows.

Each alternative was evaluated for the South and North Project Areas. The alternatives considered consisted of:

(a) 7-foot NGVD beach berm with a 50-foot width

(b) 7-foot NGVD beach berm with a 100-foot width

(c) 7-foot NGVD beach berm with a 150-foot width

BENEFITS AND COSTS FOR BEACH EROSION CONTROL PLANS

Benefits for the 50-, 100-, and 150-foot berm alternatives are shown in table 5. However, the beach berm alternative would not substantially reduce damages due to hurricane and storm overwash; measures to address this problem will be discussed in the following report section on "Berm and Dune" alternatives.

Table 5

Present Value Benefits for Beach Erosion Control Plans
(Based on 6-5/8 percent interest rate, 50-year period of analysis)
(October 1999 price levels)
(In Millions of Dollars)

Beach Berm

(South Project Area)

Benefit Category	50-ft.-wide	100-ft.-wide	150-ft.-wide
Hurricane and Storm Damage Reduction	$252.9	$278.2	$294.8
Emergency	5.2	5.2	5.2
Recreation	28.2	28.2	28.2
Present Value Total Benefits	$286.3	$311.6	$328.2

(North Project Area)

Benefit Category	50-ft.-wide	100-ft.-wide	150-ft.-wide
Hurricane and Storm Damage Reduction	$ 68.0	$ 76.5	$ 82.4
Emergency	2.0	2.0	2.0
Recreation	26.7	26.7	26.7
Present Value Total Benefits	$ 96.7	$105.2	$111.1

Table 5 (continued)

Present Value Benefits for Beach Erosion Control Plans
(Based on 6-5/8 percent interest rate, 50-year period of analysis)
(October 1999 price levels)
(In Millions of Dollars)

Beach Berm

(Total Project Area)

Benefit Category	50-ft.-wide	100-ft.-wide	150-ft.-wide
Hurricane and Storm Damage Reduction	$320.9	$354.7	$377.2
Emergency	7.2	7.2	7.2
Recreation	54.9	54.9	54.9
Present Value Total Benefits	$383.0	$416.8	$439.3

COSTS FOR BEACH EROSION CONTROL PLANS

Costs for the beach berm alternatives considered are shown in table 6. As shown in table 6, both first costs and other costs vary proportionately to the volume of the fill, the distance the fill is located from the borrow areas, and the overfill ratios for the borrow areas. The interval between periodic nourishment operations for each segment will be 3 years. A periodic nourishment will occur every year along some segment of the project area.

Table 6

Present Value Costs for Beach Erosion Control Plans

(Based on 6-5/8 percent interest rate, 50-year period of analysis)
(October 1999 price levels)
(In Millions of Dollars)

Beach Berm

(South Project Area)

Item	50-ft.-wide	100-ft.-wide	150-ft.-wide
Beachfill Construct.	$19.3	$34.8	$49.8
Walkovers	0.6	0.9	1.3
Engineering & Design	1.2	2.1	3.0
Superv. & Admin.	1.0	1.4	2.0
Total First Cost	22.1	39.2	56.1
Lands	3.8	3.8	3.8
Present Value Initial Cost	$25.9	$43.0	$59.9
Beach Nourishment	84.0	84.0	84.0
Engineering & Design	6.4	6.4	6.4
Superv. & Admin.	2.7	2.7	2.7
Present Value Other Cost	$93.1	$93.1	$93.1
Present Value Total Cost	$119.0	$136.1	$153.0

Table 6 (continued)

Present Value Costs for Beach Erosion Control Plans

(Based on 6-5/8 percent interest rate, 50-year period of analysis)
(October 1999 price levels)
(In Millions of Dollars)

Beach Berm

(North Project Area)

Item	50-ft.-wide	100-ft.-wide	150-ft.-wide
Beachfill Construct.	$8.0	$14.3	$21.8
Walkovers	0.3	0.4	0.5
Engineering & Design	0.5	0.7	1.0
Superv. & Admin.	0.2	0.2	0.2
Total First Cost	9.0	15.6	23.5
Lands	1.6	1.6	1.6
Present Value Initial Cost	$10.6	$17.2	$25.1
Other Cost:			
Beach Nourishment	70.1	70.1	70.1
Engineering & Design	4.3	4.3	4.3
Superv. & Admin.	2.0	2.0	2.0
Present Value Other Cost	$76.4	$76.4	$76.4
Present Value Total Cost	$87.0	$93.6	$101.5

Table 6 (continued)

Present Value Costs for Beach Erosion Control Plans

(Based on 6-5/8 percent interest rate, 50-year period of analysis)
(October 1999 price levels)
(In Millions of Dollars)

Beach Berm

(Total Project Area)

Item	50-ft.-wide	100-ft.-wide	150-ft.-wide
Beachfill Construct.	$27.3	$49.1	$71.6
Walkovers	0.9	1.3	1.8
Engineering & Design	1.7	2.8	4.0
Superv. & Admin.	1.2	1.6	2.2
Total First Cost	31.1	54.8	79.6
Lands	5.2	5.2	5.2
Present Value Initial Cost	$36.5	$60.2	$85.0
Other Cost:			
Beach Norishmt.	154.1	154.1	154.1
Engineering & Design	10.7	10.7	10.7
Superv. & Admin.	4.7	4.7	4.7
Present Value Other Cost	$169.5	$169.5	$169.5
Present Value Total Cost	$206.0	$229.7	$254.5

SUMMARY OF BENEFITS AND COSTS, BEACH EROSION CONTROL PLANS

Table 7 summarizes benefits, costs, and net benefits for the beach berm plans considered. As shown, the maximum net economic benefits among these alternatives are realized with the 100-foot berm.

As shown in table 7, each of the beach berm alternatives would produce benefits greater than costs. These plans would provide effective protection for long term shore erosion, however, a beach berm alone would not effectively protect structures against short-term shoreline retreat during storms. Although the berm

would later be restored by natural processes and/or by pumping sand from a borrow source, structures in the eroded area would be damaged. The beach berm alternatives would not substantially reduce damage due to hurricane and storm overwash; measures to address this problem will be discussed in the following report sections on "Beach Erosion Control and Hurricane Protection Plans."

Table 7

Present Value Benefits and Costs for Beach Erosion Protection Alternatives
(In Million of Dollars)

BEACH EROSION CONTROL PLANS
(BEACH BERM)
(SOUTH PROJECT AREA)

Alternative	PV Total Benefits	PV Total Costs	PV Total Net Benefits
50-foot Berm	$286.3	$119.0	$167.3
100-foot Berm	$311.6	$136.1	$175.5
150-foot Berm	$328.2	$153.0	$175.2

BEACH EROSION CONTROL PLANS
(BEACH BERM)
(NORTH PROJECT AREA)

Alternative	PV Total Benefits	PV Total Costs	PV Total Net Benefits
50-foot Berm	$ 96.7	$ 87.0	$ 9.7
100-foot Berm	$105.2	$ 93.6	$ 11.6
150-foot Berm	$111.1	$101.5	$ 9.6

PV - Present Value

Table 7 (continued)

Present Value Benefits and Costs for Beach Erosion Protection Alternatives
BEACH EROSION CONTROL PLANS
(BEACH BERM)
(TOTAL PROJECT AREA)

Alternative	PV Total Benefits	PV Total Costs	PV Total Net Benefits
50-foot Berm	$383.0	$206.0	$177.0
100-foot Berm	$416.8	$229.7	$187.1
150-foot Berm	$439.3	$254.5	$184.8

BEACH EROSION CONTROL AND HURRICANE WAVE PROTECTION PLANS

In order to increase the protective value of the beachfill, dunes can be incorporated into the upper portion of the fills. The added elevation and mass of the dunes would reduce the landward retreat of the beach during storms and would decrease the size of waves propagating across the island.

Five dune and beach berm fill cross sections were analyzed to determine their effectiveness in reducing storm induced erosion and wave heights across the South and North Project Areas. As with the "beach berm" alternatives discussed previously, each alternative was evaluated for the South, North, and Total Project Area. The alternatives considered consisted of:

(a) 11-foot NGVD dune and a 7-foot NGVD beach berm with a 50-foot width

(b) 13-foot NGVD dune and a 7-foot NGVD beach berm with a 25-foot width

(c) 13-foot NGVD dune and a 7-foot NGVD beach berm with a 50-foot width

(d) 15-foot NGVD dune and a 7-foot NGVD beach berm with a 50-foot width

(e) 13-foot NGVD dune and a 7-foot NGVD beach berm with a 100-foot width.

For brevity, the five sections will be referred to as the 11/50, 13/25, 13/50, 15/50, and 13/100 dune sections. As indicated above, each of the dune sections is fronted by a beach berm at elevation +7 feet NGVD.

EFFECTS OF BERM AND DUNE ALTERNATIVES ON BEACH EROSION

Each of the alternatives described above would effectively control long-term shore erosion, as would the "Beach Erosion Control Alternatives", discussed previously. In addition, the added elevation and mass of the berm and dune fills would provide a higher level of protection against short-term shoreline retreat during storms.

EFFECTS OF BERM AND DUNE ALTERNATIVES ON STORM WAVE OVERWASH

In addition to reducing storm-induced erosion, the berm and dune alternatives would reduce damages to upland development due to hurricane-wave overwash. Each berm and dune plan would reduce the heights of the waves capable of propagating across the island during hurricane events. Increasing the height and mass of the protective structure increases its resistance to storm erosion and wave overtopping. Thus, the level of protection for upland development is increased with the higher, more massive dune structures. Benefits for the berm and dune alternatives are discussed below.

BENEFITS FOR BEACH EROSION CONTROL AND HURRICANE PROTECTION PLANS

Table 8 shows benefits for the berm and dune alternatives considered. In addition, the berm and dune plans would provide substantially higher benefits for hurricane and storm damage reduction.

Table 8

Present Value Benefits for Beach Erosion Control Plan and Hurricane Protection Plans
(Based on 6-5/8 percent interest rate, 50-year period of analysis)
(October 1999 price levels)
(In Millions of Dollars)

Berm and Dune

(South Project Area)

Benefit Category	11/50	13/25	13/50	15/50	13/100
Hurricane and Storm Damage Reduction	$287.2	$290.0	$309.2	$321.9	$313.5
Emergency	5.2	5.2	5.2	5.2	5.2
Recreation	28.2	28.2	28.2	28.2	28.2
Present Value Total Benefits	$320.6	$323.4	$342.6	$355.3	$346.9

(North Project Area)

Benefit Category	11/50	13/25	13/50	15/50	13/100
Hurricane and Storm Damage Reduction	$ 79.4	$ 81.9	$ 86.9	$ 89.0	$ 87.7
Emergency	2.0	2.0	2.0	2.0	2.0
Recreation	26.7	26.7	26.7	26.7	26.7
Present Value Total Benefits	$108.1	$110.6	$115.6	$117.7	$116.4

Table 8 (continued)
Present Value Benefits
for Beach Erosion Control Plan and Hurricane Protection Plans
(Based on 6-5/8 percent interest rate, 50-year period of analysis)
(October 1999 price levels)
(In Millions of Dollars)

Berm and Dune

(Total Project Area)

Benefit Category	11/50	13/25	13/50	15/50	13/100
Hurricane and Storm Damage Reduction	$366.6	$371.9	$396.1	$410.9	$401.2
Emergency	7.2	7.2	7.2	7.2	7.2
Recreation	54.9	54.9	54.9	54.9	54.9
Present Value Total Benefits	$428.7	$434.0	$458.2	$473.0	$463.3

COSTS FOR BEACH EROSION CONTROL AND HURRICANE PROTECTION PLANS

Table 9 presents the present value of the initial cost and other cost for the berm and dune alternatives considered. As shown in table 9, both initial cost and other cost vary proportionately to the height, width and volume of the beachfill and the distance the beachfill is located from the borrow area. The interval between beach nourishment operations would be 3 years.

Table 9

Present Value Costs for Beach Erosion Control and Hurricane Protection Plans
(Based on 6-5/8 percent interest rate, 50-year period of analysis)
(October 1999 price levels)
(In Millions of Dollars)

Berm and Dune
(South Project Area)

Item	11/50	13/25	13/50	15/50	13/100
Initial Cost:					
Beachfill Construct.	$28.5	$31.8	$38.7	$50.2	$53.3
Grassing	0.9	1.0	1.2	1.6	1.6
Walkovers	0.8	0.9	1.1	1.4	1.4
Engineering & Design	1.8	2.0	2.5	3.2	3.5
Superv. & Admin.	1.2	1.5	1.7	2.3	2.4
Total First Cost	33.2	37.2	45.2	58.7	62.2
Lands	3.8	3.8	3.8	3.8	3.8
Present Value Initial Cost	$37.0	$41.0	$49.0	$62.5	$66.0
Other Cost:					
Beach Nourishment	84.0	84.0	84.0	84.0	84.0
Engineering & Design	6.4	6.4	6.4	6.4	6.4
Superv. & Admin.	2.7	2.7	2.7	2.7	2.7
Present Value Other Cost	$93.1	$93.1	$93.1	$93.1	93.1
Present Value Total Cost	$130.1	$134.1	$142.1	$155.6	$159.1

Table 9 (continued)

Present Value Costs for Beach Erosion Control and Hurricane Protection Plans
(Based on 6-5/8 percent interest rate, 50-year period of analysis)
(October 1999 price levels)
(In Million of Dollars)

Berm and Dune
(North Project Area)

Item	11/50	13/25	13/50	15/50	13/100
Initial Cost:					
Beachfill Construct.	$14.1	$16.0	$19.0	$24.5	$25.7
Grassing	0.3	0.3	0.4	0.5	0.5
Walkovers	0.4	0.4	0.5	0.6	0.7
Engineering & Design	0.7	0.9	1.0	1.2	1.3
Superv. & Admin.	0.2	0.2	0.2	0.2	0.2
Total First Cost	15.7	17.8	21.1	27.0	28.4
Lands	1.6	1.6	1.6	1.6	1.6
Present Value Initial Cost	$17.3	$19.4	$22.7	$28.6	$30.0
Other Cost:					
Beach Nourishment	70.1	70.1	70.1	70.1	70.1
Engineering & Design	4.3	4.3	4.3	4.3	4.3
Superv. & Admin.	2.0	2.0	2.0	2.0	2.0
Present Value Other Cost	$ 76.4	$ 76.4	$ 76.4	$ 76.4	$ 76.4
Present Value Total Cost	$ 93.7	$ 95.8	$ 99.1	$105.0	$106.4

Table 9 (continued)

Present Value Costs for Beach Erosion Control and Hurricane Protection Plans
(Based on 6-5/8 percent interest rate, 50-year period of analysis)
(October 1999 price levels)
(In Million of Dollars)

Berm and Dune
(Total Project Area)

Item	11/50	13/25	13/50	15/50	13/100
Beachfill Construct.	$44.5	$47.8	$57.7	$74.7	$79.0
Grassing	1.2	1.3	1.6	2.1	2.1
Walkovers	1.2	1.3	1.6	2.0	2.1
Engineering & Design	2.6	2.9	3.5	4.4	4.8
Superv. & Admin.	1.4	1.7	1.9	2.5	2.6
Total First Cost	48.9	55.0	66.3	85.7	90.6
Lands	5.4	5.4	5.4	5.4	5.4
Present Value Initial Cost	$54.3	$60.4	$71.7	$91.1	$96.0
Other Cost:					
Beach Nourishment	154.1	154.1	154.1	154.1	154.1
Engineering & Design	10.7	10.7	10.7	10.7	10.7
Superv. & Admin.	4.7	4.7	4.7	4.7	4.7
Present Value Other Cost	$169.5	$169.5	$169.5	$169.5	$169.5
Present Value Total Cost	$223.8	$229.9	$241.2	$260.6	$265.5

SUMMARY OF BENEFITS AND COSTS, BEACH EROSION AND HURRICANE PROTECTION PLANS

As shown in table 10, all of the berm and dune alternatives considered produce benefits that exceed costs. The present value net benefits, measured as present value benefits minus present value costs, are maximized with the 13-foot dune alternative with a 50-foot wide berm. As discussed in the following report section, the 13-foot dune alternative with a 50-foot wide berm is the plan of improvement recommended for implementation.

Table 10

Benefits and Costs for Beach Erosion and Hurricane Protection Alternatives
(In Million of Dollars)

BEACH EROSION AND HURRICANE PROTECTION PLANS
(BERM AND DUNE)
(SOUTH PROJECT AREA)

Alternative	PV Total Benefits	PV Total Costs	PV Total Net Benefits	
11/50	$320.6	$130.1	$190.5	
13/25	$323.4	$134.1	$189.3	
13/50	**$342.6**	**$142.1**	**$200.5**	**(NED Plan)**
15/50	$355.3	$155.6	$199.7	
13/100	$346.9	$159.1	$187.8	

PV - Present Value

(NORTH PROJECT AREA)

Alternative	PV Total Benefits	PV Total Costs	PV Total Net Benefits	
11/50	$108.1	$ 93.7	$ 14.4	
13/25	$110.6	$ 95.8	$ 14.8	
13/50	**$115.6**	**$ 99.1**	**$ 16.5**	**(NED Plan)**
15/50	$117.7	$105.0	$ 12.7	
13/100	$116.4	$106.4	$ 10.0	

Table 10 (continued)

Benefits and Costs for Beach Erosion and Hurricane Protection Alternatives
(In Million of Dollars)

BEACH EROSION AND HURRICANE PROTECTION PLANS
(BERM AND DUNE)
(TOTAL PROJECT AREA)

Alternative	PV Total Benefits	PV Total Costs	PV Total Net Benefits	
11/50	$428.7	$223.8	$204.9	
13/25	$434.0	$229.9	$204.1	
13/50	**$458.2**	**$241.2**	**$217.0**	**(NED Plan)**
15/50	$473.0	$260.6	$212.4	
13/100	$463.3	$265.5	$197.8	

RATIONALE FOR DESIGNATION OF NED PLAN AND PLAN SELECTION

All plans considered for the project area would control progressive erosion and minimize permanent land losses. All plans would, to varying extents, reduce damages to structures caused by short-term, storm-induced erosion. The berm and dune plans would also reduce damages due to overwash during storms. All plans are considered to be environmentally acceptable. As discussed previously, the National Objective for Federal water resources projects is to contribute to the National Economic Development. The plan which maximizes this contribution, measured as net economic benefits, is designated the "National Economic Development Plan". Unless there are other, overriding considerations that favor an alternative plan, the NED plan will be the plan selected for implementation.

As shown in table 10 and figures 5 and 6 present value net benefits are maximized with the 13-foot dune and 50-foot wide berm alternative. This plan of improvement is considered to be consistent to the maximum extent practicable under current Federal planning guidelines. Therefore, the District Engineer has concluded that there are no overriding considerations that would justify recommendation of a plan other than the NED Plan.

Dare County Beaches - South Project
Net Benefits vs Initial Construction Volume

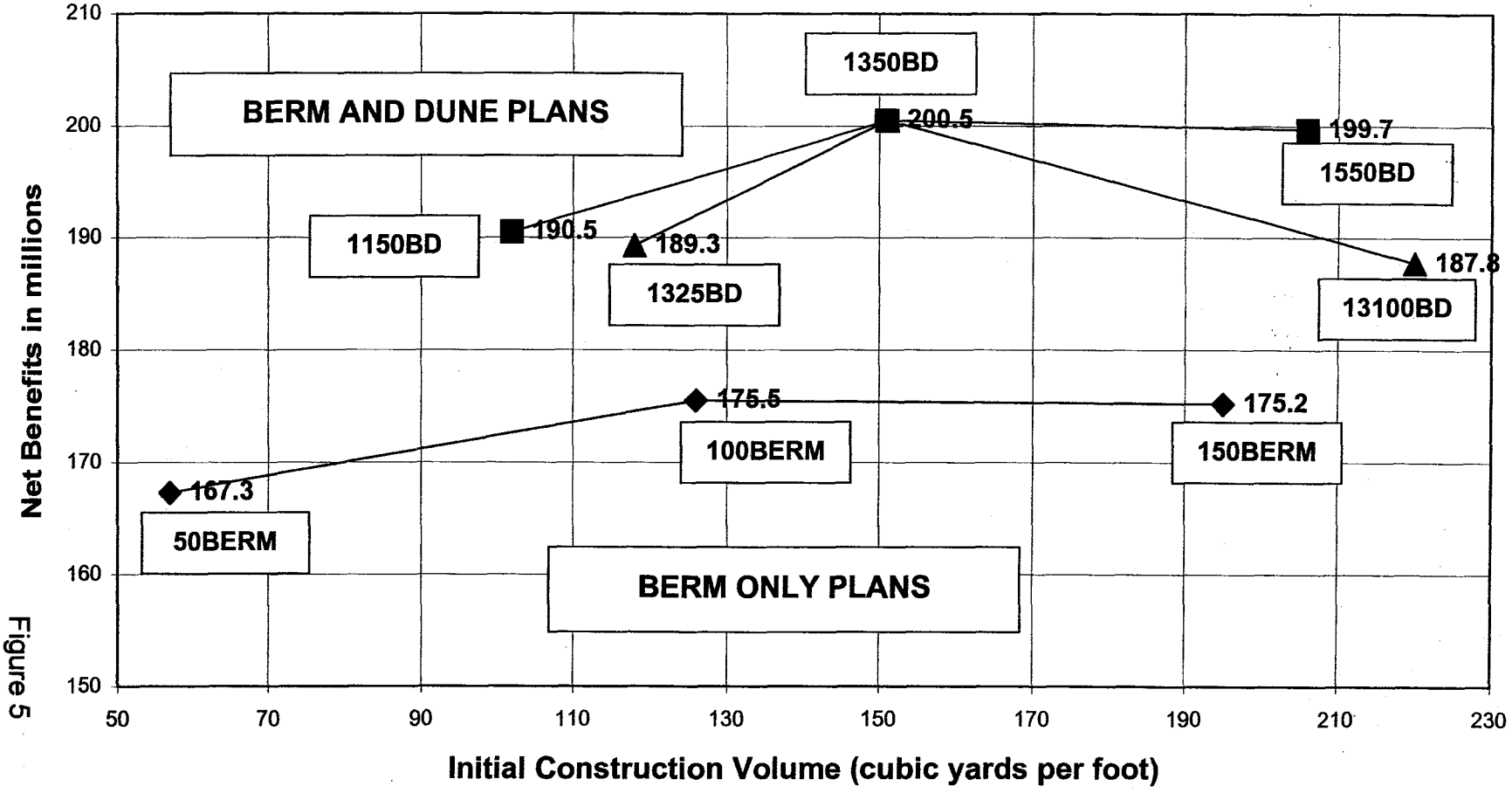


Figure 5

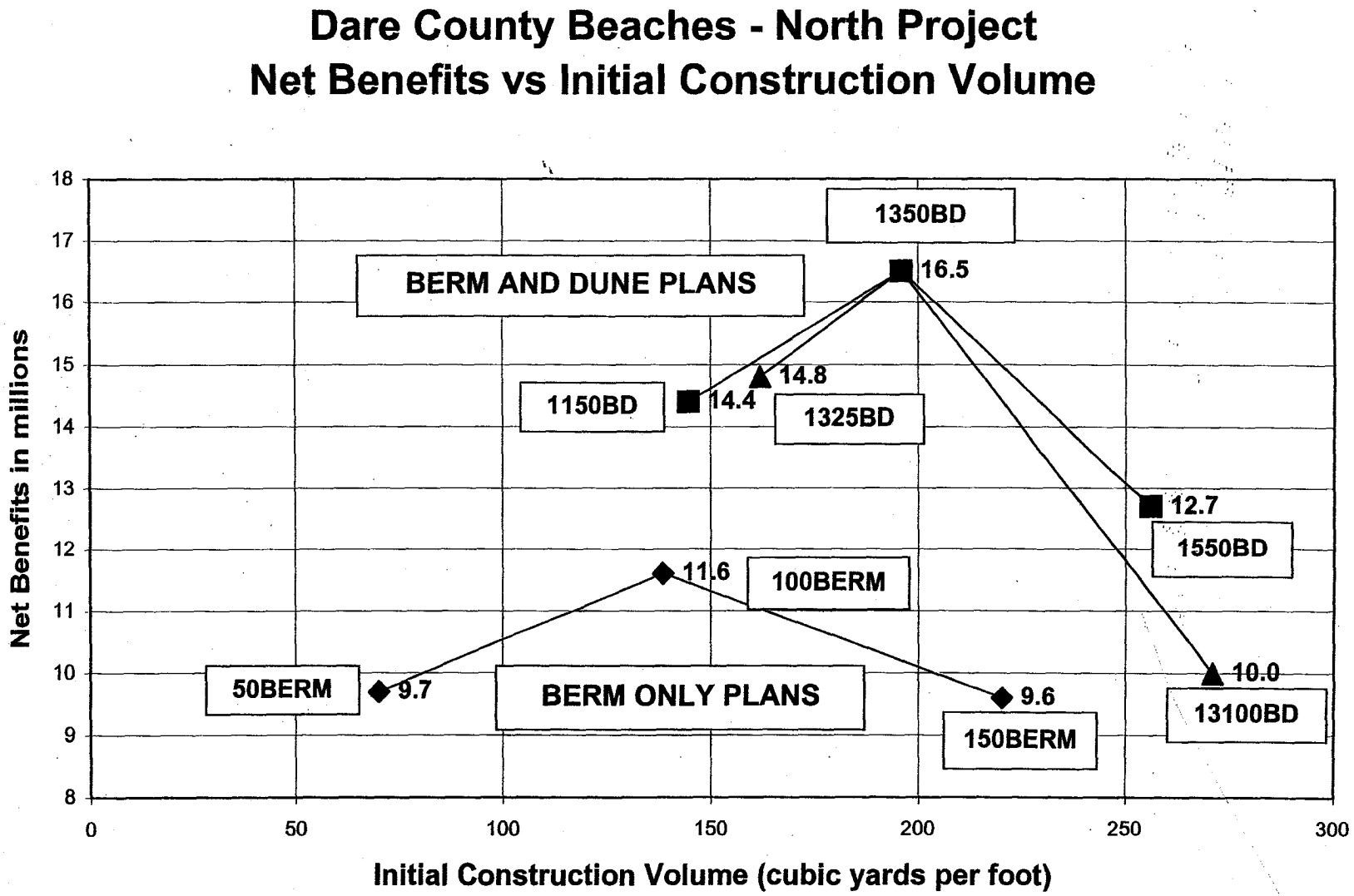

Dare County Beaches - North Project
Net Benefits vs Initial Construction Volume
Net Benefits in millions
Initial Construction Volume (cubic yards per foot)
18
17
16
15
14
13
12
11
10
9
8
0
50
100
150
200
250
300
BERM AND DUNE PLANS
1350BD
16.5
1150BD
14.4
14.8
1325BD
12.7
1550BD
10.0
13100BD
100BERM
11.6
50BERM
9.7
BERM ONLY PLANS
9.6
150BERM

Figure 6

SECTION VI - SELECTED PLAN OF IMPROVEMENT

The purpose of this report section is to centralize information concerning the Selected Plan of Improvement. The Selected Plan is discussed in terms of (1) Plan Features, (2) Construction and Operation, (3) Plan Accomplishments, (4) Plan Impacts, (5) Public Views and (6) Plan Implementation.

PLAN FEATURES

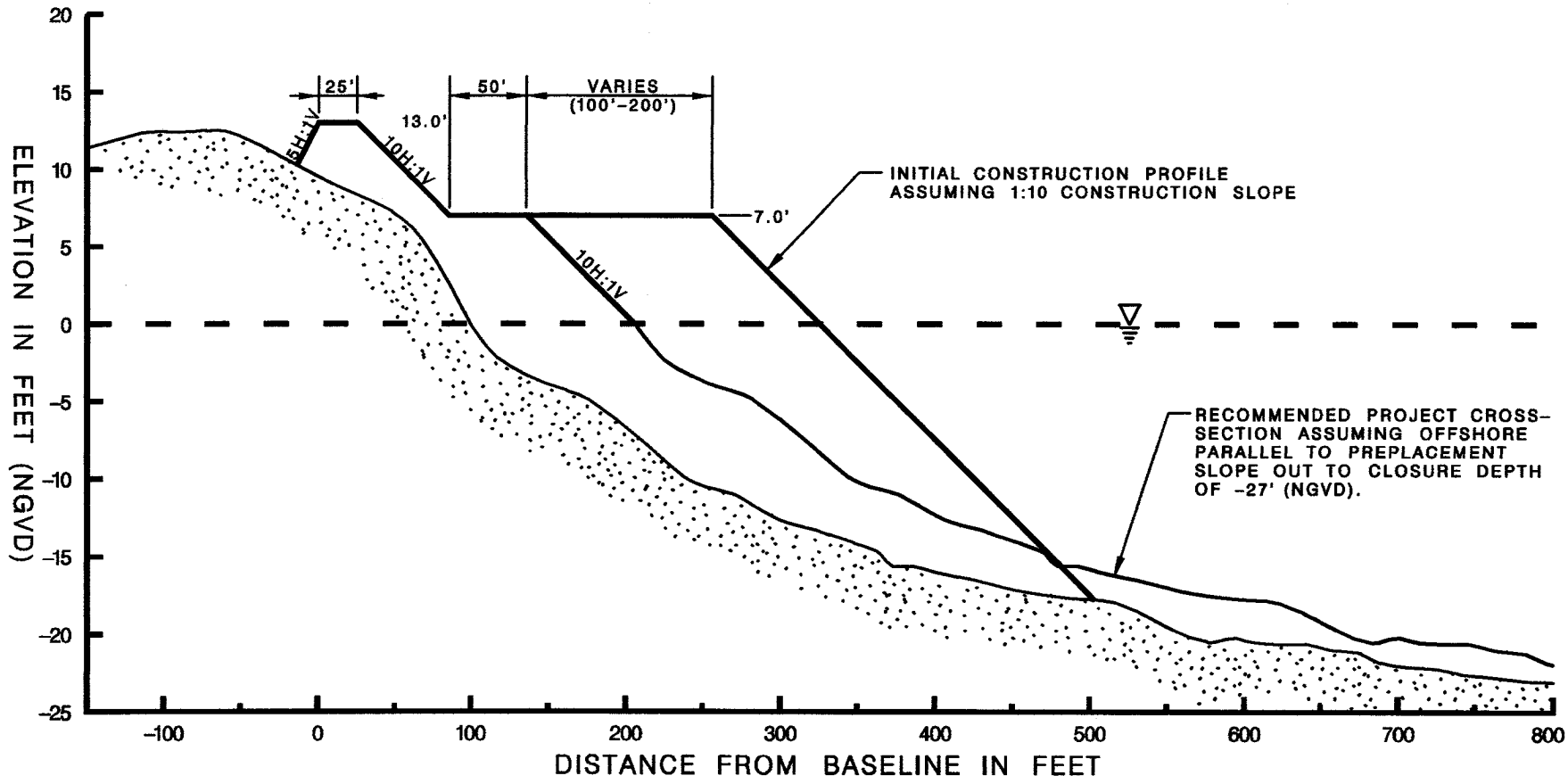
The Selected Plan of Improvement for the project area includes a 13-foot NGVD dune and a 7-foot NGVD berm. Project dimensions are shown on figure 7 and described in detail in appendix D. The berm and dune project will extend along the reaches shown on plate 1. The total length of the main fill will be 47,490 feet along the South Project Area and 15,900 feet along the North Project Area. There will be 3,000-foot transitions on each end of the main fills except for the south transition on the south project which will be 2,850 feet.

PROJECT CONSTRUCTION AND OPERATION

Initial construction will require approximately 8,040,000 cubic yards of sand for the South Project Area and 4,300,000 cubic yards for the North Project Area. Initial construction for the total project will require 12,340,000 cubic yards. The material will be pumped to the beach by pipeline dredge and shaped on the beach by earth moving equipment. Initial construction will take three years to complete. As shown on figure 8, the North Project Area will be constructed in FY 2004 and the South Project Area will be constructed in three equal stages. The South Project (Middle Segment) will be constructed in FY 2004, the South Project (Southern Segment) will be constructed in FY 2005, and the South Project (Northern Segment) will be constructed in FY 2006. The time sequence for constructing the South Project was based on erosion rates and longshore transport rates. It was also based on breaking up the nourishment are so that adjacent segments would not be nourished at the same time to allow for recovery of beach organisms.

Periodic nourishment will require approximately 2,835,000 cubic yards of sand for the South Project Area and 1,055,000 cubic yards for the North Project Area. The material will be pumped to the South Project Area by pipeline dredge and to the North Project Area by hopper dredge with pump out capability.

A periodic nourishment operation will occur every year along some segment of the project area, with each segment being nourished on a three-year cycle. The periodic nourishment cycle considerations included: borrow source distance; type of dredge equipment needed; dredge equipment availability; environmental windows; and timely restoration to maintain the protective capability of the beachfill. The schedule for periodic nourishment is shown on figure 9.



13.0' DUNE WITH 50' BERM
TYPICAL CONSTRUCTION PROFILE

Figure 7

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Initial Construction

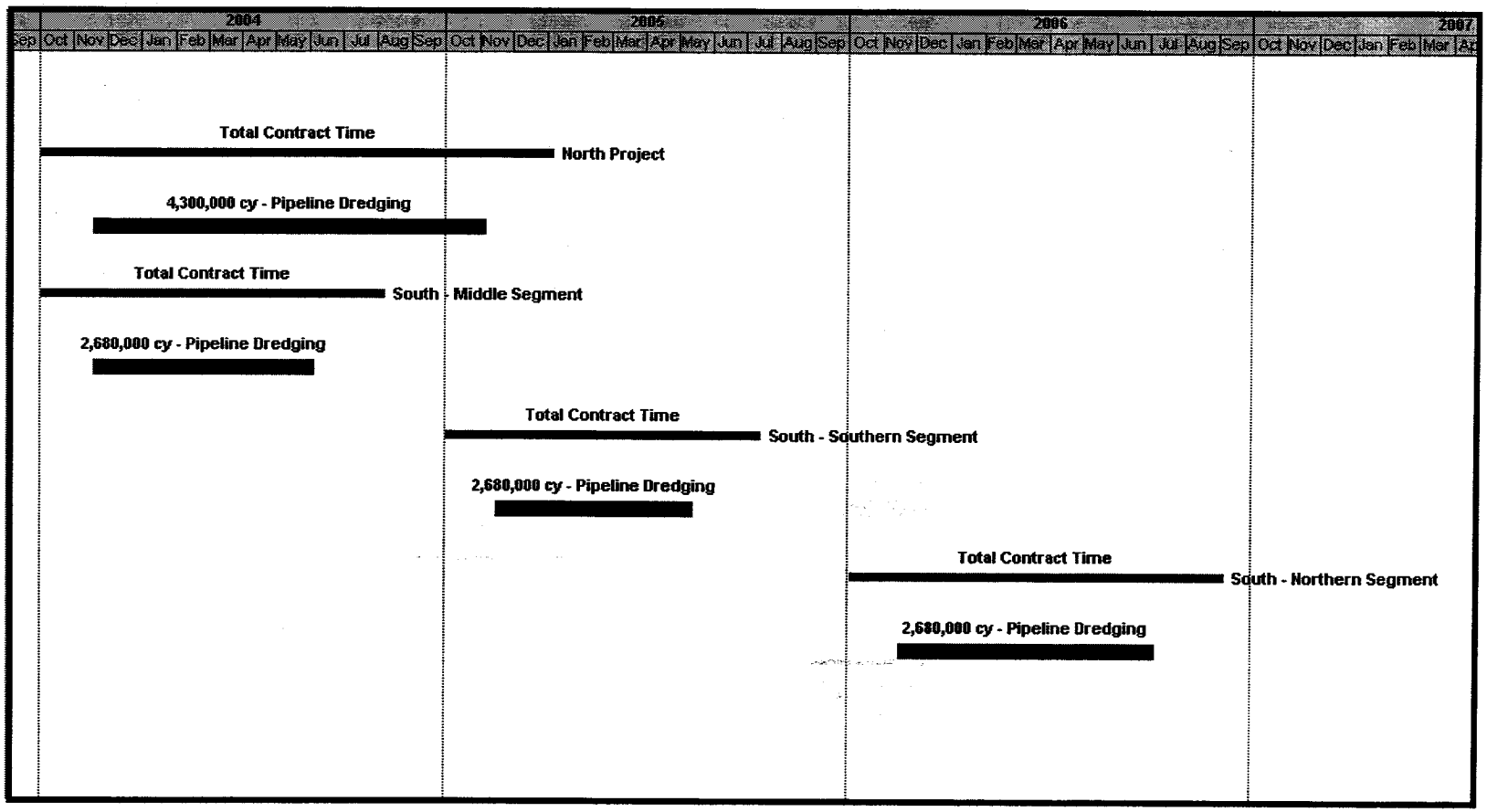

Figure 8

Periodic Nourishment

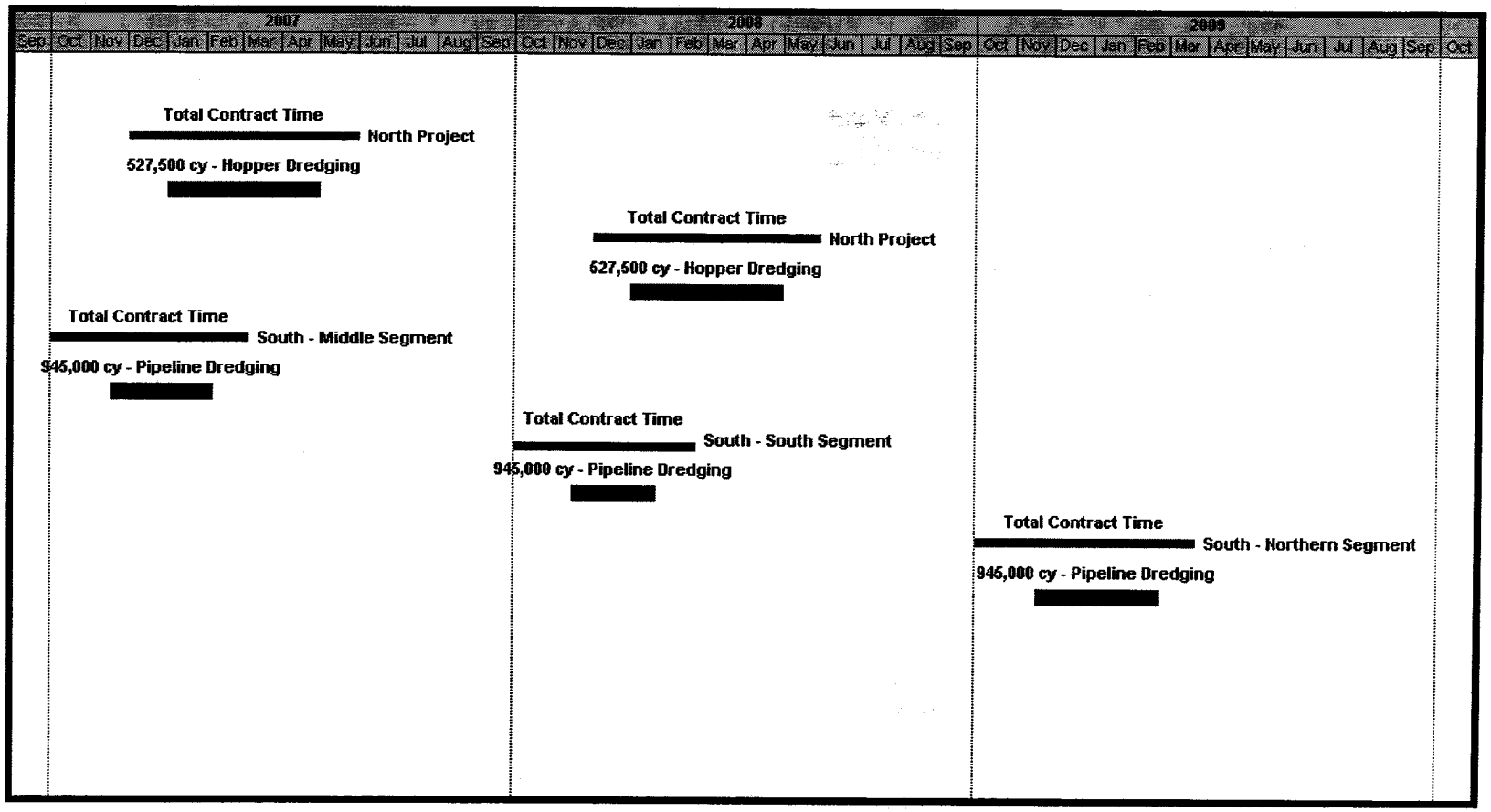

Figure 9

BORROW AREAS AND FILL MATERIAL

Potential borrow areas for beachfill are located offshore, beyond the -30-foot NGVD contour and inside the 3-mile nautical limit as shown on plate 1. See appendices D and I for average bottom depths for the potential borrow areas, descriptions for borrow area shapes, and procedures used to determine the location of the borrow areas. Based on grain size analysis of samples taken in these areas, several of the potential borrow areas contain good quality beach sand (see table 11 for compatibility analysis).

The amount of silt in the borrow areas is minimal, constituting 5 percent of the total volume of material in borrow area S1 and 9 percent of the total volume of material in borrow area N1, and 6 percent of the total volume of material in borrow area N2. The material in the southern borrow area (S-1) and the northern borrow areas (N1 and N2) is ideal for beach nourishment with less than 10 percent in fines.

Borrow site S1 will be the major source of sand for the initial construction of the South Project Area and has an overfill ratio of 1.1 (overfill ratio equals the number of cubic yards from the borrow area that is needed to match 1.0 cubic yard of fill on the beach). Borrow site N1 will be the major source of sand for the initial construction of the North Project Area and has an overfill ratio of 1.5. The 1.1 and 1.5 overfill factors for S1 and N1 respectively include allowance for expected losses of the silt and clay content. These losses will occur immediately upon discharge from the dredge pipe. The overfill factors also include the extra volume of sand needed to be eventually sorted into a distribution comparable to the native beach sand. For borrow areas S1 and N1, 5 percent and 9 percent of the dredged material will be placed in suspension and transported out of the placement area during the placement operation. The volume of material remaining on the beach immediately following placement will be reworked (sorted) by wave action into a distribution of material sizes from the berm crest seaward to closure depth that will closely mimic the native material distribution. This sorting process will take several months to occur and will result in the removal of the remaining excess material from the design template. Generally, the material removed by this sorting action will be the finer fraction of the sandy material which will be transported to offshore depths greater than 27 feet below NGVD. Borrow site S1 will be the major source of sand for periodic nourishment for both the South and the North Project Areas. Borrow site utilization is shown on table 12.

Table 11

Sand Compatibility Analysis

(Borrow Site Material Placed on Native Beach Material)

NATIVE BEACH MATERIAL

Project Area	Mean (mm)	Std Dev (Phi)
North Project	0.31	1.50
South Project	0.26	1.52

BORROW MATERIAL

Borrow Site	% Silt	Mean (mm)	Std Dev (Phi)	Overfill Ratios (N. Proj)	Overfill Ratios (S. Proj)	Final Overfill Ratios (Corrected for Silt Content) (N. Proj)	Final Overfill Ratios (Corrected for Silt Content) (S. Proj)
N1	9	0.22	1.93	1.3	1.2	**1.5**	1.3
N2	6	0.24	1.52	1.3	1.0	1.4	1.1
S1	5	0.34	1.43	1.0	1.0	**1.1**	**1.1**
S2	11	0.24	1.83	1.2	1.1	1.4	1.3
S3	13	0.21	1.27	2.0	1.2	2.8	1.7

Table 12

Borrow Site Utilization

Borrow Site	Borrow Site Volume (cu yd)	Initial Construction (cu yd)	Periodic Nourishment (50-years) (cu yd)	Total Utilized (cu yd)	Percent Utilized
N1	5,192,000	4,300,000 (NP)		4,300,000	83
S1	104,454,000	8,040,000 (SP)	62,240,000	70,280,000	67
Totals		12,340,000	62,240,000	74,580,000	

Note: "NP" denotes North Project and "SP" denotes South Project

DUNE STABILIZATION

The dune portion of the project will be stabilized against wind losses by planting appropriate beach grasses. In general, American Beach Grass will be used in combination with sea oats to cover the entire surface of the dune from the landward toe to the point of intersection with the beach berm (see figure 7).

BEACH ACCESS

There are 46 public access facilities within the limits of the proposed project which includes 31 for the South Project Area and 15 for the North Project Area. The local governments have made providing public access a priority and have never attempted to preclude public access within the primary study area. Public access and parking within the project area far exceeds the State of North Carolina's requirements for publicly financed beach nourishment projects. However, a public access point every one half-mile is a general Corps of Engineers standard, but not a rigid requirement. There are three areas within the South Project Area and one area within the North Project Area where no public access exists for more than one-half mile. The adequacy of public access will be revisited before the signing of a Project Cooperation Agreement. If additional access points and parking are deemed necessary, the Wilmington District and local sponsor will work together on the local sponsor's plan to provide these. Ultimately, the local sponsor will be responsible for providing adequate parking and access.

REAL ESTATE REQUIREMENTS

Real estate requirements for the Selected Plan of Improvement include lands, easements, rights-of-way and relocations, and disposal/borrow areas, which are referred to as LERRD's. Real estate requirements in each of these categories are discussed on the following page followed by a summary of estimated real estate costs. There are improvements that will be affected by the proposed project; this includes the acquisition of eight homes, one swimming pool, and one outbuilding. There will be no utility relocations. There are no existing Federal projects within the acquisition area.

Borrow Areas - Borrow areas are located in the ocean beyond the -30-foot NGVD contour and inside the 3-mile nautical limit (see plate 1). Borrow area N1 is located approximately 1.5 miles east of the North Project Area and borrow area S1 is located approximately 3 miles southeast of the South Project Area. These borrow areas cover about 7 square miles of sandy ocean bottom (see appendix I for detailed information on borrow areas). Permits for the sand removal from these offshore borrow areas will be required from appropriate state and/or federal agencies.

Pipeline Rights of Way - Material for initial project construction and beach nourishment will be dredged by pipeline dredge and hopper dredge from the offshore borrow areas described above, then moved by pipeline to the beach. The pipeline will be routed along the ocean shoreline.

Construction Area - The project limits for the South Project Area will extend from the southern town limits of Nags Head, northward along the beach a distance of 53,340 feet (see plate 1). The project limits for the North Project Area will extend from a point 3,500 feet south of First Street in Kill Devils Hill northward along the beach a distance of 21,900 feet. These distances include 3,000-foot transitions at each end of the main fills except for the south end of the south project which will include a 2,850-foot transition. As discussed below, real estate requirements include lands required for project construction.

The main fill for the South Project Area will extend from 800 feet south of Altoona Street to a point 200 feet north of Nags Head Pier in Nags Head (see plate 1). The main fill for the North Project Area will extend from a point 500 feet south of First Street in Kill Devil Hills to a point near Kitty Hawk Road in Kitty Hawk. As stated above, the total distance, which includes transitions, is 53,340 feet for the South Project Area and 21,900 feet for the North Project Area. The estate to be acquired for the project will be a perpetual beach storm reduction easement for approximately 969 properties, as well as P.L. 91-646 requirements for the acquisition of 8 homes, one swimming pool, and one outbuilding which are located within the project area. Improvements include 31 walkovers in the South Project Area and 15 walkovers in the North

Project Area. This will restrict access to the beach to wooden walkover structures; the town governments will control location and manner of construction.

Cost Summary, Real Estate Requirements - Estimated real estate costs for the Selected Plan of Improvement are shown in table 13. The term "offsetting benefits," as used in the real estate easement cost computation (see appendix J). Refer to lands which will be enhanced by project implementation; since this increase in value is not greater than the easement cost, the net value is assigned to the easement cost as shown in table 13

Table 13

Real Estate Requirements
13-foot NGVD Dune with 50-foot wide Berm

SOUTH PROJECT AREA

Lands - Easements (679 Ownership's)	$770,029
Improvements	330,500
Mineral Rights	0
Damages	0
Utility Relocations	0
P.L 91-646 Relocation Costs	5,250
Acquisition Cost - Admin (679 Ownership's)	1,935,150
(Federal $237,650)	
(Non-Federal $1,697,500)	
Project Cooperation Agreement	0
Sub-Total	$3,040,929
Contingencies (25%)	$ 760,232
Total Estimated Real Estate Cost	$3,801,161
	($3,801,000)

NORTH PROJECT AREA

Lands - Easements (290 Ownership's)	$228,721
Improvements	203,900
Mineral Rights	0
Damages	0
Utility Relocations	0
P.L 91-646 Relocation Costs	2,850
Acquisition Cost - Admin (290 Ownership's)	826,500
(Federal $101,500)	
(Non-Federal $725,000)	
Project Cooperation Agreement	0
Sub-Total	$1,262,271
Contingencies (25%)	$ 315,568
Total Estimated Real Estate Cost	$1,577,839
	($1,578,000)

Table 13 (continued)

Real Estate Requirements
13-foot NGVD Dune with 50-foot wide Berm

TOTAL PROJECT AREA

Lands - Easements (969 Ownerships)	$998,750
Improvements	534,400
Mineral Rights	0
Damages	0
Utility Relocations	0
P.L 91-646 Relocation Costs	8,400
Acquisition Cost - Admin (969 Ownerships)	2,761,650
(Federal $339,150)	
(Non-Federal $2,422,500)	
Project Cooperation Agreement	0
Sub-Total	$4,303,200
Contingencies (25%)	$1,075,800
Total Estimated Real Estate Cost	$5,379,000

OPERATION AND MAINTENANCE

The principal task, from a cost standpoint, for operation of the project will be periodic beach nourishment. Costs for this item is shown on table 16.

PLAN ACCOMPLISHMENTS

The Selected Plan of Improvement reduces expected annual damages to structures due to hurricane-wave action and storm induced erosion. It also reduces damages to property including NC 12 due to long-term progressive erosion. As shown in table 3, existing expected annual damages for hurricane and storm damage are estimated at $37,860,000 without a Federal project in place in the Primary Study Area. This includes $26,850,000 for Nags Head, $6,380,000 for Kill Devil Hills, and $4,630,000 for Kitty Hawk. With the Selected Plan in place, as shown in table 14, expected annual benefits for hurricane and storm damage reduction are estimated at $27,348,000 for the Total Project Area. This includes $21,351,000 for the South Project Area in Nags Head and $5,997,000 for the North Project Area in Kill Devil Hills and Kitty Hawk. Thus, as stated above, the Selected Plan would reduce hurricane and storm damages by an expected annual amount of $27,348,000 for the 20-mile-long Primary Study Area, or about 72 percent. The effectiveness of the Selected Plan in reducing hurricane and storm damages for the

Total Project Area (North Project Area plus South Project Area) is approximately 84 percent.

Although the plan will substantially reduce damages due to hurricane-wave overwash, it should be noted that the Selected Plan of Improvement provides for storm protection only in terms of protecting development from the action of ocean storm surge and wave action. There are no provisions in the project to protect the area against storm-tide flooding occurring from increased water levels in the estuary backing the barrier island.

The Selected Plan of Improvement will reduce emergency costs and other damages and will increase the width of beach available for recreation. A summary of economic benefits for the Selected Plan is presented below under "Costs and Benefits."

COSTS AND BENEFITS, SELECTED PLAN

As discussed in the report section on the "Federal Objective," any plan that is to be recommended for implementation as a result of this study must make a positive contribution to the National Economic Development. This contribution is measured by the amount by which project benefits exceed project costs. Benefits are discussed below.

BENEFITS

Total expected annual benefits for the Selected Plan are estimated at $35,402,000 based on October 1999 price levels. This includes $26,093,000 for the South Project Area and $9,310,000 for the North Project Area. An itemized listing of expected annual benefits is presented in table 14.

Table 14

Expected Annual Benefits for Selected Plan of Improvement,
13-foot NGVD Dune with 50-foot wide Berm
(6-5/8 percent interest rate, October 1999 price levels,
50-year period of analysis)

SOUTH PROJECT AREA

Benefit Category	Expected Annual Benefit
Hurricane and Storm Damage Reduction	$21,351,000
Emergency Costs and Other Damage Reduction	$ 361,000
Recreation	$ 1,944,000
Sub Total Annualized Benefits	$23,656,000
Benefits During Construction	$ 2,436,000
TOTAL EXPECTED ANNUAL BENEFITS, SELECTED PLAN OF IMPROVEMENT SOUTH PROJECT AREA	$26,092,000

NORTH PROJECT AREA

Benefit Category	Expected Annual Benefit
Hurricane and Storm Damage Reduction	$ 5,997,000
Emergency Costs and Other Damage Reduction	$ 140,000
Recreation	$ 1,844,000
Sub Total Annualized Benefits	$ 7,981,000
Benefits During Construction	$ 1,329,000
TOTAL EXPECTED ANNUAL BENEFITS, SELECTED PLAN OF IMPROVEMENT NORTH PROJECT AREA	$ 9,310,000

Table 14 (continued)

Expected Annual Benefits for Selected Plan of Improvement,
.13-foot NGVD Dune with 50-foot wide Berm
(6-5/8 percent interest rate, October 1999 price levels,
50-year period of analysis)

TOTAL PROJECT AREA

Benefit Category	Expected Annual Benefit
Hurricane and Storm Damage Reduction	$27,348,000
Emergency Costs and Other Damage Reduction	$ 501,000
Recreation	$ 3,788,000
Sub Total Annualized Benefits	$31,637,000
Benefits During Construction	$ 3,765,000
TOTAL EXPECTED ANNUAL BENEFITS, SELECTED PLAN OF IMPROVEMENT TOTAL PROJECT AREA	$35,402,000

As shown above, total expected annual benefits for the Selected Plan are estimated at $35,402,000. This includes $26,092,000 for the South Project Area and $9,310,000 for the North Project Area. If the plan is to be recommended for implementation, expected annual costs must be less than this amount. Project costs are discussed below.

PROJECT COSTS

Determination of the economic costs of the Selected Plan consists of three basic steps. First, project first costs are computed. First costs include expenditures for project design and initial construction and related costs of supervision and administration. First costs also include the lands, easements, and rights of way for initial project construction and periodic nourishment.

Second, interest during initial construction is added to the project first cost. Interest during initial construction is computed from the start of PED through the 3 year initial construction period. The project first cost plus interest during initial construction represents the total investment required to place the project into operation.

Third, expected annual costs are computed. These costs consist of interest and amortization of the initial investment, and the annual cost of project operation, maintenance, and nourishment. The expected annual costs provide a basis for comparing project costs to project benefits. A summary of the computations involved in each of these three steps is presented below.

Project First Costs - The total first cost of initial construction for the Selected Plan is estimated at $71,674,000, based on October 1999 price levels. This includes $48,961,000 for the South Project Area and $22,713,000 for the North Project Area. An itemized listing of first costs is presented in table 15.

Table 15

PROJECT COST SUMMARY
FEASIBILITY REPORT
DARE COUNTY BEACHES, NORTH CAROLINA
OCTOBER 1999 PRICE LEVEL

SOUTH PROJECT AREA

13-FT NGVD DUNE WITH 50-FOOT WIDE BERM

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY	TOTAL COST
01	LANDS AND DAMAGES				$3,041,000	$760,000	$3,801,000
17	BEACH REPLENISHMENT						
17.00	Beach Replenishment						
17.00.01	Mobilization, Demobilization, and Preparatory Work						
	Middle Segment	1	JOB	LS	1,273,000	255,000	1,528,000
	Southern Segment	1	JOB	LS	1,191,000	238,000	1,429,000
	Northern Segment	1	JOB	LS	1,417,000	283,000	1,700,000
17.00.16	Pipeline Dredging						
	Middle Segment	2,680,000	CY	$3.10	8,308,000	1,662,000	9,970,000
	Southern Segment	2,680,000	CY	$2.60	6,968,000	1,394,000	8,362,000
	Northern Segment	2,680,000	CY	$3.70	9,916,000	1,983,000	11,899,000
17.00.70	Beach fill						
	Middle Segment	2,680,000	CY	$0.40	1,072,000	214,000	1,286,000
	Southern Segment	2,680,000	CY	$0.30	804,000	161,000	965,000
	Northern Segment	2,680,000	CY	$0.40	1,072,000	214,000	1,286,000
17.00.99	Associated General Items						
17.00.99.01	Dune Vegetation	120	ACR	$8,000	960,000	192,000	1,152,000
17.00.99.02	Public Dune Walkovers	31	EA	$30,000	930,000	186,000	1,116,000
17.00.99.03	Beach Tilling	130	ACR	$200	26,000	5,000	31,000
17.00.99.04	Extension of Storm Drains	1	JOB	LS	175,000	35,000	210,000
	TOTAL, BEACH REPLENISHMENT				$34,112,000	$6,822,000	$40,934,000
30	PLANNING, ENGINEERING, AND DESIGN				$2,072,000	$414,000	$2,486,000
31	CONSTRUCTION MANAGEMENT				$1,450,000	$290,000	$1,740,000
	TOTAL COST - SOUTH PROJECT AREA				$40,675,000	$8,286,000	$48,961,000

Note: Beach Tilling is for the purpose of loosening the sand fill set, which hardens and makes nesting by sea turtles difficult.

Table 15 (continued)

PROJECT COST SUMMARY
FEASIBILITY REPORT
DARE COUNTY BEACHES, NORTH CAROLINA
OCTOBER 1999 PRICE LEVEL

NORTH PROJECT AREA

13-FT NGVD DUNE WITH 50-FOOT WIDE BERM

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY	TOTAL COST
01	LANDS AND DAMAGES				$1,262,000	$316,000	$1,578,000
17	BEACH REPLENISHMENT						
17.00	Beach Replenishment						
17.00.01	Mobilization, Demobilization, and Preparatory Work	1	JOB	LS	1,188,000	238,000	1,426,000
17.00.16	Pipeline Dredging	4,300,000	CY	$3.00	12,900,000	2,580,000	15,480,000
17.00.70	Beach fill	4,300,000	CY	$0.40	1,720,000	344,000	2,064,000
17.00.99	Associated General Items						
17.00.99.01	Dune Vegetation	40	ACR	$8,000	320,000	64,000	384,000
17.00.99.02	Public dune Walkovers	15	EA	$30,000	450,000	90,000	540,000
17.00.99.03	Beach Tilling	50	ACR	$200	10,000	2,000	12,000
	TOTAL, BEACH REPLENISHMENT				$16,588,000	$3,318,000	$19,906,000
30	PLANNING, ENGINEERING, AND DESIGN				$820,000	$164,000	$984,000
31	CONSTRUCTION MANAGEMENT				$204,000	$41,000	$245,000
	TOTAL COST - NORTH PROJECT AREA				$18,874,000	$3,839,000	$22,713,000

Note: Beach Tilling is for the purpose of loosening the sand fill set, which hardens and makes nesting by sea turtles difficult.

Table 15 (continued)

PROJECT COST SUMMARY
FEASIBILITY REPORT
DARE COUNTY BEACHES, NORTH CAROLINA
OCTOBER 1999 PRICE LEVEL

TOTAL PROJECT AREA

13-FT NGVD DUNE WITH 50-FOOT WIDE BERM

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY	TOTAL COST
01	LANDS AND DAMAGES				$4,303,000	$1,076,000	$5,379,000
17	BEACH REPLENISHMENT						
17.00	Beach Replenishment						
17.00.01	Mobilization, Demobilization, and Preparatory Work	1	JOB	LS	5,069,000	1,014,000	6,083,000
17.00.16	Pipeline Dredging	12,340,000	CY		38,092,000	7,619,000	45,711,000
17.00.70	Beach fill	12,340,000	CY		4,668,000	933,000	5,601,000
17.00.99	Associated General Items						
17.00.99.01	Dune Vegetation	160	ACR	$8,000	1,280,000	256,000	1,536,000
17.00.99.02	Public dune Walkovers	46	EA	$30,000	1,380,000	276,000	1,656,000
17.00.99.03	Beach Tilling	180	ACR	$200	36,000	7,000	43,000
17.00.99.04	Extension of Storm Drains	1	JOB	LS	175,000	35,000	210,000
	TOTAL, BEACH REPLENISHMENT				$50,700,000	$10,140,000	$60,840,000
30	PLANNING, ENGINEERING, AND DESIGN				$2,892,000	$578,000	$3,470,000
31	CONSTRUCTION MANAGEMENT				$1,654,000	$331,000	$1,985,000
	TOTAL COST - NORTH AND SOUTH PROJECT AREAS				$59,549,000	$12,125,000	$71,674,000

Note: Beach Tilling is for the purpose of loosening the sand fill set, which hardens and makes nesting by sea turtles difficult.

Interest During Initial Construction - Interest during initial construction, computed over PED and the 3-year initial construction period, is established at $5,920,000 for the South Project Area, $4,181,000 for the North Project Area, and $10,101,000 for the Total Project Area. Thus, the total investment required to place the project into operation would be $54,881,000 for the South Project Area, $26,894,000 for the North Project Area, and $81,775,000 for the Total Project Area. The investment cost for the South Project Area includes $5,920,000 for interest during initial construction, $4,181,000 for the North Project Area, and $10,101,000 for the Total Project Area.

Expected Annual Costs - Expected annual costs include interest and amortization of the initial investment over an assumed project life of 50 years. Operation, maintenance, and periodic nourishment costs are also included. As shown in table 16, expected annual costs for the Selected Plan of Improvement are estimated at $10,922,000 for the South Project Area, $7,313,000 for the North Project Area, and $18,235,000 for the Total Project Area.

Table 16

Expected Annual Costs for Selected Plan of Improvement
13-foot NGVD Dune Section with 50-foot wide Berm
(6-5/8 percent interest rate, 50-year period of analysis)

South Project Area

Item	Expected Annual Cost
Interest & Amortization of Initial Investment	$3,789,200
Periodic Nourishment	6,521,800
Other Annual Costs	600,000
Annual Environmental Monitoring	10,800
TOTAL EXPECTED ANNUAL COST, SELECTED PLAN OF IMPROVEMENT SOUTH PROJECT AREA	$10,921,800 ($10,922,000)

Table 16 (continued)

Expected Annual Costs for Selected Plan of Improvement
13-foot NGVD Dune Section with 50-foot wide Berm
(6-5/8 percent interest rate, 50-year period of analysis)

North Project Area

Item	Expected Annual Cost
Interest & Amortization of Initial Investment	$1,856,900
Periodic Nourishment	5,251,500
Other Annual Costs	200,000
Annual Environmental Monitoring	4,600
TOTAL EXPECTED ANNUAL COST, SELECTED PLAN OF IMPROVEMENT NORTH PROJECT AREA	$7,313,000 ($7,313,000)

Expected Annual Costs for Selected Plan of Improvement
13-foot NGVD Dune Section with 50-foot Berm
(6-5/8 percent interest rate, 50-year period of analysis)

Total Project Area

Item	Expected Annual Cost
Interest & Amortization of Initial Investment	$5,646,100
Periodic Nourishment	11,773,300
Other Annual Costs	800,000
Annual Environmental Monitoring	15,400
TOTAL EXPECTED ANNUAL COST, SELECTED PLAN OF IMPROVEMENT TOTAL PROJECT AREA	$18,234,800 ($18,235,000)

Benefit-Cost Ratio - The selected plan produces expected annual benefits estimated at $26,093,000 for the South Project Area, $9,310,000 for the North Project Area, and $35,402,000 for the Total Project Area (from table 14). Expected annual costs for the selected plan are estimated at $10,922,000 for the South Project Area, $7,313,000 for the North Project Area, and $18,235,000 for the Total Project Area (from table 16). Thus benefits divided by costs results in a benefit-cost ratio of 2.4 for the South Project Area, 1.3 for the North Project Area, and 1.9 for the Total Project Area. Since project benefits exceed costs, the Selected Plan is considered economically feasible for both the South Project Area and the North Project Area.

EVALUATION OF RISK AND UNCERTAINTY

The purpose of this report section is to evaluate key assumptions, which affect the economic justification of the Selected Plan of Improvement. As discussed below, risk and uncertainty was identified for the basic economic justification of the plan for the South Project Area and the North Project Area.

SENSITIVITY TO DIFFERING ASSUMPTIONS IN STRUCTURAL DATA AND STORM EROSION DISTANCE

The risk of the location of structures and the elevation of structures being inaccurate was examined as well as the storm erosion distance. It was found that applying the risk analysis, the Selected Plan of Improvement for the South Project Area has a 99.9 percent chance of being economically feasible and the North Project Area has a 76.7 percent chance of being economically feasible (see appendix D).

ENVIRONMENTAL IMPACTS

The Selected Plan of Improvement is considered to be environmentally acceptable, although some adverse environmental impacts are anticipated. Significant resources likely to be affected by the Selected Plan include biological resources, water quality, aesthetic values, and threatened species. No effect on cultural resources is anticipated. Anticipated impacts on each resource are discussed below.

IMPACTS ON BIOLOGICAL RESOURCES

Biological resources will be affected by dredging of material for initial project construction and by placement of this material on the beach. These impacts will reoccur as the project is nourished. Primary seasonal occurrences of significant resources are shown on figure 10. Initial construction and periodic nourishment activities will be conducted as shown on figures 8 and 9. Expected impacts on biological resources due to borrow area dredging and fill placement is discussed on the following pages.

Borrow Area Dredging - About 7 square miles of sandy ocean bottom will be affected over the 50-year economic life of the project. Within the borrow areas (see plate 1), existing water depths (greater than -30-foot NGVD) will be deepened, and recolonization of affected areas is expected within 2-3 years. Sample data from the overall borrow areas indicate that benthic oriented organisms inhabit the area. Since stable, productive bottom will be avoided, there should be very little impact associated with the borrow areas.

Surveys found no hardbottom in the proposed borrow areas. Several artificial reefs and potential hardbottom are located about a mile away. Harbottoms will be protected from physical impacts. The sandy material should not cause sedimentation.

No significant impact on biological resources is expected due to piping of dredged material from the ocean borrow areas to the beachfill areas. The pipeline route will extend from the seaward borrow areas to the beach and then will follow the shoreline. Negative impacts associated with pipeline routes will be minor and temporary.

Beachfill Construction - The major impacts associated with this type of operation include:

A. Increased turbidity in the surf zone;

B. Effects on the benthic communities;

During disposal operations, there will be an increase in the turbidity of the surf zone in the immediate area of sand disposition. This increase may cause the temporary displacement of various species of sport fish, causing a negative impact to surf fishing in the area of deposition.

A considerable body of information is available on the effects of dredging on benthic communities and specific environmental consequences of beach nourishment. However, there are some uncertainties on the degree of impacts on certain resources over the long term. Pre- and post-project monitoring will be conducted to address these concerns, as discussed in Section 6.0 in the FEIS.

ENDANGERED AND THREATENED SPECIES

As noted previously, 15 endangered or threatened species are considered likely to occur in the area, that will be affected by beach nourishment. These species include the Finback Whale, Humpback Whale, Right Whale, Sei Whale, Sperm Whale, Blue Whale, Piping Plover, Roseate Tern, Loggerhead Sea Turtle, Kemp's Ridley Sea Turtle, Green Sea Turtle, Hawksbill Sea Turtle, Leatherback Sea Turtle, Shortnose Sturgeon, Seabeach Amaranth. Some of these species may be

affected by initial construction of the Selected Plan of Improvement and subsequent beach nourishment. The dredging window for the endangered and threatened species is shown on figure 10. Potential project impacts to these species are discussed below.

Green Sea Turtle, Loggerhead Sea Turtle, Kemp's Ridley Sea Turtle, and Leatherback Sea Turtle - All of these turtles are known to nest in North Carolina and could nest in the project area. For this reason, they could be affected by initial project construction and beach nourishment.

In order to minimize impacts on nesting sea turtles, nourishment sand should match natural sand as closely as possible. As discussed previously, the material available from the borrow areas, shown on figure 3 and table 11, appears to closely match the existing beach material, and the sea turtles should not be affected by the type of material used for beachfill. Also, beach tilling will be accomplished for the purpose of loosening the sand fill set, which hardens and makes nesting by sea turtles difficult.

Sea turtle monitoring and nest relocation will be required during initial construction since disposal would occur during the sea turtle nesting season (see figure 8). Periodic nourishment will be scheduled to avoid the sea turtle nesting season to the degree practical (see figure 9).

Sea turtles also occur in offshore sites proposed for dredging and may be affected (by take) since hopper dredges may be used for nourishment of the North Project Area. Since hopper dredges may be used for periodic nourishment, Formal Consultation with the National Marine Fisheries Service has been conducted (see attached FEIS).

As noted above, a monitoring and nest relocation program will be implemented when beach nourishment overlaps the nesting season. However, even with this program in place, the possibility of accidental egg loss during nest relocation exists. Therefore, initial project construction and subsequent beach nourishment could affect the loggerhead and green sea turtle.

Piping Plover - Piping plover were documented to feed along the primary study area. This species is most common as a winter resident of the State and frequently uses the surf zone. The project may affect piping plover foraging distribution on the beach since beach food resources may be affected by disposal operations.

Marine Mammals - Marine mammals occur in offshore sites proposed for dredging. It is expected that these species can be detected by use of observers and avoided, therefore a no effect determination is proposed.

PRIMARY SEASONAL OCCURRENCES OF SIGNIFICANT RESOURCES
AND PROPOSED MAINTENANCE DREDGING WINDOW

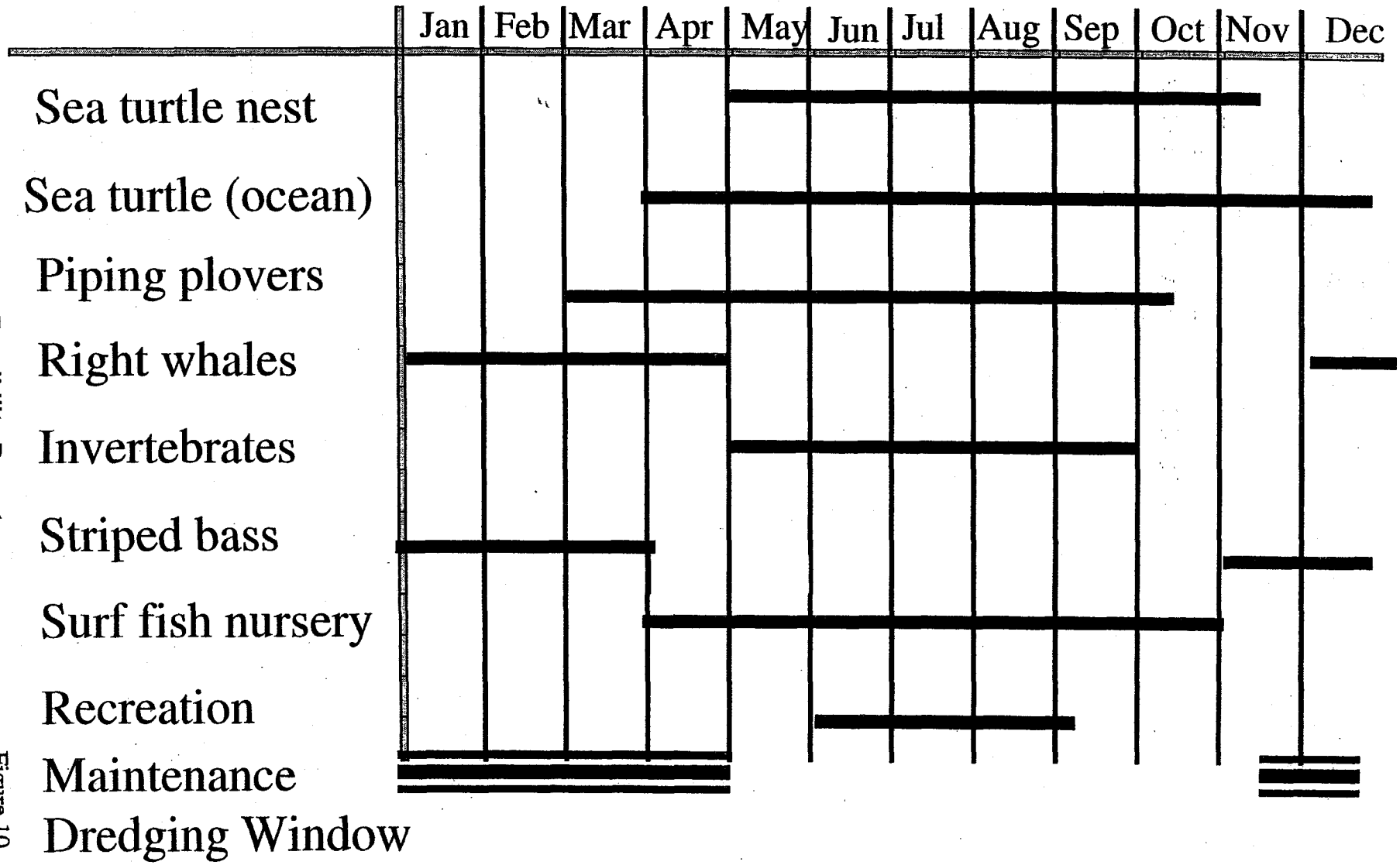

Figure 10

Seabeach Amaranth - The proposed project is potential habitat for seabeach amaranth, but this species was not found during surveys (September 1997 and July 1998) along the beaches proposed for nourishment. However, since this is an annual plant species, surveys would be required prior to each disposal operation. Based on the absence of the species in the project area, it has been determined that the project will not affect seabeach amaranth.

IMPACTS ON WATER QUALITY

The proposed project will result in elevated turbidity and suspended solids compared to the existing non-storm conditions of the surf zone in the immediate area of beachfill. Due to the low percentage of silt and clay in the proposed borrow areas (less than 10 percent), this impact is not expected to be greater than the natural increases in turbidity and suspended material during storm events. Discharge of sediment that is predominantly sand would be required for beach nourishment. Such discharge would occur within the 3-mile limit and therefore would be subject to regulation under Section 404(b)(1) of the Clean Water Act of 1977, as amended and will require a Section 401 (P.L. 95-217) State of North Carolina Water Quality Certificate.

Core samples were obtained at the potential borrow areas to determine if the subsurface sediments are suitable for beach nourishment. The more closely the sediment matches the grain size in the beachfill site, the more likely it will remain in place.

It is expected that beach nourishment would result in turbidity and suspended solids concentrations that are elevated over normal background levels in borrow areas during dredge excavation and in the surf zone in the immediate area of beachfill operation. No other water quality parameters are anticipated to be impacted significantly during dredge excavation and beachfill.

The degree of water quality impacts associated with dredge excavation and beachfill has been evaluated during this study and presented in the attached FEIS. Investigations indicated that suitable material would be used for beachfill, therefore water quality impacts would not be significant.

IMPACTS ON AESTHETIC RESOURCES

Aesthetic impacts of initial project construction are expected to be both positive and negative. The aesthetics of the beach would temporarily be degraded during beach nourishment due to the presence of heavy equipment and pipeline on the beach and elevated turbidity in the surf zone. Noise and exhaust created by the operation of the dredge and other equipment will result in minor increases in noise and air pollution. However, upon completion of the project, the aesthetics and recreational use of the beach should be enhanced due to the wider beach.

IMPACTS ON CULTURAL RESOURCES

Borrow sites were surveyed by magnetometer and side-scan sonar. Beach areas were inspected for exposed shipwrecks. No remains were found. Additional inspections for shipwrecks will be required prior to initial construction.

CUMULATIVE IMPACTS

The proposed project has been addressed in context with all other beach nourishment and beach disposal projects in North Carolina. This evaluation is contained in the FEIS.

SUMMARY OF ENVIRONMENTAL IMPACTS

Adverse environmental impacts associated with the proposed action include (1) Destruction and displacement of intertidal and benthic fauna during initial construction and nourishment operations; (2) temporary increases in turbidity and suspended solids during initial construction and nourishment operations; and (3) possible adverse impacts on threatened species, including the loggerhead sea turtle, green sea turtle, Kemp's ridley sea turtle, and leatherback sea turtle when beachfill placement occurs during the nesting season. A program of monitoring and nest relocation will be implemented to mitigate adverse impacts on the sea turtles when fill placement overlaps the sea turtle nesting season. It is not anticipated that the proposed action will have adverse impacts on the piping plover.

MITIGATION REQUIREMENTS

The term "mitigation requirements," as used herein refers to actions necessary to reduce or compensate for adverse environmental impacts of the project. Overall environmental impacts are expected to be minor, due to the scope, location, and timing of project activities. However, initial construction will occur during the nesting season of the loggerhead sea turtle, green sea turtle, Kemp's ridley sea turtle, and leatherback sea turtle (1 May through 15 November). A beach monitoring and nest relocation program will be implemented to mitigate impacts on these species. Also a program is being proposed to do monitoring for dredging effects as discussed in the FEIS.

POSSIBLE IMPACTS ON SHORE PROCESSES

Shoreline modeling shows that the beach fill for the south project can be expected to spread into the CHNS for about 9,000 feet beyond the transition area under average wave conditions. This would place the extent of the dispersed sand about 9,000 feet south of the CHNS boundary (see appendix D).

In addition, model investigations revealed that the removal of all of the potential borrow material from Borrow Area S1 would increase the net southerly

transport toward Oregon Inlet of about 130,000 cubic yards/year. Since this potential increase in sediment transport is based on the removal of all the suitable material form Borrow Area S1, this increase would not occur until near the end of the 50-year life of the Dare County Beaches project. Also, the Dare County Beaches project would only use 67 percent of the suitable material in S1. Accordingly, this potential increase in littoral transport toward Oregon Inlet is considered to be the "worst case." Assuming that this maximum rate of increase in sediment transport toward Oregon Inlet occurs linearly over the 50-year project period, southward sediment transport would increase by 26,000 cubic yards/year every 10 years. The sediment budget history of Oregon Inlet shows that the ratio of the quantity of material dredged from the inlet to the net sediment transport volume is about 0.5. Applying this ratio to the potential increase in sediment transport, results in the possible increase in of 65,000 cubic yards/year in maintenance dredging of the inlet. Again, this potential shoaling increase would not occur until the end of the 50-year project life of the Dare County Beaches project. Hence, potential increases in shoaling over the project life would be 13,000 cubic yards/year in project year 10, 26,000 cubic yards/year in year 20, 39,000 cubic yards/year in year 30, 52,000 cubic yards/year in year 40, and 65,000 cubic yard/year in year 50. Therefore, project cost increases for this item do not appear to be warranted and should fall within the normal cost contingencies for the project (see appendix D).

PUBLIC VIEWS

The project plan is considered acceptable to local interests. Required coordination related to the environmental permits and entitlements necessary for initial project construction is discussed in detail in the attached FEIS. Local views and the views of the Fish and Wildlife Service as stated in their Final Fish and Wildlife Coordination report are summarized below. Additional views will be received during public and agency coordination of this Final Feasibility Report and Final EIS.

VIEWS OF THE LOCAL SPONSOR

The Selected Plan of Improvement is considered to be acceptable to, and supported by, the local sponsor, Dare County (see "Pertinent Correspondence," appendix A.)

VIEWS OF THE STATE OF NORTH CAROLINA

The State of North Carolina, Department of Environment and Natural Resources, Division of Water Resources, supports the Selected Plan of Improvement.

VIEWS OF THE U.S. FISH AND WILDLIFE SERVICE

Views of the Fish and Wildlife Service are contained in the attached Draft Coordination Act Report (see appendix B). The Service's recommendations and Corps' responses are presented in the FEIS, Section 8.00, Public and Agency Coordination.

SUMMARY OF PLAN EFFECTS

Table 17 provides a summary of project effects. Effects are evaluated in the following categories: (1) National Economic Development (NED), which reflects the plan's economic justification; (2) Environmental Quality, which evaluates the plan's environmental acceptability; (3) Regional Economic Development; and (4) Other Social Effects, including health and safety.

Effects in these four categories encompass significant effects on the human environment as required by the National Environmental Policy Act of 1969, as amended. They also encompass social well being as required by Section 122 of the Flood Control Act of 1970. For purposes of comparison, the effects of the Selected Plan are evaluated against the "without project" or "no action" condition.

Table 17

Summary of Plan Effects

South Project Area

	SELECTED PLAN OF IMPROVEMENT	"NO ACTION"
1. NATIONAL ECONOMIC DEVELOPMENT		
Beneficial Contribution		
Expected Annual Benefits		
Hurricane Storm Damage Reduction	$21,351,000	None
Emergency Costs and Other Damage Reduction	$ 361,000	None
Recreation	$ 1,944,000	None
Benefits During Construction	$ 2,436,000	None
Total Expected Annual Benefits	$26,092,000	
Adverse Contributions		
Expected Annual Costs:		
Interest & Amortization	$ 3,789,200	Continuation of hurricane and storm damages along with damages due to progressive beach erosion.
Periodic Nourishment	$ 6,521,800	
Other Annual Costs	$ 600,000	
Annual Environmental Monitoring	$ 10,800	
Total Exp. Annual Costs South Project Area	$ 10,921,800	
	($ 10,922,000)	

Table 17 (continued)

Summary of Plan Effects

North Project Area

	SELECTED PLAN OF IMPROVEMENT	"NO ACTION"
1. NATIONAL ECONOMIC DEVELOPMENT		
Beneficial Contribution		
Expected Annual Benefits		
Hurricane Storm Damage Reduction	$ 5,997,000	None
Emergency Costs and Other Damage Reduction	$ 140,000	None
Recreation	$ 1,844,000	None
Benefits During Construction	$ 1,329,000	None
Total Expected Annual Benefits	$ 9,310,000	
Adverse Contributions		
Expected Annual Costs:		
Interest & Amortization	$ 1,856,900	Continuation of hurricane and storm damages along with damages due to progressive beach erosion.
Periodic Nourishment	$ 5,251,500	
Other Annual Costs	$ 200,000	
Annual Environmental Monitoring	$ 4,600	
Total Exp. Annual Costs North Project Area	$ 7,313,000	
	($ 7,313,000)	

Table 17 (continued)

Summary of Plan Effects

Total Project Area

	SELECTED PLAN OF IMPROVEMENT	"NO ACTION"
1. NATIONAL ECONOMIC DEVELOPMENT		
Beneficial Contribution		
Expected Annual Benefits		
Hurricane Storm Damage Reduction	$27,348,100	None
Emergency Costs and Other Damage Reduction	$ 501,000	None
Recreation	$ 3,788,000	None
Benefits During Construction	$ 3,765,000	None
Total Expected Annual Benefits	$35,402,000	
Adverse Contributions		
Expected Annual Costs:		
Interest & Amortization	$ 5,646,100	Continuation of hurricane and storm damages along with damages due to progressive beach erosion.
Periodic Nourishment	$11,773,300	
Other Annual Costs	$ 800,000	
Annual Environmental Monitoring	$ 15,400	
Total Exp. Annual Costs	$18,234,800	
Total Project Area	($18,235,000)	

Table 17 (continued)
Summary of Plan Effects
Total Project Area

	SELECTED PLAN OF IMPROVEMENT	"NO ACTION"
2. ENVIRONMENTAL QUALITY		
Beneficial Contribution	None	None
Adverse Contribution		
a. Water Quality and Aquatic Resources	*Increased turbidity during initial construction and periodic nourishment	None
b. Vegetation and Wetlands	*Minimal impact	None
c. Wildlife Habitat	*Destruction and displacement of intertidal and benthic fauna during initial construction and periodic nourishment; effect will be temporary, but will recur over life of project.	None
d. Aesthetic Value	*Minimal impact	Continued loss of aesthetic values of oceanfront as erosion intrudes upon development.
e. Air and Noise Pollution	*Increased noise and air pollution during initial construction and periodic nourishment	None
f. Threatened and Endangered	*Possible adverse impacts on loggerhead sea turtle, green sea turtle, Kemps ridley sea turtle, and leatherback sea turtle. When fill placement occurs during the sea turtle nesting season, a nest monitoring and relocation program will be implemented.	None
g. Cultural Resources	None	None

Table 17 (continued)

Summary of Plan Effects
Total Project Area

	SELECTED PLAN OF IMPROVEMENT	"NO ACTION"
3. REGIONAL ECONOMIC DEVELOPMENT		
Beneficial Contribution		
Increased Income and Employment	*Portion of project cost returned to local economy.	None
Adverse Contributions		
Increased Income and Employment	None	*Potential loss of tourism income due to beach erosion
4. OTHER SOCIAL EFFECTS		
Beneficial Contributions		
Enhancement of community social well being, health and safety	*Reduction of hurricane and storm hazard along with shoreline stabilization is expected to have favorable impact on social well being and safety; net effect not quantified	None
Adverse Contributions		
Enhancement of community social well being, health and safety	*Minor and temporary inconvenience due to construction activities	*Continued threat of erosion along with hurricane and storm damages

*Effect specified in Section 122 of PL 91-611

PROJECT SCHEDULE

Plates 2 and 3 show the schedule for the Selected Project through initial construction. This schedule assumes expeditious review and approval of the project through all steps, including congressional authorization and funding. Actual project implementation could take longer.

DIVISION OF PLAN RESPONSIBILITIES

Federal policy concerning cost sharing for water resources projects requires that project costs be allocated to the various purposes served by the project; these costs are then apportioned between the Federal Government and the non-Federal sponsor according to percentages specified in Federal guidelines. As shown in table 18, all project costs are allocated to the purposes of "shore protection." Under current Federal policy, costs allocated to this category are shared with the Federal Government paying 65 percent and the non-Federal sponsor paying 35 percent for initial construction. For beach nourishment the cost sharing is 50-50. There are no private-use shores.

Table 18

Cost Allocation and Apportionment
13-foot NGVD Dune Section with 50-foot wide Berm

PART I - INITIAL PROJECT CONSTRUCTION

SOUTH PROJECT AREA

Project Purpose	Project First Cost	Apportionment (%) Non-Federal	Federal	Apportionment ($) Non-Federal	Federal
Shore Protection	$48,961,000	35%	65%	$17,136,000	$31,825,000

NORTH PROJECT AREA

Project Purpose	Project First Cost	Apportionment (%) Non-Federal	Federal	Apportionment ($) Non-Federal	Federal
Shore Protection	$22,713,000	35%	65%	$7,950,000	$14,763,000

TOTAL PROJECT AREA

Project Purpose	Project First Cost	Apportionment (%) Non-Federal	Federal	Apportionment ($) Non-Federal	Federal
Shore Protection	$71,674,000	35%	65%	$25,086,000	$46,588,000

Table 18 (continued)

Cost Allocation and Apportionment
13-foot NGVD Dune Section with 50-foot wide Berm

PART II - PERIODIC NOURISHMENT

SOUTH PROJECT AREA

Project Purpose	Cost per Operation	Apportionment (%) Non-Federal	Federal	Apportionment ($) Non-Federal	Federal
Shore Protection	$19,668,000	50%	50%	$9,834,000	$9,834,000

NORTH PROJECT AREA

Project Purpose	Cost per Operation	Apportionment (%) Non-Federal	Federal	Apportionment ($) Non-Federal	Federal
Shore Protection	$15,323,000	50%	50%	$7,661,500	$7,661,500

TOTAL PROJECT AREA

Project Purpose	Cost per Operation	Apportionment (%) Non-Federal	Federal	Apportionment ($) Non-Federal	Federal
Shore Protection	$34,991,000	50%	50%	$17,495,500	$17,495,500

As previously shown, the Federal and non-Federal shares of initial project construction are estimated at $31,825,000 and $17,136,000 respectively for the South Project Area; $14,763,000 and $7,950,000 respectively for the North Project Area; and $46,588,000and $25,086,000 respectively for the Total Project Area. As shown in table 13, the non-Federal share for lands, easements, and rights of way includes $3,801,000 for the South Project Area; $1,578,000 for the North Project Area; and $5,379,000 for the Total Project Area. The remainder will be in the form of a cash contribution. As shown above, costs of periodic nourishment are estimated at $9,834,000 Federal and $9,834,000 non-Federal for the South Project Area; $7,661,500 Federal and $7,661,500 non-Federal for the North Project Area; and $17,495,500 Federal and $17,495,500 non-Federal for the total project area for each periodic nourishment operation. Periodic nourishment is expected to be required at intervals of about 3 years for each beach segment (see figure 9). See appendix H (Table H-11) for cost sharing schedule. Project maintenance, including dune repair, will be the responsibility of the non-Federal sponsor.

SECTION VII - CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

I have given consideration to all significant aspects in the overall public interest, including engineering feasibility and economic, social, and environmental effects. The Selected Plan of Improvement described in this report provides the optimum solution for hurricane and storm damage reduction for the project area, which includes the South Project Area in Nags Head and the North Project Area in Kill Devil Hills and Kitty Hawk.

RECOMMENDATIONS

This study has addressed the needs for hurricane and storm damage protection and beach erosion control for the 20-mile shoreline reach which includes the resort communities of Nags Head, Kill Devil Hills, and Kitty Hawk in Dare County, as requested by the non-Federal sponsor, Dare County. South of Oregon Inlet, along Pea Island, Hatteras Island and Ocracoke Island, a plan of improvement to protect NC 12, will be addressed in a separate report at a later date. The North Carolina Department of Transportation has expressed a willingness to be the non-Federal sponsor for the NC12 interim study.

I recommend that the plan of improvement described herein as the "13-foot NGVD dune, with a 7-foot NGVD (50-foot wide) berm," and selected herein for purposes of hurricane and storm damage reduction for the South Project Area in Nags Head and the North Project Area in Kill Devil Hills and Kitty Hawk, be authorized for implementation as a Federal project, with such modifications as in the discretion of the Chief of Engineers may be advisable; at a first cost presently estimated at $48,961,000, and an expected annual costs presently estimated at $10,922,000 for the South Project Area, and at a first cost presently estimated at $22,713,000, and an expected annual costs presently estimated at $7,313,000, for the North Project Area. The total project first cost is presently estimated at $71,674,000, and the total project expected annual costs is presently estimated at $18,235,000. The recommended plan consists of a dune system to be constructed to a height of 13 feet NGVD fronted by a 7-foot NGVD (50-foot wide) beach berm with a main fill length of 47,490 feet and a transition length of 3,000 feet at the north end and 2,850 feet at the south end for the South Project Area and a main fill length of 15,900 feet and a transition length of 3,000 feet at each end for the North Project Area. The Total Project Area length is 75,240 feet which includes 63,390 feet for main fill and 11,850 feet for transition. Recommendations of this plan is made, provided that, except as otherwise provided in these recommendations, the exact amount of non-Federal contributions shall be determined by the Chief of Engineers prior to project implementation in accordance with the following requirements to which non-Federal interests must agree prior to implementation.

a. Provide 35 percent of initial project costs assigned to hurricane and storm damage reduction plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits and 50 percent of periodic nourishment costs assigned to hurricane and storm damage reduction plus 100 percent of periodic nourishment costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits and as further specified below:

(1) Enter into an agreement which provides, prior to construction, 25 percent of design costs;

(2) Provide, during construction, any additional funds needed to cover the non-federal share of design costs;

(3) Provide all lands, easements, and rights-of-way, and perform or ensure the performance of any relocations determined by the Federal Government to be necessary for the initial construction, periodic nourishment, operation, and maintenance of the project;

(4) Provide, during construction, any additional amounts as are necessary to make its total contribution equal to 35 percent of initial project costs assigned to hurricane and storm damage reduction plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits and 50 percent of periodic nourishment costs assigned to hurricane and storm damage reduction plus 100 percent of periodic nourishment costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits;

b. For so long as the project remains authorized, operate, maintain, and repair the completed project, or functional portion of the project, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

c. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the Non-Federal Sponsor, now or hereafter, owns or controls for access to the project for the purpose of inspecting, operating, maintaining, repairing, replacing, rehabilitating, or completing the project. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Federal Government shall relieve the Non-Federal Sponsor of responsibility to meet the Non-Federal Sponsor's obligations, or to preclude the Federal Government from pursuing any other remedy at law or equity to ensure faithful performance;

d. Hold and save the United States free from all damages arising from the initial construction, periodic nourishment, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the United States or its contractors;

e. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

f. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended, 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the initial construction, periodic nourishment, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the Non-Federal Sponsor with prior specific written direction, in which case the Non-Federal Sponsor shall perform such investigations in accordance with such written direction;

g. Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the initial construction, periodic nourishment, operation, or maintenance of the project;

h. Agree that the Non-Federal Sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, and repair the project in a manner that will not cause liability to arise under CERCLA;

i. If applicable, comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for the initial construction, periodic nourishment, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

j. Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army, and Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), requiring non-Federal preparation and implementation of flood plain management plans;

k. Provide 35 percent of initial project costs assigned to hurricane and storm damage reduction plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits and 50 percent of periodic nourishment costs assigned to hurricane and storm damage reduction plus 100 percent of periodic nourishment costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits costs of that portion of total historic preservation mitigation and data recovery costs attributable to hurricane and storm damage reduction that are in excess of 1 percent of the total amount authorized to be appropriated for hurricane and storm damage reduction;

l. Participate in and comply with applicable Federal floodplain management and flood insurance programs;

m. Do not use Federal funds to meet the non-Federal sponsors share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

n. Prescribe and enforce regulations to prevent obstruction of or encroachment on the project that would reduce the level of protection it affords or that would hinder future periodic nourishment and/or the operation and maintenance of the project;

o. Not less than once each year, inform affected interests of the extent of protection afforded by the project;

p. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the floodplain, and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the project;

q. For so long as the project remains authorized, the Non-Federal Sponsor shall ensure continued conditions of public ownership and use of the shore upon which the amount of Federal participation is based;

r. Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms;

s. Recognize and support the requirements of Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element; and

t. At least twice annually and after storm events, perform surveillance of the beach to determine losses of nourishment material from the project design section and provide the results of such surveillance to the Federal Government.

The local sponsor has indicated that they have available the necessary funds to provide the non-Federal share of project first costs and periodic nourishment costs. I am confident that the local sponsor will provide their share.

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding.

The Administration position on funding support for hurricane and storm damage reduction projects is as follows: "The Office of Management and Budget advises that while the Water Resources Development Act of 1999 (WRDA 99) changed the cost-sharing formula for the long-term sand renourishment component of certain future shore protection projects, these changes did not go far enough considering the long-term cost of most of these projects. Further, because WRDA 99 delayed the effect of the change in cost sharing for up to a decade or more, it did not address current constraints on Federal spending. The Administration intends to work with Congress to address these problems. However, until these issues are satisfactorily resolved, the Administration will not support authorization of new shore protection projects that involve significant long-term Federal investments beyond the initial construction of these projects, and will give new shore protection projects that are already authorized low priority for funding."

As stated on the proceeding page, the Administration has expressed concern about significant long-term Federal investments associated with hurricane and storm damage reduction projects. Clearly, substantial long-term Federal investments would be required to implement the current project proposal. The Administration's projections of future inflation are 3.2 percent annually. Based on these data, the total inflation adjusted (fully funded) project costs are estimated to be $1,662,000,000 over the 50-year period of Federal participation for the recommended plan of improvement. The Federal share of the fully funded project costs is currently estimated at $843,300,000. The non-Federal share of the fully funded costs is currently estimated at $818,700,000. Given the Administration's declared budgetary concerns, potential long-term costs associated with the proposed project may be vital to decision making. As previously indicated, the total project benefit-cost ratio is 1.9, which means that for every dollar spent for the project there is one dollar and ninety cents realized in National Economic Development (NED) benefits from the project.

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