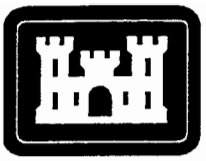

US Army Corps
of Engineers®
Wilmington District

ENVIRONMENTAL ASSESSMENT

PRECONSTRUCTION MODIFICATIONS
OF
AUTHORIZED IMPROVEMENTS

WILMINGTON HARBOR
NORTH CAROLINA

February 2000

The U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers is the Nation's oldest and largest water resources development agency. The Corps role in the planning, development, and management of the Nation's water resources began in 1824 with an act of Congress for the improvement of rivers and harbors for navigation. Early navigation projects were critical to the economic development and defense of the Nation, and their importance has continued to increase through time. The construction, maintenance, and operation of Federal river and harbor projects continue as responsibilities of the Corps of Engineers, and are performed in accordance with engineering, economic, and environmental protection principles. Navigation of the Nation's waterways and harbors remains a vital link in its transportation system and a major contributor to its economy.

The expertise of the Corps of Engineers in navigation projects led succeeding administrations and Congresses to assign additional water-related missions in such areas as flood control, shore and hurricane protection, hydropower, recreation, water supply, and environmental restoration. In most cases, Corps projects come about in response to requests from State and local government sponsors who become partners that share in project development decisions and funding responsibility. All projects are accomplished in accordance with Congressional authorization and/or direction.

Other responsibilities of the Corps of Engineers include administering Federal laws for the protection of the Nation's navigable waters and wetlands.

ENVIRONMENTAL ASSESSMENT
Preconstruction Modifications
Of Authorized Improvements

WILMINGTON HARBOR, NORTH CAROLINA
February 2000

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ENVIRONMENTAL ASSESSMENT

PRECONSTRUCTION MODIFICATIONS Of AUTHORIZED IMPROVEMENTS WILMINGTON HARBOR , NORTH CAROLINA

- **Ocean Bar Channel Realignment**
- **Beach Placement of Dredged Sand**
- **Rock Blasting Without Air Curtains**
- **Comprehensive Dredging & Disposal Plan**

1.00 PURPOSE AND NEED FOR ACTION

1.01 Introduction. Wilmington Harbor, located on North Carolina's southeast coast, is one of the state's two deep-water ports and a major contributor to its economy. This Federal project connects deep water of the Atlantic Ocean with port facilities at Wilmington by way of a 37-mile-long channel along the Cape Fear and Northeast Cape Fear Rivers. Congressionally-authorized harbor improvements scheduled to begin work in July 2000 include deepening the navigation channel generally by 4 feet, extending the existing channel seaward approximately 3.5 miles, and widening specific portions of the project. However, previously approved plans for these improvements have undergone recent modifications and refinements resulting in the following proposals:

- establishment and maintenance of a harbor entrance channel through the ocean bar on a new alignment selected to reduce deepening costs and potential environmental impacts associated with rock blasting along the existing channel alignment and excavating live coral bottom to extend it,
- placement of beach-compatible sand from the new channel alignment on nearby beaches in Brunswick County,
- placement of beach-compatible sand dredged from navigation channels and disposal islands of the lower Cape Fear River for maintenance of beaches at existing, authorized Federal shore protection projects of lower New Hanover County, to support beach erosion control activities at the Fort Fisher Revetment project, and/or to supply sand to beaches of Brunswick County,
- backfilling to restore the abandoned portion of the old ocean bar channel with material unsuitable for beach or littoral zone placement,
- placement in the ODMDS of all dredged sediment that does not go to the beaches, the littoral zone, disposal islands, or abandoned channel,
- utilization of blast pressure criteria rather than air bubble curtains as a protective measure to minimize impacts on aquatic resources during blasting for rock removal in the river, and
- establishment of a clear, comprehensive plan for utilization of all types of dredging equipment and disposal alternatives that are appropriate for use in each specific portion of the harbor, insofar as their use is consistent with protection of the environment.

Each of these proposed changes is judged to provide economic and/or environmental benefits. The changes are discussed in this environmental assessment.

1.02 Project History. The State of North Carolina began navigation improvements in the Cape Fear River in 1822 and continued until 1829 when the Federal government assumed these responsibilities. Until 1870, harbor improvements and maintenance were sporadic but have been conducted continuously since then, and channel depths and widths have been gradually increased to accommodate the increasingly larger ships calling at the port. Planned harbor improvements awaiting construction have been designed to alleviate navigation constraints that now require larger vessels to travel lightloaded or to wait for high tide. Lightloaded vessels force shippers to pay for unused cargo space, while vessels awaiting high tide continue to incur operating costs during delays. Reducing these problems will lower shipping costs and improve the economic viability of the port.

The pending construction plan integrates harbor improvements that were separately authorized by the Water Resources Development Act of 1996 as the:

- Wilmington Harbor - Northeast Cape Fear River Project,
- Wilmington Harbor - Channel Widening Project, and
- Cape Fear - Northeast Cape Fear Rivers Comprehensive Project.

These were subsequently combined into a single project by the Fiscal Year 1998 Appropriations Act. The combined project, referred to as the "Wilmington Harbor 96 Act Project," provides for increasing the authorized navigation depth of the entire channel from the ocean to Wilmington. The depth of the ocean entrance channels from Baldhead Shoal Channel upstream through Battery Island Channel would be increased from 40 feet at mean lower low water (mllw) to 44 feet; Lower Swash Channel upstream to the Cape Fear Memorial Bridge would be increased from 38 feet to 42 feet; the 32-foot portion upstream of Cape Fear Memorial Bridge to the Hilton Railroad Bridge would be increased to 38 feet; the 25-foot channel from the Hilton Railroad Bridge to 750 feet upstream would be increased to 38 feet; and the 25-foot channel from there to the turning basin near the upstream project limit would be increased to 34 feet. The project would also extend the existing Baldhead Shoal Channel seaward to natural depths equal to project depth. The authorized channel widths would remain at 500 feet from the ocean upstream through Battery Island Channel and the 400 feet upstream to the Hilton Railroad Bridge, except that specific portions of the project would undergo widening. Authorized project dimensions are shown in *Table 1.* General geographic features and the names of channel reaches comprising the harbor appear in *Figure 1.* Tables and figures in this document are at the end of the text.

1.03 Need for Proposed Action. The authorized plan would deepen the ocean bar channel (Baldhead Shoal Channel) along its current alignment and extend its present length of 5.8 miles by 3.5 miles to a new total length of 9.3 miles seaward from the inlet. However, recent attempts to dredge the hard rock bottom in this path indicate that extensive blasting would be required to achieve authorized project depth. This would be very slow and expensive, and could also adversely affect marine life. In addition, 1998 ocean bottom surveys show that seaward extension of the existing channel would pass through a substantial amount of live coral and other ecologically valuable hardbottoms. Therefore, an improved channel alignment has been selected which is more cost-efficient and environmentally acceptable (*Figure 2*). This new alignment is expected to accomplish the following:

- save about $40 million in construction costs by avoiding rock removal to a depth of 46 feet at mllw,
- avoid constructing 1 additional foot of overdepth that is required in rock bottom,
- avoid the need for rock blasting and its associated environmental impacts,
- avoid ecologically valuable hardbottom in the path of extending the existing alignment 3.5 miles,
- shorten the distance to natural deep water (i.e. the 46-foot contour) by 2.3 miles,
- reduce channel construction time, and
- locate the channel where possible future deepening, although not currently planned, would require less rock removal and, consequently, less potential future blasting.

These advantages make realignment of the ocean bar channel strongly preferable to deepening and extending the existing alignment.

A substantial amount of beach-quality sand will be dredged during construction of the ocean bar channel on its new alignment, deepening the channel reaches of the lower river, and establishment of sand recycling sites at disposal islands of the lower river (*Table 2*). This sand should be retained within the active coastal sand system rather than being permanently lost by placing it in an offshore disposal site. An estimated volume of 3.9 million cubic yards of beach-quality sand from the new channel alignment and about 2.1 million cubic yards from the river channel upstream to station 10+00 of Snows Marsh Channel (near river mile 7) will be made available for placement on beaches of Brunswick County to comply with requests from the Brunswick County Commissioners and the Brunswick Beaches Consortium. Also, an estimated 1.9 million cubic yards of beach-quality sand from Snows Marsh Channel (upstream of station 10+00) through Horseshoe Shoal Channel (near river mile 9) and from existing disposal islands in the river will be made available to the New Hanover County communities of Carolina Beach and Kure Beach for placement on their existing Federal shore protection projects and/or to the State of North Carolina's Fort Fisher Revetment project for combatting shoreline erosion. The sand offered for use at these New Hanover County projects would represent alternatives to other previously-approved sources of renourishment material, such as offshore and upland borrow sites, respectively, for Kure Beach and Fort Fisher. Dredged sand placed at these beaches would replace sand lost through natural erosional forces. In the event that New Hanover County beaches cannot utilize this sand, it may also be offered to Brunswick County beach communities, but the economic viability of this concept is uncertain due to the extremely long sand transport distances.

The authorized plan for harbor improvements estimates that the total amount of rock to be removed is approximately 1.2 million cubic yards. This quantity includes rock located along the channel bottom in the Cape Fear and Northeast Cape Fear Rivers. Depending upon the contractor(s) awarded the work contract(s), the contractor's interpretation of the rock coring data, the equipment choice available to and preferred by the contractor(s), and the method(s) utilized for rock removal, the volume that is blasted could range from around 700,000 cubic yards up to the total amount of rock present. Rock removal work is expected to be accomplished under several separate contracts. Submerged air bubble curtains were included in the previously approved plan as a measure to minimize blasting impacts on aquatic resources, but results from recent test blasting indicate that they provide little protection. However, their use drives up construction costs substantially. Therefore, air curtains will not be required as a blast containment measure, but contractors will be required, instead, to comply with specific blast pressure criteria to minimize impacts to aquatic life. In addition, monitoring requirements will be imposed to assure that environmental protection goals are met. Overall, this measure is expected to save more than $20 million.

Dredging and disposal options for Wilmington Harbor are being expanded to maximize flexibility in terms of dredging equipment and disposal locations so long as the methods are consistent with environmental protection goals, laws, and regulations. Due to nationwide shortages in the availability of dredging equipment, particularly at certain times of year, flexibility in methods will allow for greater likelihood of obtaining dredging services when needed, greater price competition in dredge contracting, and potential reductions in project costs and tax dollars spent.

1.04 Proposed Action. The proposed action consists of all the components itemized in **Section 1.01 Introduction**, above. This plan incorporates all proposed project changes that have been developed since the 1996 publication of the Final Feasibility Report and Environmental Impact Statement for the Cape Fear - Northeast Cape Fear Rivers Comprehensive Study (USACE, 1996a). Each component is discussed in greater detail in the paragraphs that follow.

1.04.1 New Alignment for the Ocean Bar Channel. The new alignment plan (*Figure 3*) follows the old channel (Baldhead Shoal Channel) from the inlet (station 0+00) seaward approximately 4,500 feet to a new 15 degree turn (at station 45+00); then proceeds about 4,343 feet to a second turn of 14 degrees (at station 88+43); and then proceeds seaward through the existing Ocean Dredged Material Disposal Site (ODMDS) to the 46-foot depth (at mllw) contour located about 7.0 miles outside the inlet (at station 370+00). Increases in channel width will be required at the inlet throat (joining Smith Island Channel) and at the two new bends in order to facilitate ship maneuverability and navigation safety. These wideners vary in width up to about 200 feet. Extending along a total distance of about 7.0 miles, the channel bottom and side slopes, as well as the wideners, will cover approximately 643 acres of the ocean floor. This path utilizes about 83 acres from the existing alignment and 122 acres within the existing ODMDS leaving a net new impact area of approximately 438 acres. Under the previous plan, seaward extension of the channel would have covered 230 acres, and wider side slopes associated with channel deepening would have impacted another 55 acres, so that a total new impact area of 285 acres would have been affected. Thus, the new channel alignment will affect about 153 acres more than new modifications of the old alignment. However, after the new channel is complete, the old channel will be abandoned and subsequently backfilled to hasten recovery of about 224 acres of ocean bottom (discussed in **Section 1.04.3**)

Construction dredging of the new ocean bar channel, the sandy channels upstream through Horseshoe Shoal Channel, and islands of the lower river will require removal of approximately 17.4 million cubic yards of sediment consisting of sands, silts, and clays (*Table 2*). This volume consists of about 8.0 million cubic yards of beach-quality sand (no more than 10% silt/clay) and about 9.4 million cubic yards of material with over 10% silt and clay. It is estimated that maintenance dredging of the new ocean bar channel will be required about every two years, that the volume of sediment removed will average about 1.1 million cubic yards annually, and that about half of the sediment volume will consist of beach-quality sand. Sediment may be removed from this channel by any seaworthy dredging method, including hydraulic pipeline or hopper dredges; hopper dredges with pumpout capability; or bucket dredges. Any of this equipment may be used with barges or scows for sediment transport. Based on our interpretation of sediment coring data, rock is not present within the required depth along the new ocean bar channel alignment, so blasting will not be necessary or allowed in this area.

1.04.2 Beneficial Use of Project-derived Sand. Historically, dredged material has been considered a waste material. Prior to the National Environmental Policy Act (NEPA) of 1969 and the Federal Water Pollution Control Act of 1972, its treatment often consisted of unconfined disposal into waters and wetlands adjacent to navigation channels. More recently, it has been deposited within diked disposal islands or transported to an ODMDS located offshore. However, dredged material is now recognized as a valuable resource that can be beneficially used in various ways depending upon its physical and chemical characteristics and its location. Sand is especially valuable for beach replenishment. Consequently, it is no longer an acceptable practice to remove sand from the active littoral system by ocean disposal when other cost-efficient and environmentally acceptable options are available. The North Carolina Coastal Management Program now requires that clean, beach-quality sand dredged from navigation channels in the coastal area not be removed permanently from the active nearshore, beach, or inlet shoal system, unless no practicable alternative exists (NC Administrative Code T15A: 07M.1102). This policy is not without controversy, however, because intertidal macroinvertebrate populations, shorebirds, and nesting sea turtles utilize beach habitat and are subject to adverse impacts from placement of dredged material during warmer months of the year.

Beach-quality sand dredged during construction and maintenance of the new ocean bar channel will be made available for placement on area beaches, to the extent feasible. Planning for the placement of this sand is being coordinated through the Brunswick Beaches Consortium, which is comprised of Bald Head Island, Caswell Beach, Oak Island (Yaupon Beach and Long Beach), Holden Beach, Ocean Isle Beach, and Sunset Beach. These communities *(Figure 4)*, except Ocean Isle Beach and Sunset Beach (which are too distant from the sand source), have expressed interest in acquiring as much sand as possible from the Wilmington Harbor project and are currently working with Federal and State governments to obtain funding assistance for sand placement, possibly through the authority of Section 933 of the Water Resources Development Act of 1986. Section 933 authorizes 50 percent Federal sharing of the extra costs of using sand dredged from Federal navigation improvements and maintenance for beach nourishment. Sand placed through the use of this authority must provide benefits at least equal to the cost of placement, but future nourishment of the beach is not a project requirement; i.e., the beach does <u>not</u> become a Federal shore protection project with a continuing maintenance obligation. Also, unlike Federal shore protection projects such as those at Wrightsville, Carolina, and Kure Beaches, there is no complex berm and dune profile.

Placement of sand on the Brunswick County beaches under this concept (i.e., Section 933) is designed to begin at mean high water (elevation + 2.7 ft NGVD or + 5.0 ft mllw, which are equivalent) and to extend the mean high water mark seaward by means of a low berm. Where shoreline erosion has resulted in a mean high water line under existing structures, sand placement would begin seaward of the structure by at least 25 feet to satisfy clearance requirements. It is anticipated that natural forces will reduce the new berm width by about 50% over a period of a few months. Actual quantities of sand to be placed on various Brunswick County beaches remain to be determined depending upon the results of coordination with the project sponsor (State of North Carolina) and the beach communities, as well as economic and engineering constraints. Constructed berm widths and berm widths adjusted by the actions of nature will, likewise, depend upon the plan selected.

Potential ***maximum*** measurements are shown below and are repeated in *Table 3*. Note that it is **not possible** for all beaches to simultaneously receive the maximum quantities shown because the available sand quantity will be limited and is not expected to exceed 6.0 million cubic yards. For one beach to receive the maximum amount shown, another beach would have to receive less than its possible maximum. These maximum amounts are presented in order to depict the most severe potential environmental impacts on beach-dwelling fauna, which would result from construction of the widest beach.

MAXIMUM Disposal Measurements with Section 933 Disposal

Location	Shoreline Length (feet)	Sediment Disposal Rate (cubic yds per linear ft)	Initial Placement Width Range (feet)	Adjusted Placement Width Range (feet)	Initial Placement Volume (cubic yds)	Net In-place Volume (cubic yds)
Bald Head Island	16,000				2,200,000	1,826,000
West Beach	2,000	120	190 - 210	95 -105	240,000	200,000
South Beach	2,000	120	190 - 210	95 - 105	240,000	200,000
South Beach	12,000	143	220 - 240	110 - 120	1,720,000	1,426,000
Oak Island	50,500				4,740,000	3,933,000
East Oak Island - Caswell Beach	25,000	110	170 - 190	85 - 95	2,750,000	2,283,000
West Oak Island - Caswell Beach	25,600	78	120 - 140	60 - 70	1,990,000	1,650,000
Holden Beach	10,600	78	120 - 140	60 - 70	830,000	690,000

During placement, deposited sand is designed not to exceed elevation +8.0 feet NGVD. The design beach profile is shown at true scale in *Figure 5* and exaggerated scale in *Figure 6*.

The time requirement to place the large volume of sand on Brunswick County beaches is estimated at 18 months. However, beach disposal is normally restricted to a 5 1/2-month cold-weather period (November 15 - April 30) to avoid impacts to sea turtles. Construction confined to this short interval could require over 3 years for completion, and up to 3 extra equipment mobilization/demobilization cycles. Continuous rather than intermittent construction could, therefore, save up to about $5.25 million ($1.75 million per mob/demob). Continuous construction is proposed on a year-around basis, but would occur in a sequential manner with progress estimated at about 1 mile of beach per month. With this plan, sand placement scheduled to start on Bald Head Island in December 2000 would proceed over all Bald Head Island beaches and about 2 miles of Caswell Beach by May 1 when sea turtle nesting begins. Oak Island beaches would be the primary recipient of beach sand during the turtle season, and Holden Beach would likely receive most of its sand during the subsequent cold-weather period.

Should present plans for sharing sand by Brunswick County beaches not materialize due to funding problems or other unforeseen reasons, the 6.0 million cubic yards of sand could be distributed according to the base disposal plan. The **base disposal plan** represents the least cost alternative for the government which is engineeringly feasible and environmentally acceptable. Under this plan, Bald Head Island would receive about 2.6 million cubic yards of sand and Oak Island-Caswell Beach would receive about 3.4 million cubic yards. This sand would be distributed over about 16,000 linear feet of beach on Bald Head Island and about 25,000 linear feet on the east end of Oak Island-Caswell Beach. Estimated sediment disposal rates, related

beach widths (initial and adjusted), and placement volumes for each section of beach are shown below and also appear in *Table 3.*

Disposal Measurements with Base Disposal Plan

Location	Shoreline Length (feet)	Sediment Disposal Rate (cubic yds per linear ft)	Initial Placement Width Range (feet)	Adjusted Placement Width Range (feet)	Initial Placement Volume (cubic yds)	Net In-place Volume (cubic yds)
Bald Head Island	16,000				2,580,000	
West Beach	2,000	120	190 - 210	95 - 105	240,000	200,000
South Beach	2,000	120	190 - 210	95 - 105	240,000	200,000
South Beach	12,000	175	280 - 300	140 - 150	2,100,000	1,734,000
East Oak Island - Caswell Beach	25,000	137	220 - 240	110 - 120	3,420,000	2,839,000
Totals	41,000				6,000,000	4,973,000

Under this design template, the maximum berm widths during construction would be about 300 feet and 240 feet, respectively, at Bald Head Island (12,000 feet of South Beach) and Oak Island-Caswell Beach. These maximum widths would be expected to diminish to about 150 feet and 120 feet, respectively, over a period of a few months. West Beach and the first 2,000 feet of South Beach on Bald Head Island would receive sand at a lower rate than the remaining 12,000 feet of South Beach under this plan. With a lower sand placement rate, the maximum berm widths would be about 210 feet during construction and 105 feet after several months. This lower sand deposition rate is intended to reduce the possibility of increased sediment transport back into the navigation channel. The design crest elevation for the base plan would remain at a maximum of +8.0 feet NGVD. Characteristics, volumes, and historical aspects of sand resources in the lower project area are discussed in more detail in ***Appendix A*, Sand Management Plan**.

Beach-quality sand will also be dredged during the deepening of the riverine channels upstream through Horseshoe Shoal Channel (to about river mile 9). Sand from these channel segments as well as the larger, sandy disposal islands in the lower river (total of 1.9 million cubic yards) will be made available to the communities of lower New Hanover County, i.e., Carolina Beach and Kure Beach, to be used for maintenance of their existing Federal shore protection projects (*Figure 7*). These projects were previously authorized and constructed, and Wilmington Harbor sand would merely be used in place of sand derived from other approved sources, including offshore borrow sites. Likewise, sand dredged from riverine or island sources would be available to the North Carolina Fort Fisher Revetment Project (USACE, 1995) to combat continuing erosion, and would represent an alternative to sand from approved upland borrow sites at Snows Cut, which is located about 7 miles to the north. If New Hanover County beaches cannot utilize sand dredged from the lower river and islands, this sand may be available to the beach communities of Brunswick County. However, this concept may not be economically feasible for Brunswick County due to the long distances sand would have to be transported.

Should the beach communities not be in a position to accept all the sand generated by construction of the Wilmington Harbor improvements, the excess sand would be placed in the littoral system, to the maximum extent practicable, so as to retain it within the active coastal sand system. This would be achieved by depositing the sand immediately seaward of the swash zone along beaches in proximity to the dredging sites.

This method would require periodic movement of the dredge discharge apparatus so as to avoid mounding of material during its placement.

Future maintenance dredging of the ocean bar channel is expected to occur approximately every 2 years, and beach-quality sand would go to the beaches of Bald Head Island and Oak Island-Caswell Beach. However, it is possible that problem shoals involving small quantities of sand may develop in the channel between regular dredging events. In such cases, economics and expediency may require that shoals be removed by hopper dredging and that disposal occur at the ODMDS.

1.04.3 Backfilling the Abandoned Channel. After the new ocean bar channel is completed, the abandoned portion of the old channel (seaward of station 130+00) will be backfilled using debris-free, non-beach-quality sediments (<90% sand) from maintenance dredging or from channel deepening in other portions of the harbor. This refilling process would utilize approximately 2 million cubic yards of sediment and is intended to hasten recovery of about 224 acres of channel bottom to more closely resemble the bathymetry of the surrounding ocean floor. Although several years may be required to complete the backfilling, the process would proceed more quickly than by natural shoaling processes alone. Upon completion of backfilling, this area of ocean bottom is expected to develop a new benthic community resulting from colonization by organisms from surrounding areas. Also, the commercial fishing industry should benefit because trawling activities could likely be resumed along the old channel alignment. After backfilling of the old channel is complete, dredged material from the project that is not suitable for beach or littoral zone placement will go to the ODMDS or to confined disposal sites (CDFs).

1.04.4 Disposal of Dredged Material at the ODMDS. The Wilmington ODMDS (*Figure 2*) will be available for the disposal of any harbor sediments that have been evaluated and meet the criteria for ocean disposal under U.S. Environmental Protection Agency (USEPA) Ocean Dumping Regulations and Criteria (40 CFR Parts 220 - 229). Generally, this will be dredged material that is not suitable for beach or littoral zone placement due to silt/clay content in excess of 10%. In addition, if neither beaches, littoral zone placement, or disposal islands can accommodate all the sand generated by the harbor improvements and maintenance, any remainder may go to the ODMDS. Disposal of rock removed from riverine portions of the harbor is intended to occur, to the maximum extent feasible, at the Wilmington Offshore Fisheries Enhancement Structure (WOFES) located adjacent to the existing ODMDS (*Figure 2*). However, if rock is not suitable for placement at the WOFES, due to substantial amounts of fine sediment (silt/clay) mixed with the rock or other unforeseen reasons, this material may, instead, go to the ODMDS or to the Eagle Island CDF, located across the river from the NC State Ports Authority (USACE, 1996a).

The existing ODMDS will be utilized for dredged material until its capacity is exhausted, which is expected to occur within a few years. Because of projected future disposal needs, a new ODMDS is already being planned jointly with the USEPA and is being coordinated through a separate, mandatory process. The new ODMDS is expected to be officially designated and available for use by the time it is needed. A new ODMDS would be required for the Wilmington Harbor project whether or not the ocean bar channel is realigned.

1.04.5 Use of Blast Pressure Limits instead of Air Bubble Curtains to Protect Aquatic Life. Evidence obtained from blasting tests conducted during late 1998 and early 1999 indicates that air bubble curtains are not effective in reducing blasting impacts on aquatic life, and physical barriers are not practicable due to the strong currents in the river. Furthermore, shortnose sturgeon which had been considered potentially sensitive

to blasting impacts were shown, through caged fish experiments, not to be affected differently by blasting with or without air curtains. The test procedures, evaluations, and findings are discussed in greater detail in ***Appendix B*, Analysis of Test Blasting Results.**

In light of these findings, the proposed action will eliminate the requirement for air bubble curtains in order to save an estimated $20 million in construction costs. Marine life will receive adequate protection by the combination of other measures that will be used to reduce blasting impacts. These measures incorporate commitments made in previous Corps of Engineers reports (USACE, 1996a; USACE, 1996b) and the refinements resulting from test blasting. The proposed blasting plan includes the following elements:

- explosive charges will be placed in holes drilled in the rock substrate,
- each charged hole will be stemmed to suppress the upward escape of blast pressure from the hole,
- a delay will be used for each hole to prevent cumulative blasting impact for each set of holes,
- blast pressures will be monitored and upper limits will be imposed on each series of 5 blasts,
- average peak pressure shall not exceed 70 pounds per square inch (psi) at a distance of 140 feet,
- maximum peak pressure shall not exceed 120 psi at a distance of 140 feet,
- pressure will be monitored for each blast only at a distance of 140 feet,
- air bubble curtains, physical barriers, and monitoring of caged fish will not be required,
- blasting previously approved for August through December, inclusive, will be expanded to include January, which was originally eliminated due to concems over impacts to shortnose sturgeon,
- gillnets will be set at least 3 hours in advance of blasting to surround the blast area as much as feasible, and will not be removed sooner than 1 hour before the blast. Any sturgeon captured will be released in the Brunswick River (location approved though agency coordination).
- channel nets will be set downcurrent of the blast area within 10 minutes of blast discharge in order to capture and document dead or injured fish,
- vessel and/or aerial surveys for sea turtles, manatees, and dolphins/porpoises will be conducted for 1 hour before and 1/2 hour after each blast. If any of these species are observed within a specified danger zone, blasting will be delayed until they leave. The danger zone will extend 3,500 feet from the blast site (expanded from original distance of 1,000 feet). Noise levels will be monitored at 3,500 feet to assure that they do not exceed 178 dB re 1uPa, and the protective radius will be increased (in 500-foot increments) if monitoring indicates this is necessary to meet the noise limit,
- scare charges will be conducted for each blast,
- surveillance for schools of fish will be conducted by vessels with sonar fish finders for a period of 20 minutes before each blast, and if fish schools are detected, blasting will be delayed until they leave. The surveillance zone will be approximately circular with a radius of about 500 feet extending outward from each blast set.

Components of the proposed blasting plan are expected to allow cost-efficient blasting production while offering adequate protection for marine life.

1.04.6 Expansion of Dredging Methods. The dredging of Federal navigation projects requires formal interagency coordination to obtain approvals for channel location(s) and dimensions, sediment quality, disposal site location(s) and characteristics, type of dredging equipment to be used, timing related to dredging impacts, timing related to disposal impacts, and possibly other aspects of proposed work. With regard to Wilmington Harbor, these factors have been addressed singly and in various combinations over a number of

years, on an as-needed basis. However, some combinations of these factors have not received much attention in the past because (1) they were not needed to accomplish the dredging work, (2) they were considered infeasible due to engineering, economic, or environmental criteria, or (3) data were insufficient to develop supportable proposals for new combinations or methods. Greater flexibility is now needed in the Wilmington Harbor dredging program in order to facilitate the costly channel construction efforts that will extend over about 5 years and 7 scheduled dredging contracts. Therefore, previously approved dredging methods have been reexamined with a goal of securing environmental approvals for all measures that do not have environmental reasons for rejection.

Current Approvals and Restrictions.

- Dredge Plant. Dredging methods approved for use in various sections of Wilmington Harbor include hydraulic pipeline, hopper, and bucket dredges with barges or scows. Overflowing of hopper dredges and scows to achieve economic loading, even with fine sediments, has also been approved for portions of the harbor where tests have demonstrated that turbidity and sedimentation do not create significant impacts in nearby areas, and has been conditionally approved for other channel reaches subject to monitoring the overflow plume to assure that it does not significantly impact nearby Primary Nursery Areas (PNAs) designated by the State of North Carolina.
- Disposal Areas. Approved disposal sites include the ODMDS, confined disposal facilities (CDFs) on islands along the river, and the major CDF at Eagle Island located near river mile 25.
- Sediment Quality. Wilmington Harbor sediments have been evaluated from Baldhead Shoal Channel upstream through the Anchorage Basin (to Memorial Bridge near river mile 27) and have been determined not to contain significant amounts of contaminants. Disposal of these sediments is approved for the ODMDS or any CDF. Sediments upstream of the anchorage basin are approved for disposal at any CDF, but have not been evaluated or proposed for ocean disposal.
- Seasonal Restrictions. Federal and state environmental agencies have approved year-around dredging by bucket and barge throughout the harbor, and hopper and hydraulic pipeline dredging in the ocean and lower river (Baldhead Shoal Channel through Battery Island Channel). Other dredging/disposal activities in Wilmington Harbor are limited to the following periods:
  - August 1 to January 31 – fishery window allows hopper dredging in the river from Lower Swash Channel (about river mile 3) upstream through Upper Brunswick Channel (about river mile 24), with monitoring requirements for overflow where channel sediments are < 90% sand and channel is adjacent to PNAs . Hydraulic pipeline dredging is allowed over the same area and upstream to the project limit (about river mile 31). Early life stages of important estuarine and anadromous species are less subject to potential dredge entrainment at this time.
  - November 15 through March 31 – sea turtle window allows hopper dredging in the ocean and lower harbor. Fewer sea turtles are present to be taken by hopper dredges at this time. This requirement is self-imposed by the Corps of Engineers, South Atlantic Division, and is more restrictive than the year-around allowance from the National Marine Fisheries Service.
  - November 15 through April 30 – sea turtle nesting and incubation restrict beach disposal to this time period to minimize impacts.

Proposed Changes. The same dredging methods and disposal sites will continue to be utilized in the future. However, the following changes are proposed for the Wilmington Harbor Project:

- all dredging methods may be used throughout the project from the ocean bar channel (Baldhead Shoal Channel) to its upstream end (mile 31), provided that their use is consistent with appropriate environmental protection measures, including those imposed to safeguard water quality, fish and wildlife, and endangered and threatened species.
- methods to achieve greater economic efficiency (such as overflowing hopper dredges and scows) may be used, so long as regulatory restrictions and conditions are not violated.
- any approved dredged material disposal site may be used for disposal of dredged material from any portion of the harbor, so long as the material is approved for disposal in accordance with Section 404 of the Clean Water Act (for inland and nearshore disposal) or Section 103 of the Marine Protection, Research, and Sanctuaries Act (for ocean dumping).
- relaxation of seasonal windows during construction (but not maintenance after construction) would apply to specific harbor improvements that involve sand dredging, transport, and disposal. Activities allowed on a year-around basis would include beach disposal of sand, as well as hopper and hydraulic pipeline dredging from Horseshoe Shoal Channel (near river mile 9) downstream. The primary purpose of this year-around window would be to allow removal of the estimated 6.0 million cubic yards of beach-quality sand located from Snows Marsh Channel (at station 10+00) downstream through the new Baldhead Shoal Channel and to place it on Brunswick County beaches under one continuous contract and avoid the additional mobilization and demobilization costs that would be incurred if only seasonal dredging is allowed. Depending upon the dredging equipment used and which disposal plan is implemented, the savings realized by year-around dredging may reach up to an estimated $5.25 million.

  In addition, the disposal plan is yet to be defined for the estimated 1.9 million cubic yards of beach-quality sand anticipated from Snows Marsh Channel (station 10+00 upstream), Horseshoe Shoal Channel, and Disposal Islands # 3 and # 4. Year-around dredging and disposal would improve scheduling flexibility for transfer of this sand and may potentially generate additional savings. However, if this material goes to existing New Hanover County beach projects, its time of placement would comply with any existing restrictions since this activity would be regulated as nourishment of an authorized project.

Table 4 summarizes the dredging methods already approved and those proposed for approval for all the channel segments of Wilmington Harbor. This table is complex in that it separates the dredging of Wilmington Harbor into 24 geographic segments, 3 categories of dredged material, 3 types of dredging equipment, and 6 categories of disposal sites, as well as overflowing or not overflowing hopper dredges, barges, and scows. *Table 4* also shows that these variables can be matched in numerous combinations, some of which appear viable (proposed) and others not (shaded out, not proposed). Viability depends upon the relative economies and efficiencies achievable, as well as environmental acceptability. **Only the dredging methods (combinations) shown in *Table 4* are proposed**.

The interpretation of *Table 4* may be more simple when considered in the context that the harbor consists of 3 segments based upon the sediment characteristics, likely disposal options for dredged material due to proximity of disposal sites, and susceptability of aquatic/marine organisms to the impacts of dredging and disposal. The **lower harbor** is comprised of the ocean entrance channels (old and new ocean bar channels upstream through Battery Island Channel) and the riverine channels upstream through Horseshoe Shoal Channel (near river mile 9). This portion is characterized by sediments exceeding 90% sand (except for the seaward ends of the old and new ocean bar channels); wide expanses of unconfined open water; and proximity to beaches, the littoral zone, the ODMDS, and the WOFES. It is proposed that dredging of the

lower harbor may employ any type of dredging equipment; that overflowing (beach-quality sand) may be allowed to achieve economic loading for floating transport vessels; that disposal may be at the WOFES (for rock, if any), area beaches (for sand), in the littoral zone (for sand), or the ODMDS (silty sediment primarily, but other sediment types, when appropriate); and that these activities may occur at any time of year during harbor construction activities. This proposal would change the previously approved methods by removing the seasonal windows for hydraulic dredging in the river from Lower Swash Channel through Horseshoe Shoal Channel (inclusive) (currently allowing August - January), removing seasonal restrictions on hopper dredging (currently allowing only 15 November - 31 March), and removing seasonal restrictions on beach placement of sand (currently allowing only 15 November - 30 April). The proposal would also include dredging disposal islands of the lower river to move the sand contents to area beaches, and, thereby, create confined facilities for placing dredged sand that can be later recycled to area beaches. After construction is complete, maintenance dredging would be resumed under the seasonal window restrictions for hopper dredges and beach placement of sand. However, it is proposed that the fishery restricted window (August - January) not be applied to maintenance dredging of the lower harbor.

The **middle harbor** is comprised of Reaves Point Channel through Lower Big Island Channel (from about river mile 9 - river mile 20). This area is characterized by an average river width of over one mile, sediments that are less than 90% sand in some reaches and over 90% sand in others, absence of viable disposal options in proximity, and available disposal sites only at Eagle Island and the ODMDS which are about equal, long distances away. PNAs are designated from the river shorelines to a line 300 yards from the navigation channel centerline, from Upper Lilliput Channel upstream through the middle harbor and into the upper harbor.

Proposed changes for the middle harbor include allowing the overflow of hopper dredges, or scows and barges used with either hydraulic pipeline or bucket dredges (overflow tests are discussed in USACE, 1997). Monitoring of the overflow plume would be done in Keg Island Channel because the sediment is less than 90% sand and PNAs are designated beginning 300 yards from the navigation channel (monitoring is discussed in ***Appendix C***). Monitoring would not be required in Upper Lilliput Channel or Lower Big Island Channel, both of which have sediments with over 90% sand and would not produce significant sediment plumes. Also, monitoring would not be required in Reaves Point through Lower Lilliput Channels even though the sediments are < 90% sand, because there are no PNAs in this reach. Economic loading of hopper dredges, barges, and scows would facilitate the cost-efficient transport of dredged material over longer distances to the ODMDS (all sediment types, when appropriate), beaches (sand to be pumped out), the littoral zone (sand to be dumped), the WOFES (rock to be dumped), diked disposal islands (material removed by pump or backhoe & truck), and/or the Eagle Island CDF (material removed by pump or backhoe & truck). It is also proposed that material could be handled by pipeline dredge directly to the Eagle Island CDF. Hydraulic dredging in the middle harbor would continue to adhere to the fishery window.

The **upper harbor** consists of reaches from Upper Big Island Channel through the upstream project limit (from about river mile 20 to river mile 31). The river in this area becomes gradually constricted to a width of about 1,500 feet and bottom sediments are high in silt/clay content in most reaches. The primary disposal option is the Eagle Island CDF, which is undergoing a program of improvement that includes reinforcing the base of the containment dike and raising the dike height in order to develop disposal capacity sufficient to meet the long-term needs of the upper harbor. Due to the weak foundation conditions and previous problems with dike stability at this site, there is concern that dikes cannot be safely raised rapidly enough to keep pace

with disposal requirements. If the Eagle Island CDF had unlimited capacity, it would likely be used for most disposal of upper harbor sediments. Since this is not the case, other options are needed.

There are no seasonal restrictions on mechanical dredging (bucket and barge or scow) in Wilmington Harbor. However, seasonal restrictions apply to hydraulic pipeline dredging, and work is allowed only during August through January. Due to concern over potential impacts to fishery resources, no change is proposed in this restriction for the upper harbor. However, it is proposed that hopper dredging also be allowed in the upper harbor with the same August through January restriction. This could facilitate transport of rock to the WOFES rather than placing it in the Eagle Island CDF by pipeline dredge.

PNAs in the upper harbor extend from the river shorelines to 300 yards from the navigation channel centerline, from Upper Big Island Channel through Upper Brunswick Channel. Since overflow tests in the harbor have shown that dredge overflow plumes migrate primarily downcurrent in the navigation channel, overflow does not pose a significant environmental threat to PNAs located 300 yards outside the channel. Therefore, it is proposed that overflowing be allowed in the sandy reaches (Upper Big Island Channel and Lower Brunswick Channel) and also, with monitoring of the overflow plume, in the silty Upper Brunswick Channel. The purpose of monitoring in the silty area would be to assure that the plume adequately dissipates without significant impacts to PNAs. The impacts of hopper dredge overflow have been previously addressed and found environmentally acceptable in the Cape Fear River from the mouth of the Brunswick River downstream, subject to monitoring requirements in channel reaches passing within 300 yards of PNAs (USACE, 1997 and ***Appendix C***).

From the Fourth East Jetty Channel upstream to the project limit, the entire river outside the navigation channel is designated as a PNA, and, therefore, potential turbidity and sedimentation impacts are a greater concern. For this reason, all dredging proposed in this reach would be subject to the condition that overflow is not allowed. Changes proposed for this reach are to allow hopper dredging; to expand the array of potential disposal sites to include the WOFES (for rock), the ODMDS, and existing CDFs; and to match up any approved dredging methods and disposal sites in any combination.

In summary, it is proposed that dredged material from Wilmington Harbor, if approved for disposal, may be placed at any and all approved disposal sites by any approved method of dredging or sediment transport. The purpose of this proposal is to put the disposal event in a generic context and avoid the future requirement to prepare and process a NEPA document merely to match up a particular dredging method with a particular sediment transport method or a particular disposal site. Any existing restrictions associated with specific aspects of dredging and disposal would still apply when these work elements are accomplished in new combinations.

While some of the dredging and disposal combinations noted above may not be economically viable at this time, this situation may change in the future. In addition, the uncertain rate of capacity expansion at Eagle Island could result in a critical capacity shortfall in the upper harbor that would force dredging by more costly methods. This proposal to allow more comprehensive dredging and disposal methods is intended to provide an extra level of assurance that the lengthy construction of the pending Wilmington Harbor improvements may proceed without unnecessary interruption and delay. No significant environmental impacts are expected as a result. Potential impacts are discussed in **Section 5.00**.

1.05 Proposed Schedule. Overall construction of the Wilmington Harbor improvements is scheduled to be accomplished by 7 contracts extending over about 5 years (originally estimated at 3 years). Within this period, dredging of the ocean bar channel is scheduled to begin in July 2000 with a contract to dredge material from its seaward end (< 90% sand) and deposit it in the existing ODMDS. A second contract also scheduled to start work in July 2000 will involve rock blasting in the river in the vicinity of Upper and Lower Big Island Channels. In the riverine portion of the project, a third dredging contract is scheduled to start work in December 2000 and to include sandy material from Disposal Islands # 3 and # 4 (*Figure 7*) and/or the river channels from Horseshoe Shoal Channel downstream through Snows Marsh Channel. This sand is expected to go to area beaches, although the destination is yet to be determined, and its placement is estimated to require up to 6 months depending upon the placement site selected. A fourth contract scheduled to start work in January 2001 would include work in the sandy portion of the ocean bar channel and the lower river channels, and plans are being coordinated to place the sand on nearby beaches in Brunswick County. Beach placement of the up to 6.0 million cubic yards of sand to be removed under this contract is expected to require approximately 18 consecutive months of dredging and disposal. Scheduled dates for work startup on all 7 planned contracts appear below:

- Jul 2000 Construct new ocean bar channel, outer portion, sediment < 90% sand
- Jul 2000 Deepen river (Keg Island - Lower Brunswick Channels), rock / mixed sediment
- Dec 2000 Deepen river channel, sandy reaches to beach / littoral zone (destination pending)
- Jan 2001 Construct new ocean bar channel, inner sandy portion to Brunswick County beaches
- Apr 2001 Deepen the Passing Lane area, mixed sediment
- Aug 2001 Deepen the Anchorage Basin vicinity, rock / mixed sediment
- Aug 2003 Deepen river from Memorial Bridge up the Northeast Cape River to project limits, rock / mixed sediment.

The actual dates scheduled for contract award precede the above dates by 2 months to allow for routine administrative matters common to dredging contracts. The overall estimated completion date for the pending harbor improvements is March 2005.

2.00 INCORPORATION BY REFERENCE

Over the past decade the U.S. Army Corps of Engineers (USACE) has produced a number of environmental and planning reports which describe Wilmington Harbor, its ongoing and proposed improvements, the details of dredging and disposal operations required for its construction and maintenance, and the environmental aspects of the project. These reports were circulated for public and environmental agency review, and they document the environmental acceptability of the methods planned for the proposed improvements. These documents are cited in the **Bibliography** in **Section 10.00**. Two of these reports which contain extensive background information are listed below and are incorporated by reference.

- U.S. Army Corps of Engineers, Wilmington District. 1989. Final Environmental Impact Statement (FEIS). Long-Term Maintenance of Wilmington Harbor, North Carolina. This document describes project history, physical and biological attributes of the harbor, dredging and disposal methods and alternatives, capacities and estimated life expectancies of disposal areas, and anticipated environmental impacts of harbor maintenance.

- U.S. Army Corps of Engineers, Wilmington District. 1996. Final Feasibility Report and Environmental Impact Statement on Improvement of Navigation, Cape Fear - Northeast Cape Fear Rivers Comprehensive Study, Wilmington, North Carolina, Volumes I, II, and III. This report provides a more current overview of Wilmington Harbor in terms of planned improvements and environmental concerns related to their construction, particularly salinity intrusion due to channel deepening and underwater blasting for removing rock in the channel bottom.

This environmental assessment will provide information that is immediately pertinent to the new proposed actions and will not repeat the detailed information incorporated by reference.

3.00 ALTERNATIVES

Alternatives for each component of the proposed action were evaluated and are discussed in this section. These include alternative channel alignments on the ocean bar, alternative sites for the disposal of dredged sand, alternative configurations of sand placement on beaches, alternative measures for minimizing blasting impacts on aquatic life, and alternative dredging and disposal options.

3.01 Alignment Alternatives for the Ocean Bar Channel. Previous analyses and reports have resulted in Congressional authorization of a 4-foot deeper channel extending from the Cape Fear River near Southport to the 46-foot depth contour of the Atlantic Ocean. However, deepening the existing ocean bar channel alignment (no action alternative) poses serious challenges, including a (1) hard rock bottom that would require removal by blasting and (2) ecologically valuable hardbottoms and their associated biological communities in the path of seaward extension of the channel. This situation prompted efforts to identify other channel alignments that would avoid or reduce these problems, but other options are somewhat restricted. Factors considered during evaluation of alternatives included:

- large ships are unable to safely maneuver through tight turns in adverse tide and wind conditions,
- the proximity of landforms around the mouth of the Cape Fear River (Battery Island, Oak Island, and Bald Head Island) is a constraint in designing safe turns,
- the top-of-rock elevation must be located deeper than the proposed dredging depth in order to avoid potential blasting. This factor eliminates the existing alignment or other more westerly choices, and
- ecologically valuable hardbottoms (some with corals present) should be avoided. This factor eliminates the existing alignment and other more westerly choices.

These restrictions forced the array of alternatives to be narrowed to a potential corridor extending southeasterly from the mouth of the Cape Fear River. The Wilmington District Corps of Engineers and the Waterways Experiment Station then worked with the Cape Fear River navigation pilots and conducted ship simulation exercises to develop channel alignment options with turns that could be safely and efficiently navigated under all conditions. The final array of channel alternatives included (1) deepening the existing ocean entrance channel along its present alignment and extending it 3.5 miles seaward (no action alternative), (2) constructing the authorized ocean entrance channel along a more easterly alignment that includes no new channel bends, and (3) constructing the authorized ocean entrance channel along a more easterly alignment that includes two new channel bends.

The no action alternative was judged unacceptable due to its high cost and adverse environmental impacts. For ease of navigation, the river pilots favored the new alignment with no additional channel bends. However, the no-bend alignment would pass closer to Bald Head Island and through more of Bald Head Shoal. This plan would require the removal of about 20 million cubic yards of sediment, as compared to the two-bend alignment, which would require removal of about 13.4 million cubic yards. In addition, the no-bend alignment would require a much higher maintenance cost. Overall, the no-bend alignment would be approximately twice as expensive as the two-turn alignment.

Ship simulation studies showed that the two-turn alignment could be safely navigated, and the river pilots concurred with this finding. Therefore, in view of its substantially lower construction and maintenance cost, the two-turn alignment was judged the optimal available plan and is a component of the proposed action.

3.02 Disposal Alternatives for Dredged Sand. Sand dredged from the lower portion of Wilmington Harbor was historically deposited in open water and, later, disposal islands. As the islands were filled to capacity and the establishment of new disposal islands would require the loss of estuarine bottom, emphasis shifted to ocean disposal. More recently, as sand has become valued more highly as a scarce resource, attention has focused on methods to use it for beach renourishment or to retain it within the active littoral system. Currently, the alternatives available for disposal of dredged sand are (1) placement on beaches, (2) placement in the littoral zone, (3) placement in disposal islands to be recycled to beaches later, and (4) placement in the ODMDS. This is the general order of preference to utilize the resource and would be consistent with requirements of the North Carolina Coastal Management Program.

Since the construction of the pending improvements is expected to generate several million cubic yards of sandy sediment, nearby beach communities view this as possibly a once-in-a-lifetime opportunity. Therefore, dredged sand will be made available to the beaches to the maximum extent practicable. However, it is possible that all sand may not go to beach destinations due to funding constraints, seasonal restrictions to protect endangered and threatened species, or other unforeseen reasons. Sand not placed at beaches will go to the littoral zone or to disposal island recycle sites, if feasible. As a last resort and if the other options are not available, dredged sand will go to the ODMDS.

Within the context of beach disposal, all 6.0 million cubic yards of sand from project construction activities in the ocean and upstream though Lower Swash Channel would go to Bald Head Island and Caswell Beach under the base plan (see **Section 1.04.2**). Under an alternative plan such as Section 933, this sand would undergo wider distribution due to sharing among Bald Head Island, Oak Island- Caswell Beach, and Holden Beach. Variations in beach placement options could provide for sand distribution in a longer, narrower pattern or a shorter, wider pattern. The long narrow alternative is considered more advantageous in that it would provide some level of sand replenishment and shoreline protection to a greater length of shoreline. Under this scenario, sand would be distributed over a maximum of about 77,200 linear feet (about 14.6 miles) of beach (and, with the exception of transition areas, would not include the pending Sea Turtle Habitat Restoration Project that will extend over about 12,100 linear feet of the middle portion of Oak Island). With an estimated retention rate of 83 percent, about 5.0 million cubic yards of in-place material would result. By restricting crest elevation of the disposal berm to +8.0 feet NGVD, the maximum estimated berm width at the time of placement could range from about 240 feet on Bald Head Island's South Beach to about to 140 feet on West Oak Island-Caswell Beach and Holden Beach (*Table 3*). The construction width is expected to be reduced about 50% over a period of a few

months as sediment moves seaward to deeper portions of the active profile. While other placement options are possible, this approach would distribute the limited amount of sand available so as to provide widespread benefits that are economically feasible and consistent with preferences expressed by the beach communities.

Sand that may go to New Hanover County beaches has not yet been designated. Analyses are being conducted to compare relative costs of Wilmington Harbor sand with other sand sources approved for the respective New Hanover County projects. Once these analyses are complete, the results can be presented to the beach communities. If this sand is found to be a cost-efficient alternative, it could be placed according to the existing requirements and constraints of the approved beach projects involved. No new alternatives are being considered or proposed for New Hanover County beaches.

3.03 Alternative Measures to Minimize Blasting Effects on Aquatic Life. Rock that does not require blasting will probably be removed with a rock cutterhead dredge or dipper dredge. Rock blasting will be used as a construction method in cases where other methods are not considered feasible. Based on our rock boring analysis, we anticipate that at least half of the rock within the proposed construction area will probably require blasting. As indicated in **Section 1.04.5**, all reasonable and prudent measures will be used to reduce impacts of blasting on aquatic life.

If rock blasting is not performed, the deepening of the channel to authorized depth could likely not be accomplished. Without blasting, several rock ledges would likely remain protruding above project depth. This situation would preclude the benefits of project construction since vessel draft restrictions must be consistent with the controlling depth, i.e. the shallowest depth in the navigation channel.

3.04 Dredging and Disposal Alternatives. The most economical approach to dredging would involve unrestricted dredging at any location at any time of year with any kind of dredging equipment and with no constraints on dredge overflows. Likewise, disposal could be accomplished most cheaply by allowing discharge of dredged material at any location, including any waterbody, at any time of year and without containment. Measurable economic savings would be derived through more efficient scheduling of dredging equipment which is in a short supply nationwide. Under present restrictions, all dredging jobs must be completed in the few months available each year and must do so by environmentally responsible methods that protect water quality, fish and wildlife resources, submerged cultural resources, endangered and threatened species, and other important aspects of our environment.

Environmental protection is a continual goal of the USACE and its contractors, and in **no** way do we encourage relaxation of environmental standards. However, as a matter of practicality and cost savings to the taxpayer, we are continually challenged to determine how to conduct our work more cost efficiently without significantly impacting the environment. Therefore, the proposed comprehensive dredging and disposal plan presented in **Section 1.04.6 Expanded Dredging Methods** was developed to be the most flexible plan that can be reasonably implemented at this time without compromising environmental values and which is consistent with environmental laws, regulations, and goals.

4.00 AFFECTED ENVIRONMENT

4.01 Geology and Sediments. Sediments of the Wilmington Harbor vicinity generally consist of sands, silts, and clays occurring in various mixtures. Occasionally, gravel, shell fragments, limestone fragments, and organic material may also be present. The sediments are generally unconsolidated and relatively soft. They overlie carbonate rocks having different degrees of cementation and hardness. Rock formations that occur in this area, from youngest to oldest, include thin layers tentatively identified as the Waccamaw Formation and the Trent Formation, the extensive Castle Hayne Limestone, the Turritellid Limestone, and the Peedee Formation. While all these strata are not generally present at any single location, they are represented within the harbor area. The Castle Hayne Limestone is one of the regional groundwater sources for southeastern North Carolina.

Substantial amounts of low-relief hardbottoms occur along the coast of Brunswick County, generally more than one mile offshore. These consist of localized areas bare of sediments and where the ocean floor consists of hard rock. Hardbottoms are also called "live bottoms" because they support a rich diversity of marine life, and they have very high ecological value. Hardbottoms occur in the path of extending the existing alignment of the ocean bar channel and also to its west. However, surveys have not identified any hardbottoms within or immediately adjacent to the proposed new channel alignment (USACE, unpublished data, Philip Payonk).

The active beach profile, or portion of the nearshore ocean bottom affected by wave action, is comprised of sediments that consist of fine to medium quartz sand, shell hash, silts, and clays. The silt/clay component of the active profile ranges from about 2% to 5% down to about -24 feet NGVD. The predominantly mud bottom seaward of the littoral zone provides valuable habitat for shrimp which support an important fishery in these waters.

Data from seismic surveys and core borings along the existing alignment of ocean bar channel show that the top of rock (TOR) occurs approximately at elevation -70 feet mllw from station 0+00 to station 95+00 and rises to approximately -50 feet mllw at station 125+00. Seaward to station 305+00 (end of existing project) the TOR varies from about -40 feet mllw to -43 feet mllw. This rock located within the depth requirements of the authorized channel represents a serious obstacle to timely and cost-efficient completion of the harbor improvements.

TOR lies generally deeper to the east of the existing channel and shallower to the west. Existing data indicate that TOR along the proposed new ocean bar channel alignment is below -45 feet mllw. Therefore, it is anticipated that the authorized project depth (-44 feet mllw) can be achieved uniformly without blasting on this alignment.

4.02 Water Resources.

Hydrology. Tides in the area are semidiumal and the mean tidal range varies from about 4.9 feet at Bald Head Island to about 1 foot as far upstream as Lock & Dam 1, which is located about 65 miles above the river mouth. Regular reversals of flow occur with each tidal cycle except during periods of high fresh water flow. The salinity of the area varies due to many factors including freshwater inflow, tidal action, and wind. Salinity may range from fresh (0 parts per thousand, or ppt) in the upper harbor to seawater (35 ppt) in the lower river

and nearshore ocean. The average flow rate of the Cape Fear River at its mouth is about 9,700 cubic feet per second.

Water Quality Classification. Three water quality classifications of the State of North Carolina apply to the waters of Wilmington Harbor. The Cape Fear River from the mouth of the Northeast Cape Fear River downstream to a line across the river from Snows Point to Federal Point is classified as "SC"; from this line downstream to the Atlantic Ocean is "SA" (except for a restricted area in the vicinity of Southport that is classified "SC"); and waters of the Atlantic Ocean in the vicinity of the Cape Fear River mouth are classified "SB." "SC" waters are suitable for fishing, fish and wildlife propagation, secondary recreation, and other uses requiring water of lower quality. "SB" waters are suitable for primary recreation in addition to "SC" uses. "SA" waters are suitable for shellfishing for market purposes, as well as "SB" and "SC" uses (15 NC Administrative Code 2B .0311).

Groundwater. In the Wilmington Harbor vicinity, groundwater is supplied primarily by two aquifers. In descending order of elevation, they are the water table aquifer of the undifferentiated surficial sands and the Castle Hayne Limestone. Most domestic water wells are set in the surficial sands. Locally, vertical groundwater movement may occur downward through the surficial sand to the Castle Hayne Limestone. Regionally, the horizontal groundwater movement is eastward with some southeast movement. The resultant groundwater movement is toward the coast.

4.03 Air Quality. The Wilmington Regional Office of the North Carolina Department of Environment and Natural Resources has air quality jurisdiction for the project area. The ambient air quality for New Hanover and Brunswick Counties has been determined to be in compliance with the National Ambient Air Quality Standards, and these counties are designated as attainment areas.

4.04 Marine and Estuarine Resources.

Nekton. Nekton collectively refers to aquatic organisms capable of controlling their location through active movement rather than depending upon water currents or gravity for passive movement. Nekton of the nearshore Atlantic Ocean along southeastern North Carolina can be grouped into three categories: estuarine dependent species; permanent resident species; and seasonal migrant species. The most abundant nekton of these waters are the estuarine dependent species which inhabit the estuary as larvae and the ocean as juveniles or adults. This group includes species which spawn offshore, such as the Atlantic croaker (*Micropogon undulatus*), spot (*Leiostomus xanthurus*), Atlantic menhaden (*Brevoortia tyrannus*), star drum (*Stellifer lanceolatus*), southern kingfish (*Menticirrhus americanus*), flounders (*Paralichthys* spp.), mullets (*Mugil* spp.), anchovies (*Anchoa* spp.), blue crab (*Callinectes sapidus*), and penaeid shrimp (*Penaeus* spp.), as well as species which spawn in the estuary, such as red drum (*Sciaenops ocellatus*) and weakfish (*Cynoscion regalis*). Species which are permanent residents of the nearshore marine waters include the black sea bass (*Centropristis striata*), longspine porgy (*Stenotomus caprinus*), Atlantic bumper (*Chloroscombrus chrysurus*), inshore lizardfish (*Synodus foetens*), and searobins (*Prionotus* spp.). Common warm water migrant species include the bluefish (*Pomatomus saltatrix*), Spanish mackerel (*Scomberomorus maculatus*), king mackerel (*Scomberomorus cavalla*), cobia (*Rachycentron canadum*), Florida pompano (*Trachinotus carolinus*), and spiny dogfish (*Squalus acanthias*).

The State of North Carolina Artificial Reef Program (NCARP) manages 8 reefs that are located off Brunswick County. Six of these reefs (*Figure 8*) occur within about 15 miles of the existing Baldhead Shoal Channel. However, all these sites are located between 1 and 10 miles offshore and are in water about 30 to 53 feet deep. None are in proximity to the proposed work.

The surf zone along the area beaches provides important fishery habitat. Surf zone fisheries are typically diverse, and 52 species have been identified from North Carolina (Ross 1996, Ross and Lancaster, 1996). Some species may be dependent upon surf zone habitat. Recent studies indicate that juveniles of certain species may have high site fidelity and extended residence time in the surf zone suggesting its function as a nursery area (Ross and Lancaster, 1996). Two species in particular, the Florida pompano and gulf kingfish (*Menticirrhus littoralis*) seem to use the surf zone exclusively as a juvenile nursery area.

Anadromous species such as blueback herring (*Alosa aestivalis*), American shad *(Alosa sapidissima*), hickory shad (*Alosa mediocris*), alewife (*Alosa pseudoharengus*), striped bass (*Morone saxatilis*), and Atlantic sturgeon (*Acipenser oxyrhynchus*) pass through the nearshore ocean and Cape Fear estuary en route to upper river spawning and nursery areas (Walburg and Nichols, 1967; Nichols and Louder, 1970). Anadromous fish use is highest from mid-winter to mid-spring. The shortnose sturgeon *(Acipenser brevirostrum*), which is Federally listed as endangered, is an anadromous species known to occur in the Cape Fear River. Its occurrence in the nearshore ocean has not been confirmed, and it is possible that the Cape Fear River population does not make ocean runs, as is true of some northern populations of sturgeon. The catadromous American eel (*Anguilla rostrata*), is widely distributed in the Cape Fear River estuary and migrates through the area of the bar channel (Schwartz et al., 1981).

The State of North Carolina defines Primary Nursery Areas (PNAs) as tidal saltwaters which provide essential habitat for the early development of commercially important fish and shellfish. It is in these estuarine areas that many fish species undergo initial post-larval development. PNAs are designated by the North Carolina Marine Fisheries Commission. Neither the old nor new alignment for the ocean bar channel is located within a designated PNA (15 NC Administrative Code 3B .1405). Within the Cape Fear River portion of the harbor, PNAs occur from Upper Lilliput Channel upstream to the end of the project. They are located from the shoreline to 300 yards outside the harbor channel from Upper Lilliput Channel to Upper Brunswick Channel, inclusive. Upstream from that point, PNAs extend from the river shoreline to the edge of the harbor channel.

Marine mammals also occur in North Carolina's coastal waters. The Federally-endangered right whale (*Eubaleana glacialis*) and humpback whale *(Megaptera novaeangliae*) are spring and fall migrants off the coast; and the right whale often occurs in shallow water. A number of other whale and dolphin species normally inhabit deeper waters offshore, while the bottlenose dolphin (*Tursiops truncatus*) and the harbor porpoise (*Phocoena phocoena*) utilize nearshore waters. The bottlenose dolphin is common in the project area. The Federally-endangered manatee (*Trichechus manatus*) is a rare visitor, and at least 10 sightings have been documented in the project area since 1952 (***APPENDIX E***).

Three species of sea turtles are known to nest on the beaches of North Carolina and also, occasionally, enter the lower Cape Fear estuary. These include the Federally-endangered Kemp's ridley sea turtle (*Lepidochelys kempii*) and the Federally-threatened green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) sea turtles. These are discussed in **Section 4.08 Endangered and Threatened Species**.

Benthos. Aquatic organisms that live in close association with the bottom, or substrate, of a body of water, are collectively called the benthos. Benthic communities of the project area exhibit a wide range of organism composition and density, and community structure may vary considerably depending on substrate type and salinity regime. Benthic organisms in this area of the nearshore ocean were reported by Birkhead et al. (1979) at densities ranging from about 90 individuals per square meter on sand bottom to over 500 per square meter on mud substrate. This study found the tube dwelling polychaete, *Spiophanes bombyx*, to be the dominant component of the benthos collected from a spot off the eastern end of Oak Island and other locations where substrates were predominantly mud or mud-sand mixtures. Other dominants reported from this marine area included several polychaete worms (*Magelona* sp., *Heteromastus filiformis*, and *Paraprionospio pinnata*); the sea pansy (*Renilla reniformis*); and an unidentified brittlestar (amphiurid). Additional taxa reported in high numbers included the sand dollar (*Mellita quinquiesperforata*) and other polychaete worms (*Diopatra cuprea* and *Nephtys picta*).

Benthic studies conducted at the Wilmington ODMDS in 1992 resulted in the collection of 165 samples containing 2,908 individuals representing 236 taxonomic groups (USEPA, 1993). Samples were collected from 5 stations within the ODMDS and 5 stations nearby, but outside, the ODMDS boundaries. The phylum Annelida comprised the largest number of taxonomic groups (107, or 45.3%) and individuals (1764, or 60.7%), while the second most abundant phylum was the Arthropoda, with 78 taxa (33.1%) and 420 species (14.4%). The most abundant species was a polychaete worm (*Polygordias* sp.) (240 individuals, or 8.3% of the total) followed, in descending order, by rhynchocoelan worms (163 individuals, or 5.6% of the total) and various polychaete worms (*Mediomastus*, *Paraprionospio pinnata*, and *Magelona* sp.), which each represented 4.0% to 4.6% of all individuals. Molluscan species were not well-represented among the dominant benthic forms, but the most abundant were *Lucina multilineata* and *Tellina versicolor* which each made up less than 1.7% of all individuals. This study noted that species diversity, evenness, and richness varied greatly among sample stations, and that these community statistics seemed to increase with percent sand, but that percent sand was not a consistent predictor of habitat quality. In addition, the study found no correspondence between habitat type and species abundance, and no relationship between previous disposal of dredged material and either infaunal assemblage or abundance/diversity.

A number of benthic studies have also been conducted in the Cape Fear River (Lawler, Matusky, & Skelly Engineers, 1975; NC Division of Environmental Management, unpublished data, 1985; Posey et al, 1996; Ray, 1996; Woodward-Clyde Consultants, 1980). These were discussed in the 1996 Final EIS for the Cape Fear-Northeast Cape Fear Rivers Comprehensive Study (USACE, 1996a) and will not be repeated in detail here since the geographic extent of potential impacts related to the new proposed action is generally the nearshore ocean, ocean beaches, and lower river. However, several studies included information specifically about the benthos of the lower river.

Lawler, Matusky & Skelly Engineers (1975) conducted a benthic investigation at six stations ranging from near the mouth of the Cape Fear River up to the mouth of Smith Creek in the Northeast Cape Fear River. Polychaetes dominated the benthic fauna below MOTSU. Of the 21 species collected, only five species occurred above Lower Lilliput channel and only one species at Smith Creek. Species included *Scolecolepides virdis*, *Capitella capitata*, *Branchioasylis americana*, *Drilonereis longa* and *Nereis succinea*. Oligochaetes were the most abundant group in the entire river, comprising 35 percent of all collected fauna. They were most abundant from Campbell Island upstream to the Anchorage Basin. Amphipods

(*Gammarus spp.*) occurred in all samples but were most abundant near MOTSU, the Anchorage Basin and at Smith Creek. Other common species collected were Cumaceans and Isopods.

The NC Division of Environmental Management performed benthic sampling at Snows Marsh in 1985. Of the 38 species collected, polychaetes, molluscs, amphipods, and decapods dominated the site (NCDEM unpublished data). Sediments ranged from coarse sand to fine silty clays. Common species collected were polychaete worms *(Leitoscoloplos variabilis* and *Paraprionospio pinnata*) and molluscs *(Ilyanassa obsoleta* and *Crassostrea virginica).*

Shellfish beds are present in the Cape Fear Estuary, primarily south of Snows Cut (Woodward-Clyde Consultants 1980). All significant beds are in shallow water east of the navigation channel. The dominant species are the American oyster (*Crassostrea virginica*) and the clam (*Mercenaria*). In this area, both species are harvested for sale and personal consumption.

Hardbottoms. Of special concern in the offshore area are hardbottoms, which are localized areas not covered by unconsolidated sediments and where the ocean floor is hard rock. Hardbottoms are also called "live bottoms" because they support a rich diversity of invertebrates such as corals, anemones, and sponges which are refuges for fish and other marine life. They provide valuable habitat for reef fish such as black seabass, red porgy, and groupers. Hardbottoms are also attractive to pelagic species such as king mackerel, amberjack, and cobia. Along the North Carolina coast, hardbottoms are most abundant in southern portion of the state, and substantial amounts of low-relief hardbottoms occur off Brunswick County, generally more than one mile offshore. Hardbottoms occur within the path of extending the existing alignment of the ocean bar channel and also to its west. However, surveys have not identified any hardbottoms within or immediately adjacent to the proposed new channel alignment (USACE, unpublished data, Philip Payonk, 1999).

Intertidal Macrofauna. Intertidal portions of ocean beaches are inhabited by a number of invertebrate species which are ecologically important. These include mole crabs (*Emerita talpoida*) and coquina clams (*Donax* spp.), as well as various species of polychaete worms and amphipods. Mole crabs and coquinas represent the largest component of the total macrofaunal biomass of North Carolina intertidal beaches, and they are consumed in large numbers by important fish species such as flounders, pompanos, mullets, and kingfish (Reilly and Bellis, 1978). Beach intertidal macrofauna are also a seasonally important food source for numerous shorebird species. Abundance of intertidal macrofauna can be influenced by man's alteration of the beach environment through activities such as (1) beach scraping and dune shaping with heavy equipment and (2) beach placement of dredged sand. During the summer of 1999 and prior to Hurricane Floyd, Corps of Engineers biologists observed a much lower than expected shorebird abundance and diversity along Brunswick County beaches and interpreted this as a potential reflection of depleted food resources associated with beach scraping which occurs there.

4.05 Essential Fish Habitat. The 1996 Congressional amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (PL 94-265) set forth new requirements for the National Marine Fisheries Service (NMFS), regional fishery management councils (FMC), and other Federal agencies to identify and protect important marine and anadromous fish habitat. These amendments established procedures for the identification of Essential Fish Habitat (EFH) and a requirement for interagency coordination to further the conservation of Federally managed fisheries. *Table 5* lists, by life stages, 77 fish

species which may occur in the vicinity of Wilmington Harbor and which are managed under MSFCMA. *Table 6* shows the categories of EFH and Habitat Areas of Particular Concern (HAPC) for managed species which were identified in the Fishery Management Plan Amendments of the South Atlantic Fishery Management Council and which may occur in southeastern states. These fish species and habitats require special consideration to promote their viability and sustainability. The potential impacts of the new proposed actions on these fish and habitats are discussed in **Section 5.05** of this report.

4.06 Terrestrial Resources. Terrestrial areas that may be influenced by the new proposed actions include the Eagle Island CDF, Disposal Islands # 3 and # 4 of the lower river, ocean beaches of Brunswick and lower New Hanover Counties, and roadway rights-of-way utilized as corridors for dredge pipelines. Terrestrial habitat types within these areas include beaches nearly devoid of vegetation; sparsely vegetated dunes; and fringe wetlands around islands in the river. Utility corridors may exhibit herbaceous or shrub cover. Barren areas are also widespread due to the disturbed nature of the disposal islands and utility corridors.

Among North Carolina's upland habitats, the beach and dune community could be considered depauperate in both plants and animals. The beach environment is severe due to constant exposure to salt spray, shifting sands, wind, and sterile soils with low water retention capacity. Common vegetation of the upper beach includes beach spurge (*Euphorbia polygonifolia*), sea rocket (*Cakile edentula*) and pennywort (*Hydrocotyle bonariensis*). The dunes are more heavily vegetated, and common species include American beach grass (*Ammophila breviligulata*), panic grass (*Panicum amarum*) sea oats (*Uniola paniculata*), broom straw (*Andropogon virginicus*) and salt meadow hay (*Spartina patens*).

North Carolina beaches offer valuable habitat for shorebirds, and use by these birds can be extremely heavy during migration periods. However, the value of project area beaches for shorebirds may have declined over time due to continued development, high public use, and man's disturbance through activities such as beach scraping with heavy equipment, which may deplete supplies of intertidal invertebrates that are important food sources for shorebirds. Dunes of the project area support fewer numbers of birds than the beaches but can be very important habitats for resident songbird species and for other species during periods of migration.

The Eagle Island CDF, located across the river from downtown Wilmington, is the largest existing upland disposal site for Wilmington Harbor. The portion used for disposal is approximately 880 acres and is dominated by a monoculture of common reed (*Phragmites australis*). This portion has marginal value to wildlife, but surrounding areas with tree and shrub cover provide important habitat for small mammals and songbirds. Linear borrow pits along the dike interior provide fresh water during most of the year, and are utilized by waterfowl, migrating shorebirds, and alligators. Along the Cape Fear and Brunswick Rivers, mixed marsh and expanses of smooth cordgrass (*Spartina alterniflora*) are common.

Disposal Islands # 3 and # 4 are small sandy islands located near river miles 7 and 8, respectively. Areas enclosed within their dikes are about 29 and 25 acres, respectively, and are mostly barren sand. Exterior to their dikes, they are also barren or vegetated with herbaceaous cover. Smooth cordgrass occurs in narrow fringes along their shorelines on the side away from the navigation channel where less wind, wave action, and ship-related turbulence occurs.

4.07 Wetlands and Flood Plains. Wetlands of the entire Wilmington Harbor project have been described in previous reports incorporated by reference in **Section 2.00**. These descriptions are still generally accurate, but encompass wetlands far more extensive than those that could be affected by the proposed action. Coastal wetlands of the vicinity include tidal salt marshes which occur along the shorelines and the island fringes of the lower Cape Fear River. These marshes are comprised mainly of smooth cordgrass and are generally more extensive where they are more protected from wind and wave action. Intertidal wetlands of the area are very important ecologically due to their high primary productivity, their role as nursery areas for larvae and juveniles of many marine species, and their refuge/forage value to wildlife. In addition, they provide esthetically valuable natural areas. Non-tidal wetlands consisting of monotypic stands of the invasive plant, *Phragmites*, occur within some of the diked island disposal areas. Wetlands within the proposed work areas are found inside the dike of Eagle Island and in small expanses scattered along pipeline corridors to beach disposal sites in New Hanover County.

4.08 Endangered and Threatened Species. Updated lists of endangered and threatened (E&T) species for the project area were obtained from NMFS (Southeast Regional Office, St. Petersburg, FL on March 17, 1999) and the U.S. Fish and Wildlife Service (USFWS) (Field Office, Raleigh, NC on March 23, 1999). These were combined to develop the composite list shown in *Table 7*, which includes E&T species that could be present in the area based upon their historical occurrence or potential geographic range. However, the actual occurrence of a species in the area depends upon the availability of suitable habitat, the season of the year relative to a species' temperature tolerance, migratory habits, and other factors. The likelihood of occurrence and potential project impacts regarding E&T species are summarized in **Section 5.08**.

4.09 Cultural Resources. The Cape Fear River has a long and active history as one of the earliest and most significant waterways in North Carolina. Spanish explorers sighted the river at least as early as the first quarter of the 16th century and European settlement began in 1664 with the establishment of Charles Town near the mouth of Town Creek. The settlement of Charles Town was accompanied by scattered plantations and farms spreading out for 60 miles along the waterways of the Cape Fear River. The most significant pre-Colonial settlement was Brunswick Town, established in 1725 and now a State Historic Site. Although never a large town, Brunswick Town survived for 60 years as the administrative center for North Carolina's five ports of entry. By 1733, the town of New Carthage, later renamed Wilmington, had been laid out, and in a few decades it would begin to outstrip Brunswick Town as a cultural and maritime center.

During the years leading up to the Revolution, numerous confrontations took place between the American patriots and British loyalists and troops. Perhaps one of the most significant was the escape of Royal Governor Josiah Martin from his home in New Bern to Fort Johnston. Local patriots had been harassing Fort Johnston for some time, and Martin was eventually forced from Fort Johnston onto the British vessel *Cruizer*. Despite this success of the patriots, the English remained in control of the Cape Fear, conducting sporadic raids on plantations and mills, with Wilmington itself being occupied by the British in October of 1781.

During the 19th century, up to 40 ships per month were visiting Wilmington's harbor, and by the mid-19th century there were over 140 named landings located along the 115 miles of river between Wilmington and Fayetteville. The importance of Wilmington to the Confederacy is reflected in the fortifications used to protect the city and her approaches. Fort Fisher, Fort Holmes, Zekes Island Battery, Camp Wyatt, Fort Hendrick, Fort Campbell, Fort Johnston, Fort Caswell, Battery Buchanan, Fort Anderson, Shaw Battery,

Mound Battery, and Battery Lamb were located on the Cape Fear River at and below Wilmington, or faced the ocean and river in Brunswick County, and all were important elements in the coastal defenses. The defenses at Wilmington were not defeated until late in the war when Fort Fisher finally fell in the largest amphibious assault then known. The Fort was pounded by 57 Union gunboats and attacked by up to 6,000 troops before it eventually surrendered in 1865; Wilmington was occupied by Union troops soon afterward.

After the Civil War, Wilmington's major water courses began to reflect the transition from plantation and agrarian economies to the commercial agriculture and industrial enterprises that would dominate throughout the 20th century. By 1905, channel improvements made the Northeast Cape Fear River navigable for pole boats all the way to Kornegays Bridge, 103 miles above the river's mouth, and ship building, fertilizer and brick factories, shipping terminals, and other capital intensive industries began to replace commercial fishing, hunting, forestry, and agriculture as economically dominant businesses. This shift to industrialization is reflected along the banks of the Wilmington waterfront by the remains of numerous shipyards, Liberty Ships, marine railways and dry docks, and the hulks of vessels of virtually every variety.

Archaeologically, the importance of the area as a maritime center is shown by the large number of shipwrecks and abandoned shipyards. Thirty-seven historic shipwrecks are listed on the 1985 National Register of Historic Places Registration addendum for the Wilmington Historic District prepared by the North Carolina Division of Archives and History (NCDAH). In addition, over 130 shipwrecks are known from the lower Cape Fear - Northeast Cape Fear River vicinity, and nearby upland historic sites include Charles Town, Brunswick Town, Fort Johnston (1750-present), the Robbins Site (1820-1925), Battery Lamb (1865), Fort Anderson (1865), Fort Fisher (1865), and Fort Caswell (1826). An additional 50 lesser known prehistoric and historic sites are also known along the rivers throughout New Hanover and Brunswick Counties.

4.10 Esthetic and Recreational Resources. A scenic setting is provided by the ocean and river, coastal beaches, and the numerous vessels common to these waters, including commercial and recreational boats as well as ships calling on the port. The marine environment provides opportunities for boating and fishing, as well as an escape from the faster pace of land-based activities. Beaches generally offer extensive recreational opportunities for activities such as swimming, sunbathing, walking, surfing, birdwatching, and fishing. However, the beaches of Brunswick County have lost some of their visual appeal due to the severe erosion resulting from the hurricanes of 1996-1999.

4.11 Recreational and Commercial Fishing. Recreational and commercial fishermen extensively utilize the nearshore marine and riverine waters of North Carolina's southeast coast. Primary species sought include flounder, trout, spot, croaker, bluefish, Spanish mackerel, king mackerel, penaeid shrimp, and blue crabs. Traditional fishing grounds, primarily for shrimp, occur in the project vicinity off Bald Head Island and Oak Island (*Figure 2*). These areas are of prime importance to the local fishing industry. In addition, sport and commercial fishing is being conducted in the vicinity of a reef-like community that is developing at the WOFES, a feature formed by the USACE placement of dredged rock at a location about 4 miles off Bald Head Island and east of the ODMDS.

4.12 Socio-Economic Resources. Wilmington Harbor provides significant economic benefits to the Nation. The harbor has handled an average of about 8 million tons of commerce annually for the last 10 years. Commerce through the port generated at least 96,000 jobs in North Carolina and about $2.4 billion of income to the State in 1994. Foreign imports and exports for North Carolina in 1994 were valued near $25 billion. Benefits from the harbor are expected to increase with future growth of commerce.

5.00 ENVIRONMENTAL IMPACTS

Construction and maintenance activities included in the proposed action involve methods that are generally similar to those addressed in previous project documents (incorporated by reference in **Section 2.00**) and which have been utilized historically for Wilmington Harbor. Environmental effects will also be similar, and discussions of impacts previously described will not be repeated here in detail. The potential impacts that will be addressed in this section would result from the following differences:

- a new ocean bar channel will impact an area of ocean floor not previously disturbed by dredging,
- beach-quality sand from the harbor may be placed on beaches of Brunswick and/or New Hanover Counties, at approved littoral zone disposal sites, or at disposal islands for future sand recycling,
- non-beach-quality sediments from harbor deepening or maintenance will be used to backfill the abandoned ocean bar channel after the new alignment is completed,
- rock blasting will be conducted in the river in a manner to protect marine/aquatic resources, but without a requirement for air bubble curtains or physical barriers, and
- dredging and disposal options will be expanded to include all those possible that are consistent with environmental protection laws, regulations, and policies. Proposed changes generally include (1) moving the boundary for year-around dredging upstream from about river mile 3 (Battery Island Channel) to about river mile 9 (through Horseshoe Shoal Channel) for hydraulic pipeline and hopper dredges; (2) overflowing sediment transport vessels to achieve economic loading upstream through Upper Brunswick Channel (with monitoring of sediment plumes in Big Island Channel and Upper Brunswick Channel due to > 10% silt/clay and proximity of PNAs); (3) operating hopper dredges without overflow from the Fourth East Jetty Channel upstream; (4) allowing placement of beach-quality sand on ocean beaches and in the littoral zone; and (5) placing dredged material from any portion of the harbor into any CDF or the ODMDS with any combination of dredging and ancillary equipment so long as the material is approved for disposal in accordance with Section 404 of the Clean Water Act (for inland and nearshore disposal) or Section 103 of the Marine Protection, Research, and Sanctuaries Act (for ocean dumping).

Impacts addressed here include only those related to new facets of the proposed work. These relate primarily to dredging and disposal, which have the potential to adversely affect animals and plants, as well as their physical and chemical environments, in a variety of ways. Effects may result from actions of the dredging equipment (i.e., cutting, suction, sediment removal, hydraulic pumping of water and sediment); physical contact with dredging equipment and vessels (i.e., impact); physical barriers imposed by the presence of dredging equipment (i.e., pipelines), and discharge of dredged material in various disposal locations (i.e., covering, suffocation, turbidity). Potential impacts vary according to the type of equipment used, the nature and location of sediment discharged, the time period in relation to life cycles of organisms that could be affected, and the nature of the interaction of a particular species with the dredging activities. Potential impacts are discussed, by category, in the following section.

Rock blasting can potentially kill or injure any organism within proximity to its explosive force, and may adversely affect animals at greater distances through behavioral responses to the discomfort or annoyance caused. Blasting impacts were addressed in detail in the Final EIS for the Cape Fear-Northeast Cape Fear Rivers Comprehensive Study (USACE, 1996a) and will not be addressed in this report except in regard to the results of test blasting and elimination of the requirement for air curtains.

5.01 Geology and Sediments. Removal of dredged sediments associated with the proposed work is not expected to produce any significant adverse geologic impacts. Sediments of the general vicinity, including the channel bottom, the nearshore ocean, and the ODMDS, are continually subject to movement facilitated by strong currents. Redistribution of sediments is, therefore, a natural and continuous phenomenon. Potential project-related impacts are addressed in the following paragraphs.

Impacts on Sediment Erosion Rates. A wave transformation analysis was conducted to determine whether the new channel alignment would result in the concentration of longshore wave energy flux along the area beaches and whether associated sediment transport would be changed by the new channel. The results of this analysis showed essentially no difference in sediment transport potential between the existing condition and that with the new channel alignment. The sand management plan (***Appendix A***) for the deepened Wilmington Harbor project requires that all beach-quality maintenance material be returned to the adjacent beaches. This will result in enhancement of the regional sediment budget. Accordingly, erosion rates on the adjacent beaches will be reduced compared to historic rates.

It should be noted that the area beaches, particularly on Oak Island, are presently sand starved, which has exposed old lagoonal deposits that are being eroded and which contribute to the fine-grain sediment loading of the area. The periodic placement of the beach-quality sand will help to assure that these lagoonal deposits remain buried and not subject to further erosion.

Impacts on Nearshore Sediment Movement. The existing natural system near the mouth of the Cape Fear River is dominated by the riverine muds transported to the ocean from upland areas of North Carolina. The primary sediments lying offshore of the active littoral zone, i.e., seaward of the 24 foot NGVD depth contour, consist of a thin veneer of muds interlaced with pockets of sand and shell hash. Rock located in this area is periodically covered and uncovered by these riverine sediments during storm events. The amount of additional sediment put into suspension during the deepening of the harbor will be minor compared to the volume of fine-grained sediment transported into the nearshore waters by the natural system. Periodic maintenance dredging for the deepened project is estimated to require dredging about the same amount of material as with the existing project. Sediment movement in the nearshore ocean will not be significantly affected by the proposed action.

Impacts of Beach Placement of Dredged Sand. Sand proposed for placement on the adjacent beaches will have a fine-grained sediment content averaging no more than 10%, which is within acceptable standards. Compatibility analyses comparing the size distribution characteristics of the new work dredge material and the periodic maintenance material with that on the adjacent beaches indicates a good match. The sand to be placed on the area beaches, particularly the periodic maintenance material, is derived from the existing littoral system of the region. This material is inherently compatible with the existing native beach sands since the beaches are the source of this sediment. Accordingly, any of this material placed on the adjacent beaches will adjust to the same profile slopes as the existing beaches. The primary

difference will be that the entire beach profile will be moved seaward, perhaps 100 feet or more. Simply moving the profile seaward does not result in a higher level of wave energy as waves moving onshore will undergo the same degree of wave transformation due to shoaling, refraction, and diffraction as they presently do.

Area beaches have experienced severe erosion resulting from the 6 hurricanes that passed through eastern North Carolina during 1996-1999 (Bertha, Fran, Bonnie, Dennis, Irene, and Floyd). The total sand volume to be derived from the proposed action will be far less than that lost through erosion, so the proposed placement of sand would only partially restore these beaches to their profile before these recent storms. The overall physical impacts of sand placement on beaches are insignificant in a geological context. Biological impacts are discussed in the sections of this report dealing with living organisms.

Impacts of Channel Backfilling. The abandoned entrance channel, if not refilled with dredged material, would gradually refill by natural sedimentation, and eventually its depths would be comparable to the surrounding bathymetry. However, backfilling of the channel is intended to hasten this recovery. Regardless of efforts to refill the old channel, its depths will ultimately be controlled by natural processes, including tides, waves, and currents, and should resemble the surrounding ocean floor.

Impacts of Ocean Disposal. Disposal of Wilmington Harbor sediments in the ODMDS has been previously addressed in the environmental documents referenced in **Section 2.00** and has been found to be environmentally acceptable. Sediments from the existing ocean bar channel (maintenance materials exceeding 10% fines) were chemically and biologically tested in 1992 (Ward et al., 1993). The tests indicated that these sediments meet the criteria of the USEPA Ocean Dumping Regulations and Criteria (40 CFR 220-229) and are, therefore, acceptable for ocean dumping under Section 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972 (PL 92-532), as amended. USEPA, Region IV, has concurred, by letter dated December 21, 1993, that this material was suitable for ocean disposal. The sediments from the new channel alignment are believed to be similar to the sediments previously tested, or even less affected by anthropogenic contaminants due to their deeper and more isolated locations. Recent evaluations indicate that Wilmington Harbor sediments from the new ocean bar channel alignment and all channels upstream to the Memorial Bridge (about river mile 27) are acceptable for ocean disposal. These results are being coordinated with USEPA, Region IV to obtain concurrence for ocean disposal. With the exception of sediments upstream of Memorial Bridge, which are not proposed for ocean disposal, any dredged materi .l from construction and maintenance of the Wilmington Harbor project is acceptable for disposal in the ODMDS and is not expected to produce any significant adverse effects.

Impacts on Hardbottoms. Hardbottoms occur extensively off the coast of Brunswick County and are present in the path of extending the existing ocean bar channel further seaward. However, the proposed action will avoid these hardbottoms, and will, instead, direct the new ocean bar channel through an area where no hardbottoms have been identified. Also, the location of all the known hardbottom off Brunswick County is seaward of the active littoral zone where all of the beach-quality material is to be placed and will ultimately reside. Hardbottoms are not expected to be affected by the proposed action.

Impacts of Rock Removal. Rock removal impacts have been addressed in previous documents (USACE, 1996a) and will not be repeated here since the proposed action has no new rock removal components.

5.02 Water Resources.

Groundwater. Dredging will not adversely affect groundwater of the area. The Castle Hayne Limestone formation below the channel bottom is already exposed to salt water. Groundwater in the area moves generally east and southeast along a regional gradient of about 8 feet per mile. The potential for saltwater intrusion into groundwater does not exist unless a reversal of hydrologic gradient occurs due to excessive groundwater pumping. Water supplies of nearby communities will not be affected by the proposed action.

Water Quality. The potential water quality impacts of dredging and disposal have been addressed in the documents incorporated by reference in **Section 2.00**. These impacts include minor and short-term suspended sediment plumes and the release of soluble trace constituents from the sediment. Suspended sediments also affect turbidity, an optical property of water (measured in nephelometric turbidity units, or NTUs) that affects light penetration into the water column. During dredging, turbidity increases outside the dredging area should be less than 25 NTUs and are, therefore, considered insignificant. In the case of overflowing hopper dredges or scows to obtain economic loading, sediment which is more than 90% sand is not likely to produce significant turbidity or other water quality impacts (USACE, 1997). When the channel being dredged is adjacent to PNAs and dredged sediments are < 90% sand, dredge/scow overflows will be monitored to verify that the turbidity plume remains within permissible limits and, also, that increased sedimentation and associated impacts do not occur in the PNAs. The approved **Overflow Monitoring Plan** appears in ***Appendix C***. Where the navigation channel is contiguous to PNAs, dredge/scow overflow will not be allowed. Overall water quality impacts of the proposed action are expected to be short-term and minor. Living marine resources dependent upon good water quality should not experience significant adverse impacts due to water quality changes.

A Section 404(b)(1) evaluation and a Section 401 Water Quality Certificate under the Clean Water Act of 1977 (PL 95-217), as amended, are required for proceeding with specific aspects of the proposed action, including placement of sand on beaches or in the littoral zone, backfilling the abandoned ocean bar channel, and relaxation of overflow restrictions in portions of the harbor not previously certified for this activity. The Section 404(b)(1) evaluation appears in ***Appendix D***. The Wilmington District is applying for a Section 401 Water Quality Certificate from the North Carolina Division of Water Quality.

Hydrology. Marine waters of the project area display considerable daily variation in current and salinity conditions due to fresh water inflow, tides, and wind. Within the ocean environment, any project-induced changes in the vicinity of the proposed work would be very small (if any) in comparison and are, therefore, considered to be insignificant.

Potential salinity intrusion into the Cape Fear River system has been previously modeled and addressed in the documents incorporated by reference in **Section 2.00**. As is discussed most recently in the Final EIS for the Wilmington Harbor Comprehensive Study (USACE, 1996a), completion of all the pending harbor improvements is predicted to produce no significant change in salinity but may increase tidal range about 4 inches (high tide 2 inches higher and low tide 2 inches lower) in the Wilmington vicinity. Because of the relatively flat topography along much of the Cape Fear River, the predicted increase in tidal range is expected to increase the lateral flow of the tide into adjacent areas. Associated riverine wetland responses could include conversion of swamps to tidal brackish marsh and the conversion of some terrestrial areas to wetlands. However, since the overall acreage of waters and wetlands would increase rather than decrease

under this scenario, the impacts are not considered to be adverse. Nevertheless, the Wilmington District USACE has committed to and initiated a pre- and post-construction monitoring program to document changes in salinity and tide elevations and associated vegetational changes. The currently proposed action is not predicted to alter the previous findings regarding salinity intrusion in Wilmington Harbor, nor to produce significant changes in the hydrology or salinity of the Cape Fear River system or the Atlantic Ocean.

5.03 Air Quality. Air quality impacts for Wilmington Harbor improvements have been previously assessed and determined to be insignificant. It was also determined that an air quality conformity determination would not be required because New Hanover and Brunswick Counties have been determined by the State of North Carolina to be attainment areas, the ambient air quality of these two counties is in compliance with National Ambient Air Quality Standards, and the direct and indirect emissions from the project will fall below prescribed de minimus levels (USACE, 1996a). While the proposed action will not increase the overall construction period, the original estimated construction period of 3 years for the entire harbor improvement project has been reevaluated and has been revised to 5 years. However, the magnitude of emissions over the construction period is not predicted to increase over those previously addressed, and air quality impacts will be insignificant. The project is in compliance with Section 176 (c) of the Clean Air Act, as amended.

5.04 Marine and Estuarine Resources.

Impacts on Nekton. Most free-swimming animals, including fish, shellfish, marine mammals, sea turtles, and cephalopod mollusks, are not expected to experience any significant direct effects from the proposed action. However, dredging and blasting may result in minor and/or temporary impacts.

- Dredging Impacts. Bucket or clamshell dredges are not anticipated to affect free-swimming animals since physical contact by the dredging equipment is unlikely, and no suction is employed. Hydraulic pipeline dredging does not pose a significant threat to most nekton because their mobility can enable them to avoid or escape from a dredge's suction-velocity field, which extends over only a small area in the vicinity of the operating cutterhead. Hopper dredges are also expected to have little, if any, impact on most nektonic species, but they pose a particular threat to sea turtles and are addressed in that regard in ***Appendix E*, Biological Assessment – Endangered Species.**

- Entrainment Impacts. Larvae and early juvenile stages of many species pose a greater concern that adults because their powers of mobility are either absent or poorly developed, leaving them subject to transport by tides and currents. This physical limitation makes them potentially more susceptible to entrainment by an operating hydraulic or hopper dredge. Organisms close to the dredge cutterhead or draghead may be captured by the effects of its suction and may be entrained in the flow of dredged sediment and water. As a worst-case, it may be assumed that entrained animals experience 100 percent mortality, although some small number may survive. Susceptibility to this effect depends upon avoidance reactions of the organism, the efficiency of its swimming ability, its proximity to the cutterhead, the pumping rate of the dredge, and possibly other factors. Behavioral characteristics of different species in response to factors such as salinity, current, and diurnal phase (daylight versus darkness) are also believed to affect their concentrations in particular locations or strata of the water column. Any organisms present near the channel bottom would be closer to the dredge cutterhead and, therefore, subject to higher risk of entrainment. Seasonal timing of dredging may also be a factor in the overall risk to larval forms. This is reflected in the present restriction by the NC Division of

Marine Fisheries that limits hopper and hydraulic pipeline dredging in the river to the months of August through January to avoid the periods of highest risk for early life stages of important species, especially anadromous fishes.

The biological effect of hydraulic entrainment has been a subject of concern for more than a decade, and numerous studies have been conducted nationwide to assess its impact on early life stages of marine resources, including larval oysters (Carriker et al., 1986), post-larval brown shrimp (Van Dolah et al., 1994), striped bass eggs and larvae (Burton et al., 1992), juvenile salmonid fishes (Buell, 1992), and Dungeness crabs (Armstrong et al., 1982). These studies indicate that the primary organisms subject to entrainment by hydraulic dredges are bottom-oriented fishes and shellfishes. The significance of entrainment impact depends upon the species present; the number of organisms entrained; the relationship of the number entrained to local, regional, and total population numbers; and the natural mortality rate for the various life stages of a species. Assessment of the significance of entrainment is difficult, but most studies indicate that the significance of impact is low. Reasons for low levels of impact include: (1) the very small volumes of water pumped by dredges relative to the total amount of water in the vicinity, thereby impacting only a small proportion of organisms, (2) the extremely large numbers of larvae produced by most estuarine-dependent species, and (3) the extremely high natural mortality rate for early life stages of many fish species. Since natural larval mortalities may approach 99 percent (Dew and Hecht, 1994; Cushing, 1988), entrainment by a hydraulic dredge should not pose a significant additional risk in most circumstances. Neither direct quantification studies nor modeling efforts have demonstrated population level impacts due to larval entrainment by hydraulic dredges (memo of August 8, 1995 from Douglas Clarke, PhD., Coastal Ecology Branch, Waterways Experiment Station, USACE, Vicksburg).

Assessment of potential entrainment impacts of the proposed action may be viewed in a more site-specific context by comparing the pumping rate of a dredge with the amount of water present in the waterbody affected. The largest hydraulic dredge likely to work in the harbor would have a discharge pipe about 30 inches in diameter and would be capable of transporting about 40,000 cubic yards of sand per day if operated 24 hours (24 hour per day, 7 day per week operation is not normal). The sediment would be pumped as a slurry containing about 15% sand and about 85% water by volume. The volume of water discharged would, thus, be about 226,700 cubic yards per day, or about 70 cubic feet per second (cfs). In contrast, the average daily flow of the Cape Fear River near its mouth is about 9,700 cfs. Therefore, the amount of water intercepted by the operating dredge (70 cfs divided by 9,700 cfs) is estimated to be less than 8/10ths of 1% of the average daily flow in the river. Because of this relatively small amount of water passing through the dredge as compared to river flow, entrainment impacts should be minor also. Essentially all dredging in the harbor is done by the USACE, with the exception of areas around docks and wharves, so other dredges are not a significant additive factor for entrainment impact in the river.

The proposed action would move the presently approved boundary for year-around dredging from the upstream limit of Battery Island Channel (near river mile 3) to the upstream limit of the lower harbor (upper end of Horseshoe Shoal Channel near river mile 9). This change would allow year-around sand removal from the lower harbor while the present seasonal restriction would still apply upstream. Designated PNAs begin at the boundary between Lower and Upper Lilliput Channels (near river mile

16), so the proposed limit change would stop about 7 miles short of the more sensitive PNA reaches of the river. Potential entrainment impacts of this proposed change are not expected to be significant.

A dredge operating in the open ocean would pump an even smaller amount of water in proportion to the surrounding water volume. Therefore, entrainment impacts of dredging for the ocean bar channel realignment are expected to be insignificant.

In summary, only a very small percentage of marine and estuarine larvae are subject to entrainment, so dredging conducted as part of the proposed action is not expected to create significant impacts on these life forms at local or regional population levels.

- Blasting Impacts. The blasting plan described in the Final Feasibility Report and Environmental Impact Statement for the Cape Fear - Northeast Cape Fear Rivers Comprehensive Study (USACE, 1996a) was estimated to produce an area of lethal impact for aquatic life (LD1, where 1% or more of fish would die) of about 34.5 acres for each blast comprised of 80 charges, if no air curtain is used. Blasting tests have since demonstrated that, without an air curtain, the lethal zone (LD1) is about 2.1 acres, or 94% less than previously predicted. In addition, further rock coring data and analyses have indicated a reduction in the estimated volume of rock to be removed from the harbor, its associated acreage, and the total estimated number of blasts that may be needed (***Appendix B***). Therefore, the blasting impacts predicted in 1996, based upon data available at that time, appear to be substantially overstated. Even with the elimination of the requirement for air curtains, blasting impacts associated with construction of the authorized project will be far less than previously estimated. While some mortality of fishes may occur in proximity to each blast, the number affected is not expected to be large, and this impact is not expected to be significant. Protective measures incorporated into the present blast plan are itemized in **Section 1.04.5**. Potential blasting impacts on endangered and threatened species are addressed in ***Appendix E***, **Biological Assessment – Endangered Species**.

Impacts on Benthos. Previous environmental documents have addressed construction and maintenance dredging for all channels of the Wilmington Harbor project, with the exception of the new alignment for Baldhead Shoal Channel. Construction of this channel will affect about 643 acres which will result in mortality of nearly all sedentary or slow-moving benthic organisms along with removal of the sediments down to -46 feet mllw. Harbor maintenance activities have previously disturbed about 205 acres of this bottom, including the shoreward end of the existing channel (83 acres) which has been periodically dredged, and the channel section that passes through the existing ODMDS (122 acres) which has experienced periodic episodes of heavy sedimentation associated with ocean disposal events. Approximately 438 acres of the new channel have not been previously disturbed by dredging activities.

Removal of benthos and benthic habitat by channel dredging represents a temporary resource loss since the channel bottom will become a new area of benthic habitat and will be recolonized by benthic organisms. However, physical conditions will be different from those of the previously undredged area because the new channel will be subject to turbulence created by passing ships and to periodic disturbance from maintenance dredging that is expected to occur on a 2-year cycle. Therefore, the new benthic community which develops may be different in terms of species diversity, biomass, or other characteristics. The ecological significance of temporary benthic losses is not well-understood but is considered minor since the

affected area is very small relative to the amount of benthic habitat present on the ocean bottom and the time span of loss is likely a period of months .

Future maintenance dredging along the new channel will result in nearly total, but temporary, loss of its benthic inhabitants, and benthic impacts are not expected to be appreciably different from those that would occur if the present channel alignment was maintained. Some degree of benthic resource recovery will occur between dredging events, and periodic fluctuation in benthic populations of the new channel bottom should resemble conditions which have been present in the existing channel bottom for many years. Benthic populations in the vicinity are in a state of flux due to the continual sedimentation and shoaling which creates the need for maintenance dredging.

After the new alignment is completed, the benthic losses related to its construction will be offset by backfilling about 224 acres of the abandoned portion of the old alignment (from station 130+00 seaward). Non-beach-quality sediments from other harbor areas will be used to refill the channel to the approximate bathymetry of the surrounding ocean floor. As the new sediments stabilize, the area is expected to repopulate with benthic organisms from nearby, and, over time, to exhibit a viable benthic community. Since sediment characteristics in the backfilled channel will not precisely match those of the surrounding ocean floor, the new benthic community may exhibit somewhat different community structure.

With construction of the realigned channel, the previously approved extension of the old Baldhead Shoal Channel will not be constructed, so this area of about 230 acres (including bottom and side slopes) will not require disturbance of its benthic resources and benthic habitat by dredging. In addition, maintenance of the new alignment will periodically impact an area of about 643 acres compared to about 657 acres if the old alignment were developed and maintained. Overall, the benthic impacts of constructing and maintaining the new alignment are considered to be less significant than deepening and extending the old alignment.

Temporary loss of the benthic habitat and benthic organisms will occur along access channels which must be established to allow a 30-inch dredge to enter Disposal Islands # 3 and # 4 to remove the sand present. Minimum dimensions for the access channels will need to be about 200 feet of bottom width and about 15 feet of depth. This is estimated based on field experience at the Brant Island disposal site at Morehead City where a 30-inch dredge is also used. Channel lengths of about 800 feet and 1,000 feet will be required for Disposal Islands # 3 and # 4, respectively. Allowing for side slopes of 1V:5H in the sandy substrate, the affected bottom area is estimated at less than 5 acres for each of the 2 entrance channels required. Essentially total loss of benthos will occur during dredging, but recovery will begin immediately and is expected to be completed over a period of months. After dredging is complete, the access channels to the islands will be plugged at the island perimeter, and the bottom of the access channel will remain undisturbed by dredging until the next sand removal episode, which is expected to be at intervals of about 8 to 10 years. During the intervening years, the benthic community is expected to fully reestablish.

Impacts on Hardbottoms. Numerous hardbottoms have been documented in the nearshore ocean off Brunswick County, including the extended path of the existing ocean bar channel and the area to its west. However, ocean-bottom surveys in the vicinity of the proposed new alignment have not indicated any hardbottoms within or near its path. Channel construction along the new path will avoid construction of the previously approved extension of the old Baldhead Shoal Channel. Therefore, the proposed action will have

no direct effect on hardbottoms and will allow avoidance of the 230 acres documented to have valuable hardbottoms present.

Impacts on Intertidal Macrofauna. Beach disposal of dredged material may have negative impacts on intertidal macrofauna through direct burial, increased turbidity in the surf zone, or changes in the sand grain size or beach profile. Some previous disposal operations have resulted in nearly complete localized mortality of intertidal macrofauna (Reilly and Bellis, 1978) while others involving disposal of coarse sand have caused only temporary shifts in population distribution that are believed to represent only minor impacts (Hayden and Dolan, 1974). Any reduction in the numbers and/or biomass of intertidal macrofauna present immediately after beach disposal may have localized limiting effects on surf-feeding fishes and shorebirds due to a reduced food supply. In such instances, these animals may be temporarily displaced to other locations. In most cases, the affected beach should recover within one or two years following the disposal event.

Depending upon the economic costs of sand placement at various area beaches and the final sand distribution plans preferred by the beach communities, sand from construction of the Wilmington Harbor Project could be placed over portions of beaches totaling up to about 77,200 linear feet in Brunswick County (*Figure 4*) and about 39,000 linear feet in New Hanover County (*Figure 7*). Sand placement on Brunswick County beaches would occur on areas that have been seriously eroded by 6 hurricanes that have passed by during 1996 through 1999. Subsequent efforts by private interests to restore these beaches to profiles more protective of oceanfront development have included beach scraping by heavy equipment. Consequently, local populations of intertidal macrofauna have likely undergone reductions from this activity. Nevertheless, new sand placed in these areas will impact the remaining populations.

Placement of sand on New Hanover County beaches would be done as a component of the normal renourishment cycle for Federal shore protection projects or to address unacceptable erosional losses at the state's Fort Fisher project that protects the historic battlefield site. The Federal shore protection projects are previously nourished beaches, and their periodic replenishment is planned and previously approved. The Fort Fisher Revetment project has not previously received sand replenishment, but this activity is approved when monitoring indicates that erosion rates exceed specific thresholds (USACE, 1995).

While beach disposal may produce negative effects on intertidal macrofauna, these are localized in the vicinity of the disposal operation. Beach disposal conducted as a component of the proposed action would occur year-around during construction of harbor improvements, but would be expected to move along the beach at a relatively slow rate of less than 200 feet per day (about 1 mile per month) on average. This rate of progress is slow enough that surf-feeding fishes and shorebirds may move to other areas that are not affected by the disposal operation. Also, this rate of progress would mean that only a few consecutive miles of beach would be affected during any season of the year. As the dredging operation passes by a given section of beach, that area is soon available for recolonization by invertebrates.

After the Wilmington Harbor improvements are completed, subsequent sand placement on beaches in conjunction with channel maintenance would be conducted, to the maximum extent practicable, during the November 15 - April 30 window established for the protection of nesting sea turtles. This seasonal sand placement would also be less disruptive of the invertebrate community of the intertidal zone.

While the proposed beach disposal will adversely impact intertidal macrofauna, these effects will be localized, short-term, and reversible. Therefore, the impacts are considered minor.

5.05 Essential Fish Habitat. The Fishery Management Plan Amendments of the South Atlantic Fishery Management Council identify a number of categories of Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC), which are listed in *Table 8.* While all 26 of these habitat categories occur in waters of the southeastern United States, more than one-third of them are absent from the project vicinity. Those absent include estuarine scrub/shrub mangroves which require a more tropical environment, Hoyt Hills located in the Blake Plateau area in water 450-600 meters deep, Big Rock and Ten-Fathom Ledge located off Cape Lookout, the Point located off Cape Hatteras near the 200-meter contour, New River located about 60 miles northeast of Cape Fear, and Bogue Sound located over 75 miles northeast of Cape Fear. In addition, there are no Council-designated Artificial Reef Special Management Zones or seagrass beds in or near Wilmington Harbor. Impacts on habitat categories potentially present in the project vicinity are discussed below.

Impacts on Aquatic Beds and Wetlands. Aquatic beds (defined as assemblages of submerged rooted vascular vegetation found in tidal freshwater areas), estuarine emergent wetlands, palustrine emergent and forested wetlands all may be present in the Cape Fear and Northeast Cape Fear Rivers of the project area. However, these habitats occur in shallow waters and/or along shorelines, so they are neither within or contiguous to the harbor channels or their side slopes. Consequently, they are distant from activities included in the proposed action and will not be affected.

Impacts on Intertidal Flats , Oyster Reefs, and Shell Banks. These habitat types may occur in the riverine portion of the harbor, but they do not occur within the authorized harbor channels. Therefore, dredging in these channels will not affect these habitat types. Dredging entrance channels to Disposal Islands # 3 and # 4 will require passing through intertidal shoreline areas estimated at about 1 acre for the channel required at each island. After removal of the sand contents of the islands, the entrance channels will be backfilled at the island perimeter, so the intertidal areas will be restored to their approximate former dimensions and are expected to resume their previous habitat function and value.

Impacts on Sargassum. *Sargassum* is a pelagic brown algae which occurs in large floating mats on the continental shelf, in the Sargasso Sea, and in the Gulf Stream. It is a major source of productivity in a nutrient-poor part of the ocean. Masses of *Sargassum* provide extremely valuable habitat for a diverse assemblage of animal life, including juvenile sea turtles, sea birds, and over 100 species of fish. Unregulated commercial harvest of *Sargassum* for fertilizer and livestock feed has prompted concerns over the potential loss of this important resource. While smaller clumps of this seaweed may float into the project area, it typically occurs much further offshore. In any case, since it occurs in the upper few feet of the water column, it is not subject to impacts from dredging or sediment disposal activities associated with the proposed action.

Impacts on Reef-forming Corals. Hermatypic, or reef-forming, corals consist of anemone-like polyps occurring in colonies united by calcium encrustations. Reef-forming corals are characterized by the presence of symbiotic, unicellular algae called zooxanthellae, which impart a greenish or brown color. Since these corals derive a very large percentage of their energy from these algae, they require strong sunlight and are, therefore, generally found in depths of less than 150 feet. They require warm water temperatures (68 to 82 F)

and generally occur between 30°N and 30°S latitudes. Off the east coast of the United States, this northern limit roughly coincides with northern Florida. Although they occur off the North Carolina coast, they are not known from the immediate project vicinity, and they should not be affected by the proposed action.

Impacts on Artificial Reefs. The State of North Carolina Artificial Reef Program (NCARP) manages 8 reefs that are located off Brunswick County. Data for the 6 reefs within the area of potential influence of the proposed action are shown in *Table* 9 and their locations appear on *Figure 8.* All these sites are between 1 and 10 miles offshore and are in water about 30 to 53 feet deep. Dredging conducted as part of the proposed action will not be done in proximity to any of these reefs, so no adverse impacts would occur. Disposal on the ocean beaches of Brunswick County will involve the discharge of high-grade sand (average sand content of at least 90%) into the swash zone, and, likewise, will have no direct effect on these reef sites. Turbidity plumes may be produced by beach disposal as fine sediments are washed away by littoral processes. If such plumes are still detectable as far offshore as the NCARP reefs, their effects should be minor, temporary, and should quickly dissipate. The proposed action will not significantly impact any NCARP reefs.

A reef community is also becoming established at the WOFES, which is located contiguous to the existing ODMDS along its southeast boundary. This structure was designed and developed by the Wilmington District USACE to utilize rock dredged to deepen the existing ocean bar channel. Because the rock was dredged along with a substantial amount of fine sediment, it was not considered desirable for placement on NCARP reefs since sedimentation might adversely affect existing reef communities. The WOFES received about 1 million cubic yards of rock-sediment mixture between October 1994 and August 1997. However, insufficient material was available to complete the WOFES to its design dimensions, and it remains to be completed as more rock becomes available. Several hundred thousand cubic yards of rock are to be removed from riverine channels of Wilmington Harbor as it is deepened over the next several years. This rock will be dredged as a mixture with sediment. Portions of the rock-sediment mixture which are compatible may be added to incomplete sections of the WOFES. All rock placed at the WOFES previously is at least 3,000 feet from the new channel alignment, and this minimum distance will be retained in future rock placement as well. The additions to the WOFES could result in covering part of the growing reef community, but the additional substrate and greater topographic relief would contribute more than offsetting benefits by expanding the reef habitat. The construction of the ocean bar channel on its new alignment is not expected to directly affect the WOFES. Any adverse impacts from the proposed action would likely be temporary turbidity and sedimentation, and such effects would not be significant.

Impacts on Hardbottoms. Numerous hardbottoms have been documented in the nearshore ocean off Brunswick County, including the extended path of the existing ocean bar channel and the area to its west. However, ocean-bottom surveys in the vicinity of the proposed new alignment have not indicated any hardbottoms within or immediately adjacent to its path. Channel construction along the new path will avoid construction of the previously approved extension of the old Baldhead Shoal Channel. Therefore, the proposed action will not adversely affect hardbottoms and will, instead, allow avoidance of the 230 acres where hardbottoms are known to be present.

Impacts on State-designated Areas Important for Managed Species. Primary Nursery Areas (PNAs) are designated by the NC Marine Fisheries Commission and are defined by the State of North Carolina as tidal saltwaters which provide essential habitat for the early development of commercially important fish and shellfish (15 NC Administrative Code 3B .1405). Many fish species undergo initial post-larval development in these areas. PNAs in the Wilmington Harbor Project are located along 15 miles of the Cape Fear River from about river mile 16 (with Upper Lilliput Channel) upstream to the project limit near river mile 31. They extend from the shoreline to an imaginary line 300 yards from the channel centerline from Upper Lilliput Channel to Upper Brunswick Channel (about river mile 24), inclusive. Upstream from that point, PNAs extend from the river shoreline to the edge of the harbor channel. No PNAs are designated in the Cape Fear River downstream of Upper Lilliput Channel or in the nearshore ocean.

Neither the old nor new alignment for the ocean bar channel is located within a designated PNA. The entrance channels that will be developed for Disposal Islands # 3 and # 4 will be downstream of river mile 9, and will be several miles from the closest designated PNA. Therefore, dredging conducted as part of the proposed action will not be in or near any designated PNAs.

Overflowing of hopper dredges is already approved for channel reaches where PNAs are 300 yards from the channel centerline, subject to monitoring requirements in channels where the sediments are over 10% fine-grained. With the anticipated expansion of dredging methods, it is also proposed to allow overflow of barges and scows with the same restriction. No overflowing of sediment transport vessels is proposed where PNAs are contiguous with the navigation channel (Fourth East Jetty Channel upstream to project limit). Based upon the results of monitoring tests conducted in the Cape fear River, these measures are believed to be adequately protective of water quality in the vicinity of PNAs. Overall impacts of the proposed action on PNAs are expected to be insignificant.

Impacts on Cape Fear Sandy Shoals. The sandy shoals extending southeasterly from Cape Fear comprise an area well-known to mariners as Frying Pan Shoals. Very dangerous to navigation, this area provides important fishery habitat. Its location is east of the old and new alignments for the ocean bar channel and outside the area to be affected by the proposed action.

Impacts on the Marine and Estuarine Water Column. The potential water quality impacts of dredging and disposal have been addressed in the documents incorporated by reference in **Section 2.00**. Dredging operations conducted during construction and maintenance of harbor improvements may create impacts in the marine water column in the immediate vicinity of the activity. These impacts may include minor and short-term suspended sediment plumes and related turbidity, as well as the release of soluble trace constituents from the sediment. During dredging, turbidity increases outside the dredging area should be less than 25 NTUs and are, therefore, considered insignificant. In the case of overflowing hopper dredges or scows to obtain economic loading, sediment which is more than 90% sand is not likely to produce significant turbidity or other water quality impacts (USACE, 1997). When the channel being dredged is adjacent to PNAs and dredged sediments are less than 90% sand, dredge/scow overflows will be monitored to verify that the turbidity plume remains within permissible limits. The approved **Overflow Monitoring Plan** appears in ***Appendix C***. Where the navigation channel is contiguous to PNAs, dredge/scow overflow will not be allowed. The potential impacts of ocean disposal of sediments at the ODMDS have been previously addressed (USEPA, 1983) and determined not to be significant. Overall water quality impacts of the proposed action

are expected to be short-term and minor. Living marine and estuarine resources dependent upon good water quality are not expected to experience significant adverse impacts due to water quality changes

Impacts of Larval Entrainment. Life forms that lack the ability to escape the suction field of an operating dredge are subject to entrainment in the flow of water and sediment passing through its pumping equipment, and mortality is the likely result. However, only an extremely small percentage (a fraction of 1%) of the marine and estuarine larvae in the Cape Fear River are realistically subject to entrainment based upon the amount of water that a dredge can pump, and an even smaller percentage of the larvae in the ocean are likely to be affected. This is discussed in greater detail in **Section 5.04**. Overall, the dredging conducted as part of the proposed action is not expected to create significant impacts on these life forms at local or regional population levels.

Impact Summary for Essential Fish Habitat. The proposed action is not expected to cause any significant adverse impacts to Essential Fish Habitat of EFH species.

5.06 Terrestrial Resources. The Eagle Island CDF has been used for dredged material disposal for several decades and is the primary disposal area for material dredged from the upper harbor. Activities and impacts at this facility have been addressed in previous reports, and no new categories of impacts are anticipated to occur at the site. Likewise, disposal of dredged material on disposal islands of the Cape Fear River has been previously addressed. However, Disposal Islands #3 and # 4 may experience new types of impacts in that previously dredged sand comprising their center portions may be removed by dredging and transferred to area beaches. Their present status as barren or partially vegetated uplands will be changed to that of a closed lagoon at the completion of dredging. The previously-dredged material at Disposal Islands # 3 and # 4 has already been evaluated for grain size and found to be compatible for beach placement. Once, recyclable disposal sites are established on these islands, they would be utilized for periodic disposal of dredged sand until the volume of their content is sufficiently large to justify mobilizing the equipment necessary for transfer to beaches. During the years between events that empty their sand contents, their interior elevation would gradually increase to near their present level. If disposal at these sites occurs every year or two, it is likely that they will remain nearly barren or in early successional stages of vegetation (i.e., herbaceaous or small shrubs). In this case they may provide nesting habitat for waterbird species which favor this habitat. Otherwise, wildlife habitat value would likely remain low. In cases where waterbirds are nesting on these islands, dredging activities would be scheduled to minimize potential impacts on them.

Previous documentation of harbor maintenance impact (USACE, 1989) has addressed the intermittent disposal of dredged material in CDFs at existing disposal islands along the Cape Fear River. While most of the smaller CDFs are filled to near capacity, they may provide disposal options if consolidation of dredged material increases their capacity. Infrequent disposal at these locations would reset ecological successional stages to early barren conditions which would be followed by new plant growth. Vegetational cycles are a normal occurrence at islands that periodically receive dredged material, and each stage of a cycle typically provides habitat value for some wildlife species.

Ocean beaches are targeted to receive as much Wilmington Harbor sand as is feasible, given the constraints imposed by sand compatibility requirements, desires of beach communities, seasonal restrictions for protected species, and the funding and logistics of beach placement. However, all sand placement will be consistent with previously approved plans in the case of authorized Federal and State projects, or will be

placed from the high tide line seaward in the case of beaches without such authorized projects. Impact assessment has been previously addressed in environmental documents accompanying the authorization process for existing Federal and State projects, and will not be repeated here. Those beaches receiving sand as dredged material disposal or as new projects under Section 933 will experience added beach disturbance as a result of the proposed action.

Organisms that may be affected by beach placement of sand include intertidal macrofauna (discussed in **Section 5.04**), nesting sea turtles (discussed in **Section 5.08**), seabeach amaranthus (discussed in **Section 5.08**), and shorebirds. Reductions in the population numbers and community structure of the intertidal macrofaunal assemblage will temporarily deplete food supplies for shorebirds at affected beaches. These areas will be less attractive to shorebirds until invertebrate populations recover, which would normally occur over a period of one or two years following disposal. The effects on shorebirds would be minor relative to the amount of such habitat available and temporary in that sand placed under the authority of Section 933 or by the Base Disposal Plan would be a one-time event.

Maintenance dredging of the ocean bar channel is expected to result in beach placement of about 1.1 million cubic yards of sand every 2 years during the normal disposal window (November 15 - April 30), to the degree practicable. Placement of this sand is planned to occur on Bald Head Island during years 2 and 4 followed by placement on the eastern end of Oak Island-Caswell Beach in year 6. Each disposal event would target beach areas shown through monitoring to be more eroded and in need of sand. Therefore, the beach disposal cycle in conjunction with the erosion criterion would allow at least 2, and possibly several, years to pass between replenishment events for specific sections of beach. Also, since beach sections that receive sand would be those suffering most from erosion, they may likely have reduced habitat values that would benefit from additional sand. Macroinvertebrate populations should recover over substantial portions of these beaches between disposal events, and shorebirds should benefit from restored food supplies provided by these invertebrate populations. Also, habitat for nesting sea turtles should improve through sand replenishment at eroded beaches. Specific aspects of the proposed action in relation to sea turtles and seabeach amaranthus are addressed in ***Appendix E*, Biological Assessment - Endangered Species.**

5.07 Wetlands and Flood Plains.

Wetlands. The proposed work is not located in any wetlands nor will it directly affect any wetlands, with two categories of exceptions. First, the dredging of any disposal island along the river will require that a dredge gain access to the site by creating a channel (about 15 feet deep X 200 feet wide) from the harbor channel to the island, dredging through any marsh fringe (if present) adjacent to the island, and then entering the island itself. This pathway will, in each case, be selected to minimize environmental impacts by choosing an approach as short as possible and with the least amount of fringe wetland. Islands # 3 and # 4 (*Figure 7*) are not expected to experience any significant impacts to fringe wetland because their locations expose them to substantial wind and wave action as well as turbulence from passing ships. As a result, their shorelines are erosive and generally unvegetated along the side facing the harbor channel (*Figure 10).* If minor wetland impacts would be caused by the dredging of any island, affected areas would be repaired or replaced, as appropriate. Such repairs would be accomplished in conjunction with the dredging contract. If the proposed dredging of any island would create significant wetland effects, a wetland replacement plan would be developed in coordination with other agencies prior to that action.

The second category of potential wetland impacts could occur at locations where dredge pipelines are routed to deliver sand to the area beaches. Such routes will be selected to utilize existing roadway and utility corridors to the maximum extent practicable. However, such routes may require crossing short expanses of wetlands, and temporary impacts may result. Such cases would be addressed as is discussed above, in that minor impacts would be corrected by wetland repairs.

Flood Plains. Dredging to realign the ocean bar channel will not affect floodplains, but sand placement on any beach would occur within the floodplain. This sand placement is an alteration of the floodplain in that the zone of tidal flooding is displaced seaward. This is consistent with the purpose of beach nourishment, which is to offset erosion. This activity cannot be accomplished outside the floodplain. Dredging and disposal in the river will not significantly affect the floodplain. Dredging into disposal islands will reduce their crest elevations and create new floodplains within their interior. These floodplains would be only temporary, however, since future dredged material disposal would gradually raise the island elevation out of the floodplain similar to its present status. Impacts to floodplains will be temporary and insignificant.

5.08 Endangered and Threatened Species. A biological assessment evaluating the potential impacts of the proposed action on endangered and threatened species has been prepared and is being coordinated with the USFWS (jurisdiction over the Florida manatee, nesting sea turtles, and seabeach amaranth) and NMFS (jurisdiction over other protected marine and aquatic species which may occur in the project vicinity) pursuant to Section 7 of the Endangered Species Act of 1973 (PL 93-205), as amended. The biological assessment resulted in a determination that the project, as currently proposed, may adversely affect the piping plover, seabeach amaranth, green sea turtle, loggerhead sea turtle, Kemp's ridley sea turtle, and shortnose sturgeon. The biological assessment appears in ***Appendix E***, and discusses the relationship of the proposed action to these species. Project plans have been refined to minimize potential effects, to the extent feasible. Interagency coordination for endangered and threatened species will be completed prior to the initiation of the proposed action.

Disposal of sand will be conducted between November 15 and April 30 to the degree practicable, in order to minimize potential impacts on nesting sea turtles. However, if disposal is conducted during May 1 through November 15, impacts will be reduced through the implementation of a standard beach monitoring and turtle nest relocation program. Also, after placement of dredged material, any affected beach will be monitored for hardness and areas exceeding 500 CPUs will be tilled in order to make them more suitable for sea turtle nesting. Thus, any adverse impacts on sea turtles should be minor. In addition, the portion of beach which receives sand should provide improved nesting habitat for sea turtles as compared to the currently eroded condition of these areas.

5.09 Cultural Resources. The potential effects of the proposed action have been considered by the Wilmington District USACE in cooperation with the NC Division of Archives and History through its Underwater Archaeology Unit (UAU). Effects are likely to be most profound on underwater shipwreck sites located adjacent to the existing channels and planned alternatives. Surveys of the ocean entrance channel alternatives have been completed and coordinated with the State Historic Preservation Officer (SHPO) per provisions of the National Historic Preservation Act of 1966 and the Abandoned Shipwreck Act.

The Wilmington District has investigated the entrance channel and ODMDS alternatives through a program of remote sensing (magnetometer and side-scan sonar) and diver investigation of discovered targets. Areas proposed for channel improvement were surveyed over a length of 60,000 feet and an average width of about 2,000 feet. In addition, a potential site for the new ODMDS was surveyed over an area of about 12,000 by 24,000 feet. A total of 113 magnetic and/or acoustic anomalies were discovered. Of these, 35 were considered potentially associated with a significant cultural resource and were evaluated further through diver investigations. The diver survey confirmed only one target as a shipwreck. This target has been tentatively identified as a late 19th-century, wood-hulled sailing vessel. It is located on Jay Bird Shoal well beyond the area of potential project impact. This target will not be investigated further unless plans for the alignment change significantly.

Only one other site may be investigated for this project. This is the Fort Caswell Steamer, located near Southport. The site has been investigated by the NCDAH, UAU. This site is unlikely to receive direct impact from project construction but may be investigated to assure that accurate positioning is available for the site. The decision to investigate the site beyond precise relocation, size of site area, and relationship to the channel will be made through further coordination with the NCDAH. Any information generated will be used for future monitoring of the site. It is unlikely that investigations at this site will conflict with project construction or maintenance. However, any potential conflict between project construction or maintenance activities and the preservation of significant known cultural resources will be coordinated with the SHPO prior to any actions which might adversely impact these resources. In summary, the proposed action is not anticipated to significantly affect cultural resources.

5.10 Esthetic and Recreational Resources. Implementation of the proposed action may cause temporary reduction of esthetic appeal and interference with recreational activities in the areas of project construction. However, since project construction will be conducted in relatively small areas at any particular point in time, recreational and esthetic impacts will be localized. Upon completion of work activities in any area, esthetic values and recreational opportunities will be restored or enhanced as construction equipment is moved away.

The nautical environment will be affected to only a minor extent in that dredges, barges, and other water craft associated with the work are commonly used for maintenance dredging that is conducted annually in a number of channels in Wilmington Harbor. These vessels may be on-site for a longer continuous period of time than is normally required, but this is judged to be an insignificant effect.

Placement of beachfill will result in temporary use of dredge pipeline, bulldozers, and other equipment on the beach, and these objects will detract from the normal appearance of the beach. Also, recreational activities on beaches may experience some interruption or interference during work periods, but the degenerated, eroded conditions of the beaches already present recreational constraints. After work is completed on any beach and the heavy equipment is removed, the resulting wider beach is expected to represent an esthetic enhancement and an improvement for recreation.

Overall, esthetic and recreational impacts of the proposed action represent minor improvements.

5.11 Recreational and Commercial Fishing. Both the existing and new alignments of the ocean bar channel pass through important commercial fishing grounds. However, commercial fishing activities generally favor bottoms outside the navigation channel. Therefore, commercial fishermen may experience a reduction in fishable waters coinciding with the period during which new channel construction is being done and the old channel is also being maintained for navigation. Once the new ocean bar channel is completed, the old channel will be abandoned, maintenance dredging disturbances will stop, and backfilling can begin. Backfilling will utilize dredged material generally free of debris. As the old channel is filled, its flatter bathymetry and more natural bottom community should offer additional fishing grounds to replace those lost to new channel construction.

During construction activities, dredges and ancillary equipment, such as sediment transport vessels, underwater disposal pipelines, anchors, and lines, will be required to avoid the fishing grounds to the maximum extent practicable. This will be accomplished by requiring this equipment to remain within the old or new channel alignments, the existing ODMDS, or a designated work zone (*Figure 9*) that lies between these areas. While the designation of a work zone will remove some bottom area from fishable status during construction, this procedure is considered the most effective way to avoid conflicts among fishermen and work crews. Once the construction of the new alignment is complete, the old channel and the designated work zone will be abandoned, and fishing activities may resume.

5.12 Socio-Economic Resources. Benefits from the Wilmington Harbor to the national and regional economy are substantial and reach well beyond the immediate vicinity of Wilmington. Personal income resulting from commerce through Wilmington Harbor totaled about $2.4 billion in 1994. This trade provided jobs for about 96,000 workers. Each 1,000 tons of cargo moved across Wilmington's docks in 1994 generated about $306,000 in income and an estimated 12 jobs. Income and employment will be favorably affected by completion of the Wilmington Harbor improvements, including the proposed action.

The components of the proposed action were developed in order to provide additional economic and/or environmental benefits as the pending improvements are constructed. Economic benefits will be derived through savings in project costs that save expenditure of tax dollars. Environmental benefits will result in less significant impacts to the environment, which translate into conservation of natural resources and habitat, consistent with the National goals of our society. Estimated benefits include the following:

Economic Benefits:

- Savings of $40 million in construction costs by avoiding rock in the existing channel alignment
- Savings of up to $5.25 million in construction costs by year-around dredging and disposal
- Savings of $20 million through elimination of air bubble curtains for blasting rock
- Substantial unquantified benefits in combatting shoreline erosion along beaches that receive sand
- Substantial unquantified benefits through dredging options allowing greater contracting flexibility
- Providing for future beneficial use of sand by establishing sand recycle sites at disposal islands

Environmental Benefits:

- Avoidance of rock on the ocean bar to eliminate the need for blasting there
- Avoiding destruction of live coral/hardbottoms in the path of extending the existing alignment
- Backfilling the abandoned ocean bar channel to promote reestablishment of natural bottom.

5.13 Summary Comparison of the Proposed Action to the Previously Approved Plan. The components of the proposed action are expected to reduce the overall environmental impacts of the proposed Wilmington Harbor improvements when compared to those described in the 1996 Final EIS (USACE, 1996a). Specific comparisons are as follows:

- construction of an ocean bar channel on a new alignment will impact a new area of ocean floor estimated at 438 acres, whereas construction under the previous plan would have disturbed about 285 new acres. The increase of about 153 acres of bottom disturbance with the new plan will be offset by backfilling approximately 224 acres of the old channel after it is abandoned. This area will then be allowed to revert to a more natural status. In addition, the new alignment plan would avoid blasting and its associated ecological impacts and would alleviate the need to extend the channel 3.5 miles through known hardbottoms and their ecologically important inhabitants.
- placement of dredged sand on area beaches is a beneficial use of this sediment and would improve the esthetic qualities of affected beaches and reduce economic threats posed by erosion. These benefits to society would offset temporary reductions in intertidal macrofaunal populations, related temporary reductions in local shorebird habitat, and short term concerns regarding the safety of nesting sea turtles and their hatchlings when sand placement occurs in summer. Upon project completion, the replenished beaches should offer improved nesting habitat for sea turtles.
- utilization of blast pressure criteria rather than air curtains for rock blasting in the river should not significantly reduce the protection of marine/aquatic resources, since air curtains were ineffective in reducing blast pressure and a combination of other protective measures is proposed. The results of test blasting also show that the area of lethal impact for aquatic life (LD1) was substantially overestimated previously at about 34.5 acres, without air curtains, whereas the measured size of a blast impact area is about 2.1 acres, without air curtains. Furthermore, additional data and analyses regarding rock hardness and distribution indicate reductions in the estimated volume and acreage of rock requiring blasting and the associated number of blasts anticipated.
- establishment of a comprehensive dredging and disposal plan for the harbor is intended to improve economic efficiencies by allowing the combination of approved dredging and disposal methods so long as their use is consistent with environmental laws, regulations, and policies. Implementation of this plan is not anticipated to result in any significant environmental impacts or to create new categories of impacts but is expected to save tax dollars.

5.14 Cumulative Impacts. The lower Cape Fear River basin has experienced substantial modification and impact resulting from man's activities, especially during the 300 years since European settlement. Old maps indicate that prior to 1761 the low-water depth across the bar at the river mouth was about 14 feet and the shallowest depth up to Wilmington was about 7-1/2 feet (U.S. House of Representatives, 1929). Federal navigation improvements began in 1829, and harbor dimensions have since been expanded numerous times to keep pace with continually increasing demands for economical transportation of agricultural, forestry, and industrial products. Depths of the river channel were increased to 12 feet in 1874, 20 feet in 1890, 26 feet in 1912, 34 feet in 1950, and 38 feet in 1962. Channel widths were enlarged to 100 feet in 1874, 270 feet in 1890, 300 feet in 1912, and 400 feet in 1945. These substantial changes occurring in Wilmington Harbor were merely a reflection of the vast changes occurring in the river basin as it was converted from a wilderness into an industrialized region.

The size progressions described above show that the river channel had already been enlarged to its approximate present dimensions (38 feet deep and 400 feet wide) by 1962, more than 35 years ago. The pending harbor improvements that were authorized as the "96 Act Project" will further deepen this channel generally by 4 feet and widen specific portions. In a historic context, even these changes are not major, relative to the extent of previous harbor modifications.

The components of the proposed action are expected to cause only very minor effects compared to the impacts of the past major harbor modifications. The proposed action will:

- utilize dredged sand beneficially for replenishment of eroded ocean beaches,
- avoid valuable hardbottoms and potential rock blasting in the ocean,
- not enlarge the harbor footprint, except temporarily while 2 ocean entrance channels exist,
- not significantly impact water quality,
- not significantly impact marine or estuarine life,
- not significantly impact cultural resources, and
- not cause significant adverse impacts for any other aspects of the environment.

Cumulative impacts of the proposed action appear negligible.

6.00 COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

6.01 Water Quality. A Section 404(b)(1) evaluation and a Section 401 Water Quality Certificate under the Clean Water Act of 1977 (PL 95-217), as amended, are required for specific aspects of the proposed action. The Section 404(b)(1) evaluation is included in ***Appendix D***. The Wilmington District is applying for a Section 401 Water Quality Certificate from the NC Division of Water Quality. Work will not proceed until the certificate is received.

6.02 Ocean Disposal of Sediments. Dredged material proposed for transport for the purpose of dumping it in ocean waters (outside the 3-mile limit of the territorial sea) is regulated under MPRSA of 1972 (PL 92-532), as amended. An assessment based on USEPA's Ocean Dumping Regulations and Criteria (40 CFR Parts 220 - 229) has been prepared for the Wilmington Harbor project and has resulted in a determination that the sediments to be dredged during the proposed navigation improvements and subsequent maintenance from the ocean bar channel upstream to Cape Fear Memorial Bridge (about river mile 27) are environmentally acceptable for ocean disposal. The proposed disposal of dredged material, including silt, sand, gravel, and/or rock, will not cause unacceptable human health effects or other permanent adverse effects. The proposed action is being coordinated with USEPA, Region IV, and concurrence will be obtained prior to the proposed ocean disposal. In addition, measures will be taken to assure that dredged material that undergoes disposal at the ODMDS does not contain any significant amount of wood debris.

6.03 Essential Fish Habitat. Potential project impacts on Essential Fish Habitat species and their habitats have been evaluated. It has been determined that the proposed action will not have a significant adverse effect on these resources. By coordination of this document with the National Marine Fisheries Service, consultation is officially initiated and concurrence with our findings is requested. Compliance obligations related to Essential Fish Habitat provisions of the 1996 Congressional amendments to the Magnuson-Stevens

Fishery Conservation and Management Act (PL 94-265) will be fulfilled prior to initiation of the proposed action.

6.04 Endangered and Threatened Species. A biological assessment evaluating the potential impacts of the proposed action on endangered and threatened species has been prepared (***Appendix E***) and is being coordinated with the USFWS (jurisdiction over the Florida manatee, nesting sea turtles, and seabeach amaranth) and NMFS (jurisdiction over other protected marine and aquatic species which may occur in the project vicinity) pursuant to Section 7 of the Endangered Species Act of 1973 (PL 93-205), as amended. Compliance obligations under Section 7 will be satisfied prior to implementation of the proposed action.

6.05 Cultural Resources. Significant impacts to known archaeological or historic resources are not anticipated due to the proposed work. Project-specific historic survey data are being coordinated with the NCSHPO, and, prior to initiation of bottom disturbing activity, concurrence will be obtained that the proposed action will not cause significant adverse impacts to submerged cultural resources.

6.06 Executive Order 11988 (Flood Plain Management). Placement of beach fill may occur in the flood plain of area beaches. This placement will be conducted specifically for its beneficial effect in offsetting erosion and restoring damaged beaches, and is, therefore, judged acceptable. This action is not anticipated to induce development of the floodplain, nor to otherwise adversely affect any floodplain. The proposed action is in compliance with the requirements of Executive Order 11988.

6.07 Executive Order 11990 (Protection of Wetlands). The work will not require filling any wetlands. Minor wetland impacts may occur due to placement of dredge pipeline along corridors to the beaches or due to dredging through narrow bands of fringe marsh, if present, around disposal islands where sand is to be removed to restore capacity. Disposal Islands # 3 and # 4 do not currently have wetlands along the side where entrance channels would be dredged, but it is possible that narrow fringe wetlands could be present at a future time when entry to the islands is required for sand recycling to the beaches. Any damaged wetlands that do not recover naturally in a short period of time will be restored after completion of the disturbing activity and a reasonable recovery period. The proposed work will not produce any significant hydrologic or salinity changes affecting any wetlands beyond those addressed previously in other environmental documents incorporated by reference (USACE, 1996a). The proposed action is in compliance with Executive Order 11990.

6.08 North Carolina Coastal Management Program. The proposed action will be conducted in the designated coastal zone of the State of North Carolina. Pursuant to the Federal Coastal Zone Management Act (CZMA) of 1972, as amended (PL 92-583), Federal activities are required to be consistent, to the maximum extent practicable, with the Federally approved coastal management program of the state in which their activities will occur. The components of the proposed action have been evaluated and determined to be consistent with the NC Coastal Management Program and local land use plans. Concurrence with this determination is being requested from the NC Division of Coastal Management

6.08.1 Areas of Environmental Concern (AECs). Components of the proposed action would take place in areas designated under the NC Coastal Management Program as AECs. Specifically, the activities will occur in Estuarine System AEC categories including Coastal Wetlands, Estuarine Waters, and Public Trust Areas. Activities will also occur in Ocean Hazard System AEC categories including the Ocean Erodible Area, High Hazard Flood Area, and Inlet Hazard Area. The following determination has been made regarding the consistency of the proposed action with the State's management objective for each AEC that may be affected:

Coastal Wetlands. The proposed action is consistent with the highest priority use of coastal wetlands, which is their conservation. The work is planned so as to minimize the amount of wetlands that could be affected, and if wetlands are damaged, they will be repaired during the construction contract. Second priority use includes activities requiring water access, such as Federal navigation projects and their management.

Estuarine Waters. The highest priority use of estuarine waters is their conservation and second highest priority use is for activities requiring water access, such as navigation channels. The proposed action will not have significant adverse impacts on estuarine waters or those life forms dependent on these waters.

Public Trust Areas. These areas include (1) waters of the Atlantic Ocean and the lands thereunder from the mean high water mark to the 3-mile limit of state jurisdiction and (2) waters of the Cape Fear and Northeast Cape Fear Rivers and the lands thereunder to the high water mark. Acceptable uses include those that are consistent with protection of the public rights for navigation and recreation, as well as conservation and management to safeguard and perpetuate the biological, economic, and esthetic value of these areas. The activities that comprise the proposed action are intended to support and enhance the public right to navigation and its economic values, and are consistent with conservation of the biological, physical, and esthetic values of public trust areas.

Ocean Erodible Areas. This AEC includes areas along the Atlantic Ocean from the mean low water line to an established recession line landward of the first line of stable natural vegetation. Beach-related work, including the discharge of dredged material, the associated temporary operation of heavy equipment, and placement of dredge pipeline, would not cause any significant adverse effects to ocean erodible areas.

High Hazard Flood Areas. These natural hazard areas occur along the Atlantic Ocean shoreline and are subject to high velocity waters in a storm having a one percent chance of being equaled or exceeded in any given year (100-year event). Placement of dredged material on the beach would provide short-term protection benefits for high hazard flood areas.

Inlet Hazard Areas. These AECs extend from the mean low water line landward a distance sufficient to encompass the area within which the inlet is predicted to migrate, based upon statistical analysis, physical features, and human influences. Due to their proximity to dynamic ocean inlets, these hazard areas are especially vulnerable to erosion, flooding, and other adverse effects of sand, wind, and water. While components of the proposed action may involve the movement of equipment across these areas, no construction or maintenance activities are proposed for these areas, and no adverse impacts are anticipated.

6.08.2 Other State Policies. The following state policies found in the NC Coastal Management Program document are also applicable to the proposed action in terms of beach placement of sand.

Shoreline Erosion Response Policies. NC Administrative Code 7M - Section .0200 addresses beach restoration projects as feasible alternatives to the loss or massive relocation of oceanfront development when public beaches and public or private properties are threatened by erosion; when beach restoration, renourishment, or sand disposal projects are determined to be socially and economically feasible and cause no significant adverse environmental impacts; and the project is consistent with state policies for shoreline erosion response and state use standards for Ocean Hazard and Public Trust Areas AECs.

Policies on Beneficial Use of Materials from the Excavation or Maintenance of Navigation Channels. NC Administrative Code 7M - Section .1101 states that it is the policy of the state that material resulting from the excavation or maintenance of navigation channels be used in a beneficial way wherever practicable. Policy statement .1102 (a) indicates that "clean, beach quality material dredged from navigation channels within the active nearshore, beach, or inlet shoal systems must not be removed permanently from the active nearshore, beach, or inlet shoal system unless no practicable alternative exists. Preferably, this dredged material will be disposed of on the ocean beach or shallow active nearshore area where environmentally acceptable and compatible with other uses of the beach."

Components of the proposed action are consistent with these policies of the NC Coastal Management Program.

6.08.3 Local Land Use Plans. The proposed action could affect a number of areas that have local land use plans. These plans include the Brunswick County Land Use Plan, 1997 Update (Brunswick County, 1997). Town of Caswell Beach, North Carolina, 1997 Land Use Plan (Caswell Beach, 1997); Holden Beach, North Carolina, 1990 Land Use Plan Update (Holden Beach, 1990); Town of Long Beach, North Carolina, 1998 CAMA Land Use Plan Update (Long Beach, 1998); Town of Yaupon Beach, North Carolina, 1997 Land Use Plan (Yaupon Beach, 1997); Kure Beach, 1997 Land Use Plan Update (Cape Fear Council of Governments, 1997); Town of Carolina Beach, North Carolina, 1997 CAMA Land Use Plan (Carolina Beach Planning Board, 1997); and the Wilmington - New Hanover Land Use Plan Update - 1993 (New Hanover County Planning Department, 1993). The proposed action is consistent with the policies addressed in these plans, including growth, development, shoreline stabilization, and beach restoration/renourishment.

6.09 Coastal Barrier Resources Act. The Coastal Barrier Resources Act (CBRA) of 1982 (PL 97-348) and the Coastal Barrier Improvement Act of 1990 (PL 101-591) restrict Federal expenditures in those areas comprising the Coastal Barrier Resources System (CBRS). Review of CBRS maps for North Carolina prepared by the USFWS indicates that no components of the proposed action are within the CBRS. Therefore, the proposed action is in compliance with the CBRA.

7.00 PUBLIC AND AGENCY INVOLVEMENT

7.01 Scoping. On January 28, 1999, a scoping letter was sent to agencies, interest groups, and the public to request identification of significant resources and issues of concern. Eight letters of comment and one email were received. A follow-up scoping letter was sent on June 22, 1999, to address potential beneficial uses of sediment dredged from the ocean bar channel. Twelve letters of comment and 3 telephone calls were received. The scoping letters and a list of commentors appear in ***APPENDIX F***. The proposed action was also presented to State and Federal agencies during a meeting on September 29, 1999. Comments received have addressed various aspects of the project changes that were being considered. These comments generally (1) stated support for the project, (2) suggested beneficial uses of dredged material, or (3) identified resource concerns needing to be addressed. All were considered during the continuation of project planning and design. Additional coordination has been conducted with representatives of the USFWS, NMFS, NCDAH, NCDCM, NCDMF, NCWRC, USEPA, the Brunswick Beaches Consortium, and the Village of Bald Head Island.

7.02 Fish & Wildlife Coordination. The proposed improvements for Wilmington Harbor that were later incorporated in the "96 Act Project" were coordinated with the USFWS during their development. The USFWS provided a Final Fish and Wildlife Coordination Act Report (FWCA) (USFWS, 1996) which was included in the Final EIS for the Cape Fear - Northeast Cape fear Rivers Comprehensive Study (USACE, 1996a). That FWCA report fulfilled responsibilities of the USFWS under the Fish and Wildlife Coordination Act (48 Stat. 40; 16 U.S.C. 661-667d) and Section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1543). Recently developed information regarding the components of the proposed action, potential alternatives, and related environmental issues have also been coordinated with the USFWS, and their views are documented in a Supplemental Fish & Wildlife Coordination Act Report (***Appendix G***). Recommendations of that report have been considered during project development. Specific new recommendations and USACE responses are presented in the following paragraphs.

1. USFWS Recommendation. A Tier I Assessment according to the Inland Testing Manual (ITM) adopted by the Corps and the EPA in 1998 should be conducted on all sediments in the project, and such documentation should be included in the environmental documents. Sediments to be assessed include those from any disposal islands proposed for pumpout for either beach or offshore disposal. Should any sediments contain contaminants or toxins that exceed EPA standards, appropriate measures should be taken to manage the contaminants.

Corps Response. The Tier 1 evaluation specified by the Inland Testing Manual (EPA 1998) is essentially the same as the Tier 1 evaluation under the Ocean Disposal Manual (Green Book, EPA 1991). A Tier 1 evaluation under the Green Book has been performed for the entire harbor from the Anchorage Basin downstream. All these sediments were found acceptable for ocean disposal (USACE 2000). Therefore, a separate evaluation under the Inland Testing Manual is not required.

2. USFWS Recommendation. The Corps should address the issue of existing and proposed Essential Fish Habitats (EFH) in the new channel alignment and immediate surrounding areas. If any existing or proposed EFH are located in the new alignment construction area or offshore disposal areas, the Corps should coordinate with the NMFS to take the appropriate conservation measures.

Corps Response. Essential Fish Habitat (EFH) is described in the EA in **Section 4.05** and potential project impacts on EFH are discussed in **Section 5.05**. No significant impacts on EFH or EFH species are expected to result from the proposed action. This information is being coordinated with the NMFS.

3. USFWS Recommendation. Loss of benthic habitat with the creation of the new channel should be mitigated in-kind with backfilling the abandoned channel with identical or very similar substrate grain size, composition, and geomorphology as adjacent benthic substrates

Corps Response. Benthic resources and habitats of the project vicinity are described in **Section 4.04** of the EA, and potential impacts are addressed in **Section 5.04**. Although benthic habitat along the new channel alignment will be destroyed within its area of new impact and the inhabitants of this area will be lost, a larger area of benthic habitat will result from backfilling approximately 3.3 miles of the abandoned channel. However, it would be impossible to reestablish substrate characteristics along the backfilled channel that are identical to those of the surrounding area, given the practical constraints associated with contract dredging operations and the existing variable grain size distribution of sediments to be derived from harbor deepening. Planned backfilling of the channel would maximize the utilization of sediment that has high sand content but that does not meet the required 90% minimum for beach placement. After completion of backfilling, the surface of the abandoned channel is expected to be similar to the surrounding bathymetry.

4. USFWS Recommendation. The 2500' designated buffer surrounding the channel where it passes through the existing ODMDS should be regularly surveyed for bathymetric changes in order to monitor increased shoaling rates in the channel, which would lead to increased maintenance needs. Additional surveys should be conducted along a similar 2500' corridor for the entire new channel alignment, seaward of station 50+00, in order to monitor for shoaling from other adjacent sediment bodies. Multi-beam bathymetry would yield more accurate bathymetry than a few scattered soundings and increase spatial resolution and coverage.

Corps Response. Routine bathymetric surveys are conducted periodically along all Wilmington Harbor channels to monitor deviations from authorized project depths. Encroaching shoals are then removed by maintenance dredging. Bathymetric changes that may occur outside authorized Federal navigation channels are not a concern of our maintenance dredging program and, therefore, are not monitored.

5. USFWS Recommendation. Sediments used to backfill the abandoned navigation channel should match the native grain size, mineral composition, and organic content in order to better mimic the native habitat.

Corps Response. We agree with this concept but do not believe it is a fully achievable goal. See responses to **USFWS Recommendation 3** above and **Recommendation 6** below.

6. USFWS Recommendation. Backfilling of the abandoned channel should approximate the natural bathymetric contours and geomorphology of surrounding areas. Deviation from natural conditions could prevent or delay re-colonization of the newly filled area by benthic organisms.

Corps Response. See response to **USFWS Recommendations 3** and **5** above. In addition, it is generally recognized that substrate characteristics may influence benthic communities in various ways and that benthic communities inhabiting different substrates typically vary in a number of characteristics, including species composition, species diversity, total biomass, and population numbers. Benthic organisms in this area of the nearshore ocean have been were reported at densities ranging from about 90 individuals per square meter on sand bottom to over 500 per square meter on mud substrate (Birkhead et al., 1979). However, later benthic studies conducted in the vicinity of the ODMDS found no correspondence between habitat type and species abundance, and no relationship between previous disposal of dredged material and either infaunal assemblage or abundance/diversity (USEPA, 1993). From this information, one could conclude that backfilling the abandoned channel with available dredged material may result in changes in benthic community structure that are so small as to be insignificant, or that if the average grain size of backfill sediments is finer, that larger numbers of individuals may populate the area. In either case, no significant impacts on benthic resources or benthic habitat are expected to result from the proposed action.

7. USFWS Recommendation. The backfilled channel should be monitored regularly with both bathymetric surveys (perhaps multi-beam) and benthic organism surveys to establish recolonization rates and success or failure. Bathymetric surveys would generate data on changes to the former channel due to altered current and wave patterns, which could suspend portions of the fill and remove it from the channel. Any measured impacts over the life of the project should be mitigated through coordination with the Service, NMFS, and other relevant agencies.

Corps Response. Bathymetric surveys will be conducted at least annually along the abandoned channel in order to document the progress and ultimate completion of the backfilling activity.

Surveys of benthic organisms are not proposed since the backfilled channel will repopulate with benthos from surrounding areas. The actual rate of recolonization and the future characteristics of community structure, if known, are not expected to lead to identifiable management decisions or additional Federal actions since changes can not be judged adverse merely because they occur. For example, fishes that consume benthic organisms tend to be opportunistic feeders, and are not generally dependent upon the presence of specific benthic species as critical food sources. Therefore, changes in benthic community structure would not necessarily translate into specific impacts through the food chain.

8. USFWS Recommendation. No disposal of dredged materials should take place on beaches or the littoral zone during the sea turtle nesting and incubation season of May 1 through November 15, which roughly coincides with shorebird nesting and beach invertebrate spawning and recruitment seasons.

Corps Response. Disposal of maintenance dredged material on the beaches or the littoral zone will comply with this time period to the maximum extent feasible. However, due to the large volume of dredged material during construction and the cost and time savings of one continuous construction period, placement of sand on the beaches is scheduled to begin December 2000 and continue for about 18 months (see **Section 1.04**).

9. USFWS Recommendation. Fill placement should not create a pronounced hill or mound of sand that could create an obstacle or scarp to wildlife and human resources utilizing the beach.

Corps Response. Beach fill will be shaped immediately after placement to achieve a gradual slope and will be periodically monitored for scarp formation. Scarps will be leveled, as necessary, to comply with requirements of Section 7 of the Endangered Species Act.

10. USFWS Recommendation. Heavy equipment used to manipulate fill sediments placed on the beach should be kept to a minimum, perhaps only one regular size bulldozer on any given beach at any given time. Night work should use the minimum amount of light necessary (which may require shielding) or low pressure sodium lighting during project construction.

Corps Response. Usage of heavy equipment on beaches will be minimized to the extent consistent with work requirements. Lighting for night work must comply with safety requirements and not impede work progress, but will be minimized to the extent practicable.

11. USFWS Recommendation. Sediments disposed on the beaches or adjacent littoral zones should be *at least 90%* sand, match native grain size ranges and mineral composition, contain as little organic matter as possible, and be free of contaminants exceeding safe levels.

Corps Response. See the **Sand Management Plan** in **Appendix A**. The sediments to be placed on the beaches or in the littoral zone will meet these criteria.

12. USFWS Recommendation. Beach fill should be monitored for compaction, escarpment formation, and subaerial and subaqueous profiles on a regular basis (perhaps quarterly and after every storm) in order to determine the longevity of the material's placement. Immediately after completion of sand disposal on beaches and prior to sea turtle nesting seasons, monitoring shall be conducted to determine if escarpments are present, and escarpments shall be leveled as required to reduce the likelihood of impacting sea turtle nesting and hatching activities.

Corps Response. After placement of dredged material on the beaches and prior to the first turtle nesting season, the beaches will be monitored for compaction. The beach will be monitored for escarpment formation prior to each nesting season. If the beach hardness exceeds 500 cone penetrometer units, the beach will be tilled. If an escarpment exceeds 18 inches, then it will be leveled.

13. USFWS Recommendation. Beaches scheduled to receive maintenance materials (i.e. Bald Head Island and Caswell Beach) should be monitored long-term for increased erosion rates, decreased biological productivity, and cumulative impacts to fish and wildlife resources, especially Federally-listed species such as sea turtles, piping plovers, and seabeach amaranth. Any measured impacts over the lifespan of the project and its maintenance should be mitigated through coordination with the Service, NMFS, and other relevant agencies.

Corps Response. Dredged material is being placed on the beach because it is the least cost alternative, reduces erosion impacts, and has minimal long-term environmental impacts (see **Sections 5.04 and 5.08**). In addition, it is the policy of the North Carolina Division of Coastal Management that "beach quality material dredged from navigation channels within active nearshore, beach, or inlet shoal system must not be removed permanently from the active nearshore, beach or inlet shoal system unless no practicable alternative exists."(T15A:07M.1102(a)).

See ***Appendix E*** for the biological assessment of listed species. All the impacted beaches are monitored annually for sea turtles, piping plover, and seabeach amaranth. Due to the severely eroded nature of area beaches, beach nourishment should actually improve habitat for sea turtles and seabeach amaranth. Attempted nesting by piping plovers has not been observed in recent years at Bald Head Island or Caswell Beaches, but dredged material will not be placed in active inlet areas where they normally nest. Maintenance material will be placed on the beaches during the least active biological period to the extent feasible.

14. USFWS Recommendation. Hopper dredges should not be used during the summer sea turtle nesting season or spring and fall migration periods when species numbers in inland waters are high.

Corps Response. The impacts of hopper dredging are discussed **Sections 5.04 and 5.06**, and in **paragraphs 4.02.5 and 4.02.6** of the **Biological Assessment** at ***Appendix E***.

15. USFWS Recommendation. Observers should be present on all hopper dredges to monitor for incidental takes of sea turtles year-round. All takes should be documented and reported to the Service and NMFS, and appropriate conservation measures coordinated in the event of excess takes.

Corps Response. Sea turtle monitoring on hopper dredges will be in accordance with the NMFS September 25, 1997 Regional Biological Opinion on Hopper Dredging along the South Atlantic Coast.

16. USFWS Recommendation. Dredging activities should not occur adjacent to disposal islands during colonial waterbird nesting season of April 1 to October 31 in order to minimize disturbance to such nests. Activities should be minimized from disturbing colonial waterbirds with potential noise, lights, and fumes at all times of the year. Potential Screening/blocking or other appropriate conservation measures should be coordinated with the North Carolina Colonial Waterbird Management Committee and other relevant agencies.

Corps Response. The only disposal islands involved in the proposed action are Eagle Island across from the State Port in Wilmington and Disposal Islands # 3 and # 4 in the lower harbor. Eagle Island has had no known nesting by colonial waterbirds. Disposal Islands # 3 and # 4 have not had any nesting by colonial waterbirds since 1983, probably due to their height (over 25 feet)and size (about 30 acres each). The height has increased the effects of wind blown sand, which destroys nests, and the islands' size enables predators to survive year round. However, prior to any dredging or disposal actions that may affect Disposal Islands # 3 and # 4 during the nest season, the area will be surveyed for colonial waterbirds. If nesting is present, action will be delayed until nesting activities are complete.

17. USFWS Recommendation. Spoil islands should not be pumped out or refilled during the colonial waterbird nesting season to minimize disturbances to nesting habitat and existing nests.

Corps Response. See response to **Recommendation 16** above.

18. USFWS Recommendation. All dredging activities should comply with existing agreements with the National Marine Fisheries Service and the U.S. Fish and Wildlife Service as to timing and types of allowable dredges. The 1995 Biological Opinion and Incidental Take Statement issued by the NMFS to the Corps should be fully complied with in particular.

Corps Response. The most recent biological opinion and incidental take statement for hopper dredging was issued by NMFS on September 25, 1997. We will comply with all aspects of this biological opinion except that we have requested a separate incidental take. See our **Biological Assessment** in ***Appendix E***. Regarding timing and types of allowable dredges, we will comply with all conditions that result from the current NEPA process.

19. USFWS Recommendation. The Service recommends mitigation for the loss of fish associated with the blasting of rock during the project. The Service proposes the Corps provide structural fish passage at Lock and Dams 2 and 3 in addition to the fish locking sequence that is currently employed for anadromous fish and fund a graduate student (Master of Science) to examine the effectiveness of the structures.

Corps Response. As indicated in ***Appendix B***, mitigation for the loss of fisheries habitat was discussed in detail in the EISs related to the Wilmington Harbor project (USACE 1990, 1994a & b, 1996a & b) and in the Final Mitigation Plan for the project (USACE 1999b). This included consideration of loss of bottom habitat where blasting would occur. No mitigation was proposed for the act of blasting because blasting in and of itself will not result in a permanent additional loss of habitat. Blasting will impact organisms in the water column near each blast during the short time each blast occurs (1.25 seconds = 25 msec between holes x 50 holes per blast). Impacts of each blast were minimized to the extent feasible by using air curtains, a delay after each hole, stemming, and blasting only during the NC Division of Marine Fisheries dredging window (1 August through 31 January). The only difference proposed now is the elimination of air curtains because they were not effective in reducing blasting impacts. Also, the EIS model overestimated the impact area by about 94 percent compared to the impact area indicated in the test blast project for blasts without an air curtain. In addition, the acres of rock blasting and number of blasts will be about 47 and 22 percent less, respectively, than indicated in the EISs. Therefore, mitigation is not needed for elimination of the bubble curtain.

Appendix E (at **paragraph 5.02.6(b)**) indicates that recent changes have been made in the operation of the locks and dams on the Cape Fear River to enhance the passage of anadromous fish. If the USFWS is aware of additional procedures that are cost effective and that would significantly improve passage of anadromous fish, we would be glad to discuss them.

20. USFWS Recommendation. All blasting should avoid times of spawning or known important juvenile stages of fish in the project area.

Corps Response. As indicated in this EA, blasting will be restricted to the NC Division of Marine Fisheries dredging window of August 1 to January 31.

21. USFWS Recommendation. The Corps should provide contractual opportunities to local universities to conduct aquatic resource surveys before, during, and after the project construction period in order to document and gather important data on valuable fish and wildlife resources such as shortnose sturgeon and

impacts to their populations and distributions. This data should be made available to the Service, NMFS, and all interested parties.

Corps Response. Environmental studies will be conducted if and when specific needs are identified. The USACE obtains services for needed investigations through procedures specified in the Federal Acquisition Regulation (FAR) at Title 48 of the Code of Federal Regulations. These procedures emphasize open competition and, in the past, have permitted our utilization of commercial contractors and university personnel. For the Wilmington Harbor project, the Wilmington District has an ongoing contract for long-term monitoring of potential hydrologic and salinity changes associated with harbor improvements. This contract effort is being conducted by a commercial contractor with subcontractual arrangements with faculty members at UNCW. Scientific data produced by the USACE is public domain and available to all.

7.03 Coordination of this Document. This Environmental Assessment is being provided to a standard list of Federal, State, and local agencies; elected officials; environmental groups; and interested individuals for review and comment. After a 30-day review period, further coordination will be conducted, if appropriate, and all input received will be considered.

We invite your comments and suggestions regarding the proposed action. In accordance with Council on Environmental Quality regulations (40 CFR 1500-1508) for implementing the National Environmental Policy Act (NEPA), your comments should be as specific as possible and should be made with recognition that NEPA documents must focus on the issues that are truly significant to the proposed action rather than amassing needless detail. The NEPA process is intended to help public officials make decisions based upon an understanding of environmental consequences. NEPA directs that Federal activities be conducted so as to attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable or unintended consequences. As individual resources and stakeholder interests increasingly compete for priority, public officials are challenged to make management decisions that reflect a balance of the overall public interest. Please respond with a focus on essential issues that will be useful in guiding our decisions and actions as the Wilmington Harbor project proceeds.

7.04 Recipients of this Assessment

Federal Agencies
Advisory Council on Historic Preservation
Center for Disease Control, Center for Environmental Health
Federal Emergency Management Administration
Military Ocean Terminal Sunny Point (MOTSU), Commander
National Marine Fisheries Service, Habitat Conservation Division,
Beaufort Marine Fisheries Center
National Marine Fisheries Service, Southeastern Regional Office
National Park Service, Departmental Consulting Archaeologist
National Park Service, Natural Resources
National Park Service, Southeast Regional Office, Archaeology
U.S. Coast Guard, Fifth District, Norfolk
U.S. Coast Guard, Marine Safety Office, Wilmington
U.S. Coast Guard Station, Ft. Macon

U.S. Coast Guard Station, Oak Island
U.S. Coast Guard Station, Wrightsville Beach
U.S. Department of Agriculture, Forest Service, Area Director
U.S. Department of Agriculture, Natural Resources Conservation Service, Burgaw
U.S. Department of Agriculture, Natural Resources Conservation Service, Goldsboro
U.S. Department of Agriculture, Natural Resources Conservation Service, State Conservationist
U.S. Department of Commerce, NOAA, Ecology & Environmental Conservation Office
U.S. Department of Energy, Office of Environmental Compliance
U.S. Department of Housing and Urban Development, Atlanta Regional Office
U.S. Department of Housing and Urban Development, Office of Environmental Quality
U.S. Department of Interior, Energy & Resources Division
U.S. Department of Interior, Office of Environmental Policy & Compliance
U.S. Department of Transportation, Deputy Director for Environment and Policy Review
U.S. Department of Transportation, Division Engineer, Raleigh, NC
U.S. Department of Transportation, Federal Highway Administration
U.S. Environmental Protection Agency, Office of Federal Activities
U.S. Environmental Protection Agency, NEPA Compliance Division
U.S. Environmental Protection Agency, Region IV, Environmental Policy Section
U.S. Environmental Protection Agency, Region IV, Regional Administrator
U.S. Fish & Wildlife Service, Asheville, NC Field Office
U.S. Fish & Wildlife Service, Raleigh, NC Field Office
U.S. Fish & Wildlife Service, South Atlantic Fisheries Coordination Office

State Agencies
N.C. Aquarium, Fort Fisher
N.C. State Clearinghouse
N.C. Division of Archives and History, Underwater Archaeology Unit
N.C. Department of Environment, Health, and Natural Resources
- N.C. Division of Coastal Management
- N.C. Division of Marine Fisheries
- N.C. Office of Water Resources

N.C. Department of Transportation
N.C. Marine Fisheries Commission
N.C. National Estuarine Research Reserve
N.C. Sea Grant Program, Fort Fisher
N.C. State Historic Preservation Officer
N.C. State Ports Authority
N.C. Wildlife Resources Commission

Local Agencies
Baldhead Island, Town Manager
Brunswick Beaches Consortium
Brunswick County Emergency Management Coordinator
Brunswick County Manager

Brunswick County Planning Director
Brunswick County Soil & Water Conservation District
Cape Fear Council of Governments
Carolina Beach, Town Manager
CAMA Officer, Brunswick County
CAMA Officer, New Hanover County
CAMA Officer, Town of Carolina Beach
CAMA Officer, Town of Kure Beach
CAMA Officer, Town of Long Beach
CAMA Officer, Town of Southport
CAMA Officer, Town of Wrightsville Beach
CAMA Officer, Yaupon Beach
Long Beach, Town Council
Long Beach, Town Manager
New Hanover County, Director of Engineering and Facilities
New Hanover County Engineer
New Hanover County Health Department
New Hanover County Planning Department
New Hanover County Soil and Water Conservation District
New Hanover County Zoning Department
North Carolina Council of Governments, Region O
Southport, City Manager
Town of Caswell Beach
Town of Holden Beach
Town of Ocean Isle Beach
Town of Sunset Beach
Town of Wrightsville Beach
Wilmington Chamber of Commerce
Wilmington, Director of Public Works
Wilmington, Planning Department
Wrightsville Beach Building Inspector
Wrightsville Beach Finance Manager
Postmasters

Elected Officials
Baldhead Island, Councilman Sanders
Brunswick County, Board of Commissioners
Honorable Patrick J. Ballantine, N.C. Senate
Honorable Eva M. Clayton, United States House of Representative
Honorable John Edwards, United States Senate
Honorable Jesse Helms, United States Senate
Honorable Dewey L. Hill, N.C. House of Representatives
Honorable Luther H. Jordan, Jr., N.C. Senate
Honorable Daniel F. McComas, N.C. House of Representatives
Honorable Mike McIntyre, U.S. House of Representatives

Honorable Edd Nye, N.C. House of Representatives
Honorable E. David Redwine, N.C. House of Representatives
Honorable R. C. Soles, Jr., N.C. Senate
Honorable Thomas E. Wright, N.C. House of Representatives
New Hanover County, Board of Commissioners
Mayor, City of Wilmington
Mayor, Town of Caswell Beach
Mayor, Town of Carolina Beach
Mayor, Town of Holden Beach
Mayor, Town of Kure Beach
Mayor, Town of Long Beach
Mayor, Town of Shallotte
Mayor, Town of Southport
Mayor, Town of Wrightsville Beach
Mayor, Town of Yaupon Beach

Conservation Groups
American Rivers
Conservation Council of North Carolina
National Audubon Society
National Wildlife Federation
North Carolina Coastal Federation
North Carolina Environmental Defense Fund
North Carolina Wildlife Federation
Sierra Club

Libraries, Museums, & News Media
Brunswick Beacon
Duke University Library
East Carolina University Library
Librarian, North Carolina Department of Environment and Natural Resources
New Hanover County Law Library
New Hanover County Library
North Carolina Maritime Museum
Shallotte Broadcasting Company
State Library of North Carolina
Stateport Pilot
UNC-Wilmington Library
UNC-Chapel Hill Library

Interested Businesses, Groups, and Individuals
Arcadian Corporation (Mr. Dave Robinson)
Bellsouth Telecommunications (Mr. Timothy Winstead)
Brunswick County Commercial Fisherman's Association (Mr. Arden Moore)
Cape Fear Community College (Mr. Ray Brandi)

Cape Fear River Research Institute
Cape Fear Towing, Inc.
Central Realty Company (Mr. Alex Malpass)
Dr. Vince Bellis
Dr. Bill Cleary
Dr. Anne B. McCrary
Dr. Orrin Pilkey
Dr. Laela Sayigh
Exxon Company USA
Hanover Towing Company
Land Management Group, Inc.
Lavino Shipping Company
Mr. Rick Civelli
Mr. Ed Flynn
Mr. Paul Foster
Mr. Edward M. Gore, Sr.
Mr. Bill Hickman
Mr. Cecil Holden
Mr. John Hooten
Mr. John A. Potter
Mr. R W Roberts
Mr. Bill Robertson
Mr. Julius C. Smith III
Mr. Odell Williamson
Mr. J. W. Willis
Mrs. Barbara Ford
Ms. Brenda R. Nichols
North Carolina Fisheries Association (Mr. Jerry Schill)
North Carolina Fisheries Association (Ms. Sandy Semans)
Olsen & Associates (Mr. Eric Olsen)
Paktank Corporation, Wilmington
Pirelli & Jacobsen (Mr. John Hoskins)
Shell Island Corporation
Stevens Towing Company
T D Eure Construction Company
Unocal Chemicals
Wilmington-Cape Fear Pilots Association
Wilmington Industrial Development, Inc.
Wilmington Shipping Company (Mr. Peter Ruffin)
Wrightsville Marina

8.00 POINT OF CONTACT

Written comments regarding this Environmental Assessment should be sent to Mr. John Meshaw, CESAW-TS-PE, U.S. Army Engineer District, PO Box 1890, Wilmington, North Carolina 28402-1890. Questions may be directed to telephone (910) 251-4175.

9.00 DRAFT FINDING OF NO SIGNIFICANT IMPACT

The proposed action is not expected to significantly affect the quality of the human environment. If this judgement is confirmed through coordination of this EA, an Environmental Impact Statement will not be required, and a Finding of No Significant Impact (FONSI) will be signed prior to the initiation of the proposed action. The signed FONSI will be available to the public.

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TABLES

Table 1. Wilmington Harbor Authorized Channel Dimensions in Feet.

Channel Name From Ocean To Upstream	Channel Length	Channel Width	Width[1] at Widener or Basin	Channel Depth[2]	Required Overdepth for Rock	Allowable Overdepth for Dredging Inconsistencies	Total Allowable Dredging Depth
Baldhead Shoal	49,100	500		44	0	2	46
Channel bend widener	-	-	910	44	0	2	46
Smith Island	5,188	500		44	0	2	46
Baldhead-Caswell	1,987	500		44	0	2	46
Southport	5,363	500		44	0	2	46
Battery Island	2,588	500		44	0	2	46
Lower Swash	9,733	400		42	0	2	44
Snows Marsh	15,775	400		42	0	2	44
Channel bend widener	-	-	610	42	0	2	44
Horseshoe Shoal	6,098	400		42	0	2	44
Reaves Point	6,531	400		42	0	2	44
Lower Midnight[3]	8,240	600		42	0	2	44
Upper Midnight[3]	13,736	600		42	0	2	44
Lower Lilliput[3]	10,825	600		42	0	2	44
Channel bend widener	-	-	560	42	1	2	45
Upper Lilliput	9,915	400		42	1	2	45
Keg Island	7,725	400		42	1	2	45
Channel bend widener	-	-	733	42	1	2	45
Lower Big Island	4,099	400		42	1	2	45
Channel bend widener	-	-	646	42	1	2	45
Upper Big Island	2,644	642		42	1	2	45
Channel bend widener	-	-	648	42	1	2	45
Lower Brunswick	8,682	400		42	1	2	45
Channel bend widener	-	-	823	42	1	2	45
Upper Brunswick	4,079	400		42	1	2	45
Fourth East Jetty	8,874	400	500	42	1	2	45
Between	2,675	400		42	1	2	45
Anchorage Basin	8,643	400	1,200	42	1	2	45
Mem. Bridge – Hilton RR Bridge	12,045	400	750	38	1	2	41
Hilton RR Bridge - 750' upstream	750	200		38	1	2	41
750' above Hilton RR Br. - Project Limit	5,955	250	800	34	1	2	37
Total Length in Feet	211,250						
Total Length in Miles	40.0						

[1] Width shown is widest point at wideners and basins, and includes the channel width. Widened areas taper down through transition areas to the adjacent channel widths.

[2] Channel depths are at mean lower low water.

[3] This channel reach includes the Passing Lane.

Table 2. Sediment Volumes of Lower Wilmington Harbor.

Area Name	Station Number	Sediment Volumes, Cubic Yards > 90%Sand (Predominantly sand)	Sediment Volumes, Cubic Yards <90% Sand (High fines content)	Sediment Volumes, Cubic Yards Total	Planned Potential Destination
Baldhead Shoal Channel	120+00 seaward	0	6,662,831	6,662,831	ODMDS
Baldhead Shoal Channel	0+00 to 120+00	3,926,612	2,776,822	6,703,434	Bruns. Beaches/ODMDS
Subtotal, Baldhead Shoal		3,926,612	9,439,653	13,366,265	
Smith Island Channel		1,216,112	0	1,216,112	Brunswick Beaches
Baldhead-Caswell Channel		109,672	0	109,672	Brunswick Beaches
Southport Channel		88,247	0	88,247	Brunswick Beaches
Battery Island Channel		78,104	0	78,104	Brunswick Beaches
Lower Swash Channel		286,159	0	286,159	Brunswick Beaches
Snows Marsh Channel	Upstream to 10+00	327,296	0	327,296	Brunswick Beaches
Subtotal, Smith Island – Snows Marsh 10+00		2,105,590	0	2,105,590	
TOTALS		6,032,202	9,439,653	15,471,855	
ROUNDED TOTALS		6,000,000	9,400,000	15,500,000	
Snows Marsh Channel	10+00 Upstream	101,594	0	101,594	New Han./Bruns. Beaches
Horseshoe Shoal Channel		466,946	0	466,946	New Han./Bruns. Beaches
Subtotal, Snows Marsh – Horseshoe Shoal		568,540	0	568,540	
River Disposal Islands 3 & 4		1,359,240	0	1,359,240	New Han./Bruns. Beaches
Subtotal, River Disposal Islands		1,359,240	0	1,359,240	
TOTALS		1,927,780	0	1,927,780	
ROUNDED TOTALS		1,900,000	0	1,900,000	
GRAND TOTALS		7,959,982	9,439,653	17,399,635	
ROUNDED GRAND TOTALS		8,000,000	9,400,000	17,400,000	

[1] - Beach placement is planned for sand from the lower harbor; however, small scattered sand quantities may go to the ODMDS for cost efficiency.

Table 3. Comparison of Sand Distribution under Section 933 and the Base Disposal Plan.

MAXIMUM Disposal Measurements with Section 933 Disposal

Location	Shoreline Length (feet)	Sediment Disposal Rate (cubic yds per linear ft)	Initial Placement Width Range (feet)	Adjusted Placement Width Range (feet)	Initial Placement Volume (cubic yds)	Net In-place Volume (cubic yds)
Bald Head Island	16,000				2,200,000	1,826,000
West Beach	2,000	120	190 - 210	95 -105	240,000	200,000
South Beach	2,000	120	190 - 210	95 - 105	240,000	200,000
South Beach	12,000	143	220 - 240	110 - 120	1,720,000	1,426,000
Oak Island	50,500				4,740,000	3,933,000
East Oak Island - Caswell Beach	25,000	110	170 - 190	85 - 95	2,750,000	2,283,000
West Oak Island - Caswell Beach	25,600	78	120 - 140	60 - 70	1,990,000	1,650,000
Holden Beach	10,600	78	120 - 140	60 - 70	830,000	690,000

Note: ***Maximum*** can be achieved in one area only at the expense of another area since available sand is limited. Total volumes not shown in table because they exceed available amounts.

Disposal Measurements with Base Disposal Plan

Location	Shoreline Length (feet)	Sediment Disposal Rate (cubic yds per linear ft)	Initial Placement Width Range (feet)	Adjusted Placement Width Range (feet)	Initial Placement Volume (cubic yds)	Net In-place Volume (cubic yds)
Bald Head Island	16,000				2,580,000	
West Beach	2,000	120	190 - 210	95 - 105	240,000	200,000
South Beach	2,000	120	190 - 210	95 - 105	240,000	200,000
South Beach	12,000	175	280 - 300	140 - 150	2,100,000	1,734,000
East Oak Island - Caswell Beach	25,000	137	220 - 240	110 - 120	3,420,000	2,839,000
Totals	41,000				6,000,000	4,973,000

Table 4. Approved and Proposed Dredging Methods for Construction[A].

CHANNEL CHARACTERISTICS					Hydraulic Pipeline Dredge												Hopper Dredge								Bucket and Barge or Scow (No Seasonal Restrictions downstream of Fourth East Jetty Channel)																	
Name of	>90%	Rock[R]	Primary		Sand > 90%					Sediment < 90% Sand				Rock			Sand >90%			Sediment < 90% Sand				Sand > 90%						Sediment < 90% Sand						Rock					
Channel Reach	Sand	Present	Nursery		Pipeline Directly To				Overflow	Pipeline Directly To			Overflow	Pipeline	Overflow	No	Overflow,			W/ Overflow		No Overflow		W/ Overflow			No Overflow		Overflow			No Overflow		Overflow	No Overflow,					
From Ocean	&	&	Relative to		ODMDS	Nearby	Littoral	Disposal	Scow,	ODMDS	Disposal	Eagle	Scow,	Directly	Scow,	Overflow,	Then Haul To			Pump to	Haul	Pump to	Haul	To Diked Disposal Site		Haul	To	Haul	To Diked Disposal Site		Haul	To	Haul	Scow,	Scow Haul to					
Proceeding	Gravel	May	Channel			Beaches	Zone	Islands	To ODMDS		Islands	Island	Then To	To Eagle	To WOFES	To WOFES	ODMDS	Beaches	Zone	Islands	ODMDS	Islands	ODMDS	Backhoe	Hydraulic	To	Eagle	To	Backhoe	Hydraulic	To	Eagle	To	Haul to	Eagle	To WOFES			
Upstream		Blast	inside	Outside					or Littoral				ODMDS	Island	or ODMDS[W]	or ODMDS[W]								& Truck	Pump	ODMDS	Island	ODMDS	& Truck	Pump	ODMDS	Island	ODMDS	WOFES or	Island	or ODMDS[W]			
									Zone																									ODMDS[W]					
Baldhead Shoal, outer			no	no						all yr[3]			propose[Y]							all yr[4]		all yr[2,3,4,5,9]						all yr[3,4]		all yr[3,4]								
Baldhead Shoal, inner	yes		no	no	all yr[3]	propose[Y]	propose[Y]		propose[Y]								all yr[2]	propose[Y]	propose[Y]						all yr[3,4]		all yr[3,4]												
Smith Island	yes		no	no	all yr[3]	propose[Y]	propose[Y]		propose[Y]								all yr[2]	propose[Y]	propose[Y]						all yr[3,4]		all yr[3,4]												
Baldhead-Caswell	yes		no	no	all yr[3]	propose[Y]	propose[Y]		propose[Y]								all yr[2]	propose[Y]	propose[Y]						all yr[3,4]		all yr[3,4]												
Southport	yes		no	no	all yr[3]	propose[Y]	propose[Y]		propose[Y]								all yr[2]	propose[Y]	propose[Y]						all yr[3,4]		all yr[3,4]												
Battery Island	yes		no	no	all yr[3]	propose[Y]	propose[Y]		propose[Y]								all yr[2]	propose[Y]	propose[Y]						all yr[3,4]		all yr[3,4]												
Lower Swash	yes		no	no	propose[Y]	propose[Y]	propose[Y]	propose[Y]	propose[Y]								propose[Y]	propose[Y]	propose[Y]					propose[Y]	propose[Y]	all yr[3,4]		all yr[2,4]												
Snows Marsh	yes	yes	no	no	propose[Y]	propose[Y]	propose[Y]	propose[Y]	propose[Y]						propose[Y]	propose[Y]	propose[Y]	propose[Y]	propose[Y]					propose[Y]	propose[Y]	all yr[3,4]		all yr[1,2,4]						propose[Y]		all yr[4]			
Horseshoe Shoal	yes		no	no	propose[Y]	propose[Y]	propose[Y]	propose[Y]	propose[Y]								propose[Y]	propose[Y]	propose[Y]					propose[Y]	propose[Y]	all yr[3,4]		all yr[1,2,4]											
Reaves Point			no	no						Aug-Jan[2,4]	Aug-Jan[2,4]	propose[F]								propose[F]	Aug-Jan[6]	propose[F]	Aug-Jan[2,6]						propose[Y]	propose[Y]	propose[Y]	propose[Y]	all yr[1,2,4]					
Lower Midnight			no	no						Aug-Jan[2,4]	Aug-Jan[2,4]	propose[F]								propose[F]	Aug-Jan[6]	propose[F]	Aug-Jan[2,6]						propose[Y]	propose[Y]	propose[Y]	propose[Y]	all yr[1,2,4]					
Upper Midnight			no	no						Aug-Jan[2,4]	Aug-Jan[2,4]	propose[F]								propose[F]	Aug-Jan[6]	propose[F]	Aug-Jan[2,6]						propose[Y]	propose[Y]	propose[Y]	propose[Y]	all yr[1,2,4]					
Lower Lilliput			no	no						Aug-Jan[2,4]	Aug-Jan[2,4]	propose[F]								propose[F]	Aug-Jan[6]	propose[F]	Aug-Jan[2,6]						propose[Y]	propose[Y]	propose[Y]	propose[Y]	all yr[1,2,4]					
Upper Lilliput	yes	yes	no	> 300 yd				Aug-Jan[2,4]	propose[F]					propose[F]	propose[F]	propose[F]	Aug-Jan[2,6]	propose[F]	propose[F]					propose[Y]	propose[Y]	all year[4]	propose[Y]	all yr[1,2,4]						propose[Y]	propose[Y]	all yr[4]			
Keg Island		yes	no	> 300 yd						Aug-Jan[2,4]	Aug-Jan[2,4]	propose[F,M]		propose[F]	propose[F,M]	propose[F]				propose[F,M]	Aug-Jan[6,M]	propose[F]	Aug-Jan[2,6]						propose[M,Y]	propose[M,Y]	propose[M,Y]	propose[Y]	all yr[1,2,4]		propose[M,Y]	propose[Y]	all yr[4]		
Lower Big Island	yes	yes	no	> 300 yd				Aug-Jan[2,4]	propose[F]					propose[F]	propose[F]	propose[F]	Aug-Jan[6]	propose[F]	propose[F]					propose[Y]	propose[Y]	all year[4,6]	propose[Y]	all yr[4,6]						propose[Y]	propose[Y]	all yr[4]			
Upper Big Island	yes	yes	no	> 300 yd				Aug-Jan[2,4]	propose[F]					Aug-Jan[4]	propose[F]	propose[F]	Aug-Jan[6]	propose[F]	propose[F]					propose[Y]	propose[Y]	propose[Y]	propose[Y]	propose[Y]						propose[Y]	all yr[4]	all yr[4]			
Lower Brunswick	yes	yes	no	> 300 yd				Aug-Jan[2,4]	propose[F]					Aug-Jan[4]	propose[F]	propose[F]	Aug-Jan[6]	propose[F]	propose[F]					propose[Y]	propose[Y]	propose[Y]	propose[Y]	propose[Y]						propose[Y]	all yr[4]	all yr[4]			
Upper Brunswick		yes	no	> 300 yd						Aug-Jan[2,4]	Aug-Jan[4]	propose[F,M]		Aug-Jan[4]	propose[F,M]	propose[F]				propose[F]	Aug-Jan[5,M]	propose[F]	Aug-Jan[5]						propose[M,Y]	propose[M,Y]	propose[M,Y]	propose[Y]	propose[Y]		propose[M,Y]	all yr[4]	all yr[4]			
Fourth East Jetty		yes	no	all						Aug-Jan[2,4]	Aug-Jan[4]			Aug-Jan[4]		propose[F]						propose[F]	propose[F]										propose[Y]	propose[Y]		all yr[4]	all yr[4]		
Between		yes	no	all						Aug-Jan[2,4]	Aug-Jan[4]			Aug-Jan[4]		propose[F]						propose[F]	propose[F]										propose[Y]	propose[Y]		all yr[4]	all yr[4]		
Anchorage Basin		yes	no	all						Aug-Jan[2,4]	Aug-Jan[4]			Aug-Jan[4]		propose[F]						propose[F]	propose[F]										propose[Y]	propose[Y]		all yr[4]	all yr[4]		
Mem. Br.- Chemserve		yes	no	all						Aug-Jan[2,4]	Aug-Jan[4]			Aug-Jan[4]								propose[F]											propose[Y]			all yr[4]			
Chemserve-Proj. Limit		yes	no	all						Aug-Jan[2,4]	Aug-Jan[4]			Aug-Jan[4]								propose[F]											propose[Y]			all yr[4]			

ASSUMPTIONS:
- Sediment to be dredged includes material within the limits of the authorized navigation channel and material present in existing island disposal sites located along the project, subject to compatibility with destination.
- Sediment with sand content > 90% is suitable for beach or littoral zone placement, and would go to such sites to the extent feasible (otherwise to ODMDS); if sand content < 90%, sediment is not suitable for beach or littoral zone placement.
- Predominantly fine sediment from Fourth East Jetty Channel upstream can not be overflowed due to contiguous primary nursery area beginning at edges of navigation channel.

REASON NOT APPLICABLE:
- = Sediment in this channel reach is not the type addressed in this column of the table.
- = Sediment not suitable for overflow contiguous to primary nursery area due to silt / clay >10%.
- = Alternative judged not cost-effective at this time; distance of sediment source to disposal area is too great.

CONDITIONS:
- [A] Annual maintenance dredging and disposal will be by the same methods except that seasonal constraints for sea turtles will allow hopper dredging only during 15 November through 31 March and beach disposal only during 15 November through 30 April.
- [F] Fishery-related window allows hydraulic dredging in river only during months of Aug, Sep, Oct, Nov, Dec, and Jan.
- [M] Activity is allowable with monitoring of overflow plume.
- [R] Known rock of variable hardness occurs in portions of channels indicated; removal may require blasting, depending upon work methods and equipment used by contractor. Rock may also be encountered in other riverine channels and may require blasting.
- [W] The WOFES is the preferred and approved ocean site for rock placement; however, if loads of rock are judged unsuitable for the WOFES due to high silt/clay content or other factors, it is proposed that such material go to the ODMDS instead.
- [Y] Year-around dredging and disposal proposed.

REFERENCES & APPROVALS:

- [1] USACE, 1986. EA/FONSI Maintenance Dredging with Clamshell Dredge and Ocean Disposal, Keg Island to Snows Marsh Channels, Wilmington Harbor.
- [2] USACE, 1989. FEIS Long-term Maintenance of Wilmington Harbor.
- [3] USACE, 1991. EA/FONSI Maintenance Dredging in Wilmington HarborOcean Bar Channels by Ocean-certified Pipeline or Bucket & Barge Dredge with Disposal in ODMDS.
- [4] USACE, 1996. Feasibility Report & FEIS Cape Fear River-Northeast Cape Fear River Comprehensive Study.
- [5] USACE, 1997. South Atlantic Division Hopper Dredging Protocol for Atlantic Coast.
- [6] USACE, 1997. EA/FONSI for Use of Hopper Dredge with Overflow for Portions of Wilmington Harbor.
- [7] USACE, 1998. Monitoring Plan for Hopper Dredge Overflow in Wilmington Harbor.
- [8] NMFS, 1997. Regional Biological Opinion on Hopper Dredging along the South Atlantic Coast.

NOTES:
- THE MAJOR PURPOSE OF THIS TABLE IS TO CLARIFY THE ACCEPTABLE USES OF SPECIFIC DREDGING EQUIPMENT BASED ON SEDIMENT TYPE, DISTANCE TO DISPOSAL SITES, SEASONAL RESTRICTIONS, AND OTHER CONSTRAINTS AND CONDITIONS.
- DISPOSAL OF DREDGED MATERIAL AT EAGLE ISLAND, DISPOSAL ISLANDS OF THE CAPE FEAR RIVER, AND THE ODMDS IS NOT SEASONALLY RESTRICTED AND IS ENVIRONMENTALLY ACCEPTABLE ON A YEAR-AROUND BASIS.

Column Number -->	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37

Table 5. Essential Fish Habitat (EFH) Species of Wilmington Harbor, North Carolina.

FISH SPECIES	Water Bodies		FISH SPECIES	Water Bodies	
	Cape Fear & NE Cape Fear Rivers	Atlantic Ocean South of Cape Hatteras		Cape Fear & NE Cape Fear Rivers	Atlantic Ocean South of Cape Hatteras
Red drum	E L J A	A	Gray triggerfish	N/A	E L J A
Bluefish	E L J A	J A	Yellow jack	N/A	E L J A
Summer flounder	L J A	E L J A	Blue runner	N/A	E L J A
Gag grouper	J	E L J A	Crevalle jack	N/A	E L J A
Gray snapper	J	E L J A	Bar jack	N/A	E L J A
Dolphin	N/A	E L J A	Greater amberjack	N/A	E L J A
Cobia	E L J A	J A	Almaco jack	N/A	E L J A
King mackerel	J A	E L J A	Banded rudderfish	N/A	E L J A
Spanish mackerel	J A	E L J A	Spade fish	N/A	E L J A
Black sea bass	L J A	E L J A	White grunt	N/A	E L J A
Spiny dogfish	J A	E L J A	Hogfish	N/A	E L J A
Brown shrimp	E L J A	E L J A	Puddingwife	N/A	E L J A
Pink shrimp	E L J A	E L J A	Blackfin snapper	N/A	E L J A
White shrimp	E L J A	E L J A	Red snapper	N/A	E L J A
Atlantic bigeye tuna	N/A	E L J A	Cubera snapper	N/A	E L J A
Atlantic bluefin tuna	N/A	E L J A	Silk snapper	N/A	E L J A
Skipjack tuna	N/A	E L J A	Vermillion snapper	N/A	E L J A
Longbill spearfish	N/A	E L J A	Blueline tilefish	N/A	E L J A
Shortfin mako shark	N/A	J A	Sand tilefish	N/A	E L J A
Blue shark	N/A	J A	Bank sea bass	N/A	E L J A
Spinner shark	N/A	E L J A	Rock sea bass	N/A	E L J A
Swordfish	N/A	E L J A	Graysby	N/A	E L J A
Yellowfin tuna	N/A	E L J A	Speckled hind	N/A	E L J A
Blue marlin	N/A	E L J A	Yellowedge grouper	N/A	E L J A
White marlin	N/A	E L J A	Coney	N/A	E L J A
Sailfish	N/A	E L J A	Red hind	N/A	E L J A
Calico scallop	N/A	E L J A	Jewfish	N/A	E L J A
Scalloped hammerhead shark	J A	J A	Red grouper	N/A	E L J A
Big nose shark	J A	J A	Misty grouper	N/A	E L J A
Black tip shark	J A	J A	Warsaw grouper	N/A	E L J A
Dusky shark	J A	J A	Snowy grouper	N/A	E L J A
Night shark	J A	J A	Yellowmouth grouper	N/A	E L J A
Sandbar shark	J A	J A	Scamp	N/A	E L J A
Silky shark	J A	J A	Sheepshead	N/A	E L J A
Tiger shark	J A	J A	Red porgy	N/A	E L J A
Atlantic sharpnose shark	J A	J A	Longspine porgy	N/A	E L J A
Longfin mako shark	J A	J A	Scup	N/A	E L J A
Whitetip shark	J A	J A	Little tunny	N/A	E L J A
Thresher shark	J A	J A			
LIFE STAGES PRESENT:	**E = Eggs; L = Larval; J = Juvenile; A = Adult; N/A = Not Found**				

Source: National Marine Fisheries Service, Beaufort, North Carolina, October 1999.

Table 6. Categories of Essential Fish Habitat and Habitat Areas of Particular Concern in Southeast States.[1]

ESSENTIAL FISH HABITAT

Estuarine Areas

Aquatic Beds
Estuarine Emergent Wetlands
Estuarine Scrub / Shrub Mangroves
Estuarine Water Column
Intertidal Flats
Oyster Reefs & Shell Banks
Palustrine Emergent & Forested Wetlands
Seagrass

Marine Areas

Artificial / Manmade Reefs
Coral & Coral Reefs
Live / Hard Bottoms
Sargassum
Water Column

GEOGRAPHICALLY DEFINED HABITAT AREAS OF PARTICULAR CONCERN

Area - Wide

Council-designated Artificial Reef Special Management Zones
Hermatypic (reef-forming) Coral Habitat & Reefs
Hard Bottoms
Hoyt Hills
Sargassum Habitat
State-designated Areas of Importance of Managed Species
Submerged Aquatic Vegetation

North Carolina

Big Rock
Bogue Sound
Capes Fear, Lookout, & Hatteras (sandy shoals)
New River
The Ten Fathom Ledge
The Point

[1]Areas shown are identified in Fishery Management Plan Amendments of the South Atlantic Fishery Management Council and are included in Essential Fish Habitat: New Marine Fish Habitat Mandate for Federal Agencies. February 1999. (Tables 6 and 7)

Table 7. Endangered and Threatened Species Potentially Present in Wilmington Harbor, NC.

Species Common Names	Scientific Name	Federal Status
MAMMALS		
Blue whale	(*Balaenoptera musculus*)	Endangered
Eastern cougar	(*Felis concolor cougar*)	Endangered
Finback whale	(*Balaenoptera physalus*)	Endangered
Humpback whale	(*Megaptera novaeangliae*)	Endangered
Manatee	(*Trichechus manatus*)	Endangered
Right whale	(*Eubaleana glacialis*)	Endangered
Sei whale	(*Balaenoptera borealis*)	Endangered
Sperm whale	(*Physeter macrocephalus*)	Endangered
BIRDS		
Peregrine falcon	(*Falco peregrinus anatum*)	Endangered
Bald eagle	(*Halieetus leucocephalus*)	Threatened
Piping plover	(*Charadrius melodus*)	Threatened
Red-cockaded woodpecker	(*Picoides borealis*)	Endangered
Wood stork	(*Mycteria americana*)	Endangered
REPTILES		
American alligator	(*Alligator mississippiensis*)	Threatened/SA[1]
Green sea turtle	(*Chelonia mydas*)	Threatened[2]
Hawksbill sea turtle	(*Eretmochelys imbricata*)	Endangered
Kemp's ridley sea turtle	(*Lepidochelys kempii*)	Endangered
Leatherback sea turtle	(*Dermochelys coriacea*)	Endangered
Loggerhead sea turtle	(*Caretta caretta*)	Threatened
FISHES		
Shortnose sturgeon	(*Acipenser brevirostrum*)	Endangered
PLANTS		
Cooley's meadowrue	(*Thalictrum cooleyi*)	Endangered
Rough-leaved loosestrife	(*Lysimachia asperulaefolia*)	Endangered
Seabeach amaranth	(*Amaranthus pumilis*)	Threatened

[1]The American alligator is listed as threatened only because of its similarity of appearance to crocodilians which are endangered or threatened and which are tracked for illegal commercial trade in hides or other products. The status of the American alligator is not actually threatened.

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

Table 8. Summary of Potential Impacts to Essential Fish Habitat and Habitat Areas of Particular Concern

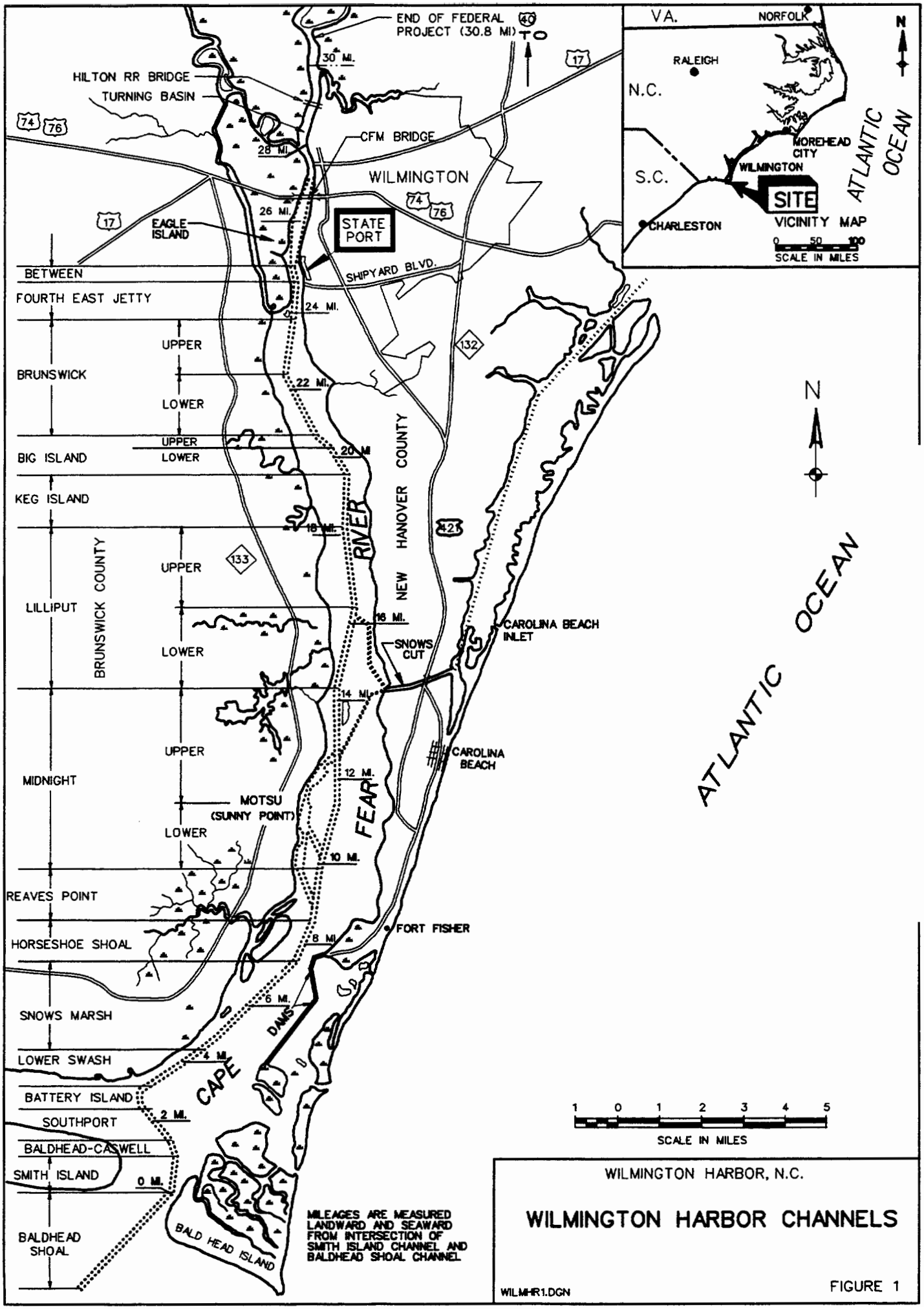
ESSENTIAL FISH HABITAT		Present in Project Area	Potential Impacts: Dredge Plant Operation	Potential Impacts: Sediment Disposal Activities
Estuarine Areas				
1	Aquatic Beds	yes	no	no
2	Estuarine Emergent Wetlands	yes	no	no
3	Estuarine Scrub / Shrub Mangroves	no		
4	Estuarine Water Column	yes	insignificant	insignificant
5	Intertidal Flats	yes	no	no
6	Oyster Reefs & Shell Banks	yes	no	no
7	Palustrine Emergent & Forested Wetlands	yes	no	no
8	Seagrass	no		
Marine Areas				
9	Artificial / Manmade Reefs	yes	no	no
10	Coral & Coral Reefs	yes	no	no
11	Live / Hard Bottoms	yes	no	no
12	Sargassum	yes	no	no
13	Water Column	yes	insignificant	insignificant
GEOGRAPHICALLY DEFINED HABITAT AREAS OF PARTICULAR CONCERN				
Area - Wide				
14	Council-designated Artificial Reef Special Management Zones	no		
15	Hermatypic (reef-forming) Coral Habitat & Reefs	yes	no	no
16	Hard Bottoms	yes	no	no
17	Hoyt Hills	no		
18	*Sargassum* Habitat	yes	no	no
19	State-designated Areas Important for Managed Species	yes	insignificant	insignificant
20	Submerged Aquatic Vegetation	yes	no	no
North Carolina				
21	Big Rock	no		
22	Bogue Sound	no		
23	Capes Fear, Lookout, & Hatteras (sandy shoals)	yes	insignificant	insignificant
24	New River	no		
25	The Ten Fathom Ledge	no		
26	The Point	no		

Areas shown are identified in Fishery Management Plan Amendments of the South Atlantic Fishery Management Council and are included in Essential Fish Habitat: New Marine Fish Habitat Mandate for Federal Agencies, February 1999.(tables 6 and 7)

Table 9. North Carolina Artificial Reefs in the Vicinity of Wilmington Harbor, NC.

NC REEF SITE #	NEAREST INLET ACCESS	DISTANCE NAUTICAL MILES			VERTICAL DISTANCES FT		REEF SITE LOCATION	
		Cape Fear Buoy 2CF Sea Buoy	Nearest Inlet Sea Buoy	Nearest Shoreline	Approximate Water Depth	Maximum Vertical Profile	Loran C Buoy	Lat / Long
420	Cape Fear River	2.9	2.9	3.4	36	16	45347.9 59184.8	33 51'15"N 78 06'30"W
425	Cape Fear River	4.4	4.4	1.3	30	10	45354.7 59169.6	33 53'06"N 78 07'24"W
440	Lockwood Folly Inlet	8.3	4.4	4.4	42	12	45365.8 59246.6	33 50'00"N 78 13'00"W
445	Lockwood Folly Inlet	9.8	9.3	9.8	53	33	45352.0 59289.0	33 45'00"N 78 14'00"W
455	Shallotte Inlet	12.2	7.0	7.6	46	26	45373.0 59306.0	33 47'00"N 78 18'00"W
460	Shallotte Inlet	15.4	3.0	4.0	38	23	45398.0 59323.0	33 50'00"N 78 22'00"W

FIGURES

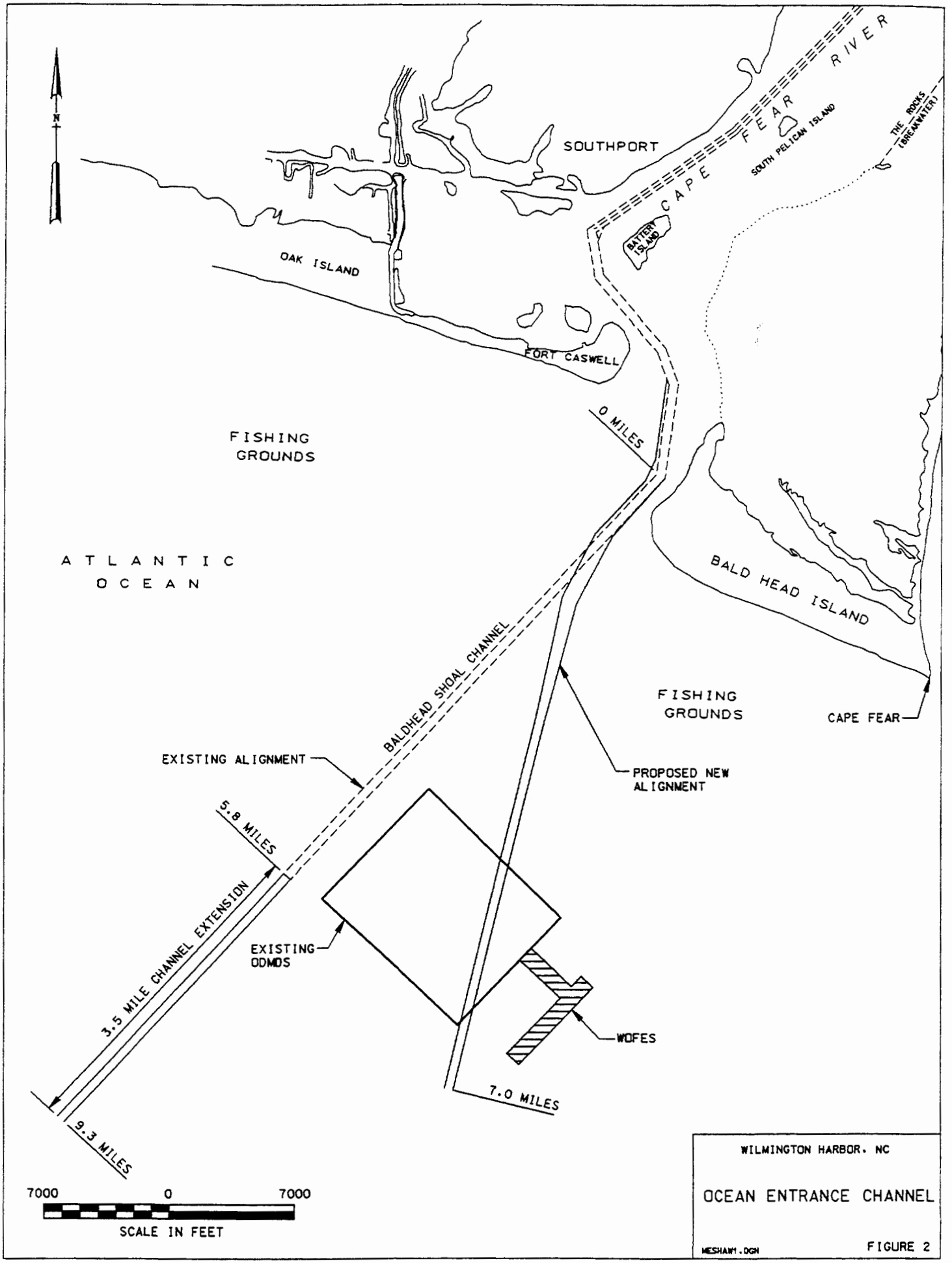


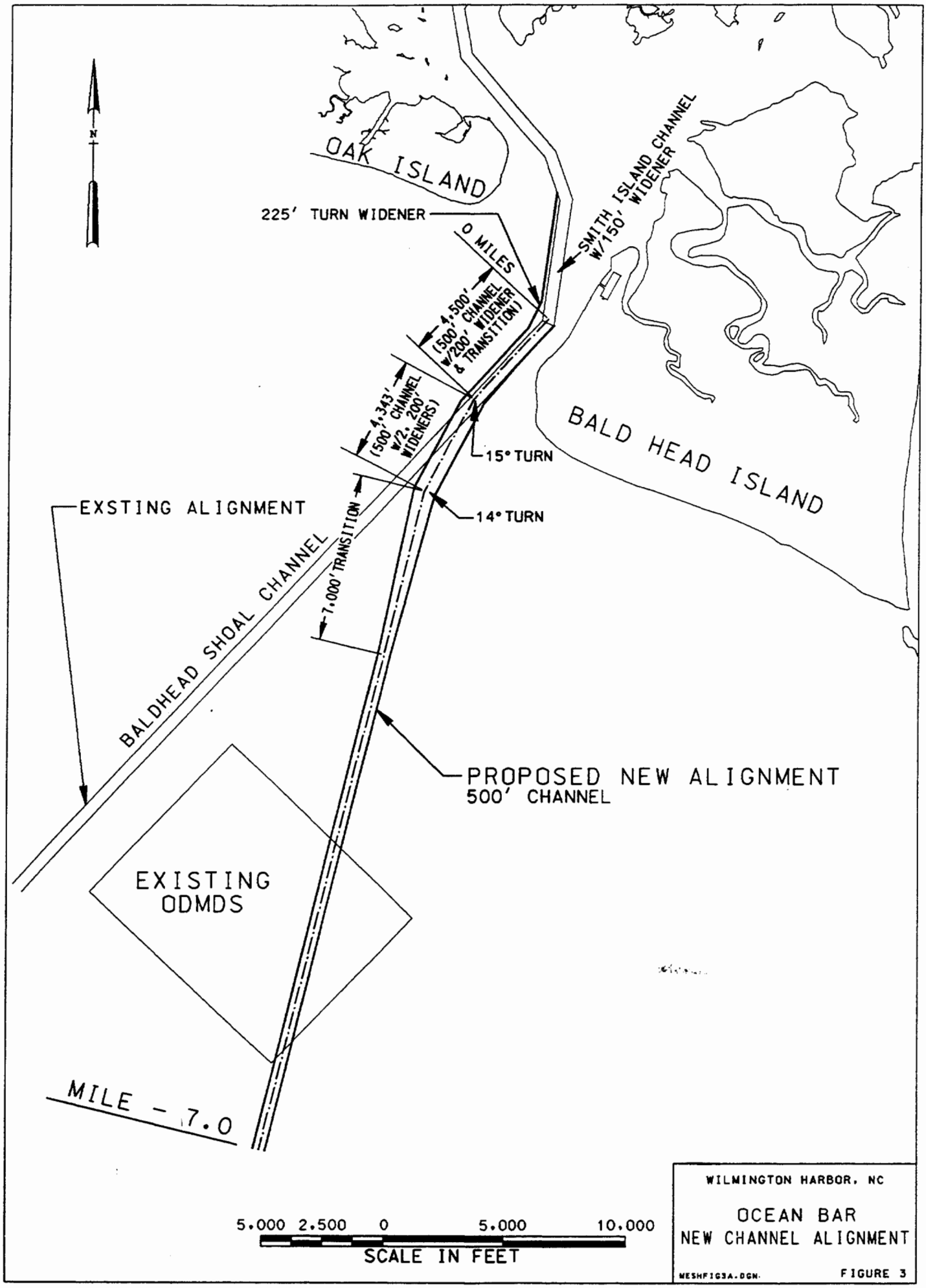
WILMINGTON HARBOR, N.C.

WILMINGTON HARBOR CHANNELS

WILMHR1.DGN

FIGURE 1


N
SOUTHPORT
CAPE FEAR RIVER
SOUTH PELICAN ISLAND
THE ROCKS (BREAKWATER)
BATTERY ISLAND
OAK ISLAND
FORT CASWELL
0 MILES
FISHING GROUNDS
ATLANTIC OCEAN
BALD HEAD ISLAND
BALDHEAD SHOAL CHANNEL
FISHING GROUNDS
CAPE FEAR
EXISTING ALIGNMENT
PROPOSED NEW ALIGNMENT
5.8 MILES
3.5 MILE CHANNEL EXTENSION
EXISTING ODMDS
WOFES
7.0 MILES
9.3 MILES
7000 0 7000
SCALE IN FEET
WILMINGTON HARBOR, NC
OCEAN ENTRANCE CHANNEL
MESHAW1.DGN
FIGURE 2

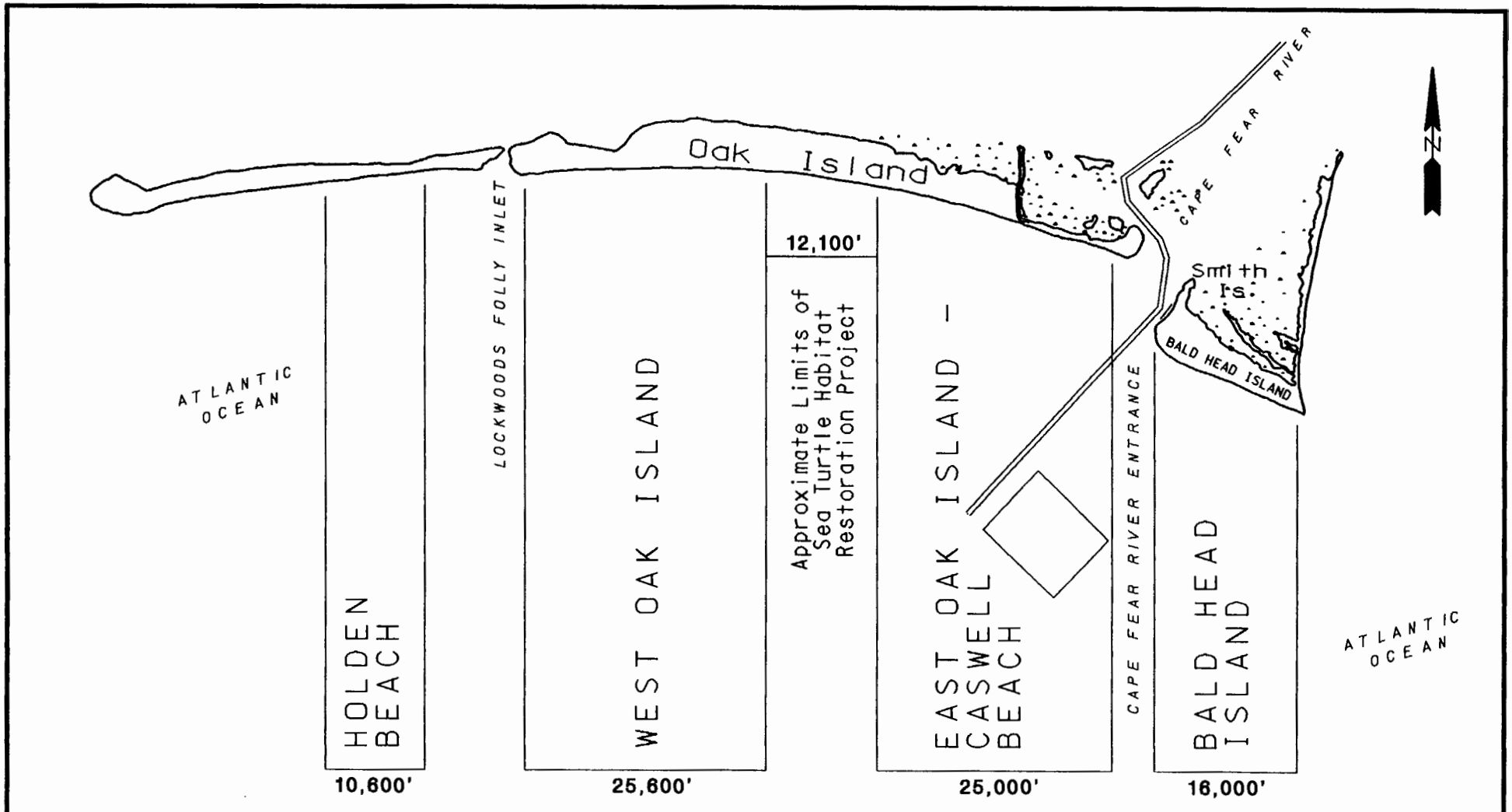


WILMINGTON HARBOR, NC

OCEAN BAR
NEW CHANNEL ALIGNMENT

MESHFIG3A.DGN

FIGURE 3



WILMINGTON HARBOR, NC

POTENTIAL BEACH DISPOSAL AREAS
BRUNSWICK COUNTY, N.C.

Figure 4

f:\barchan99\newbar\outer\bcbase2d.dgn

Brunswick County
Typical Beach Disposal Profile

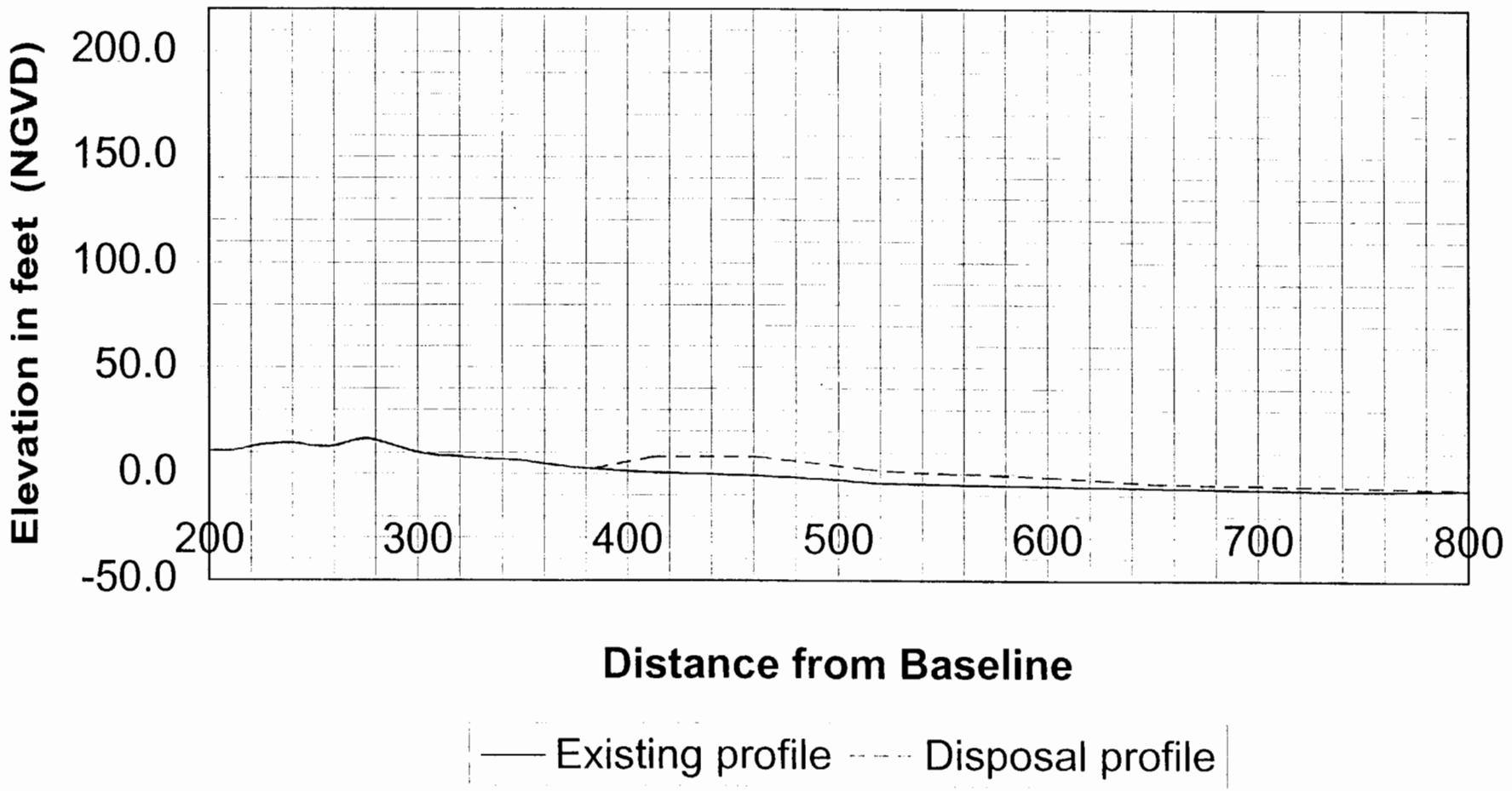
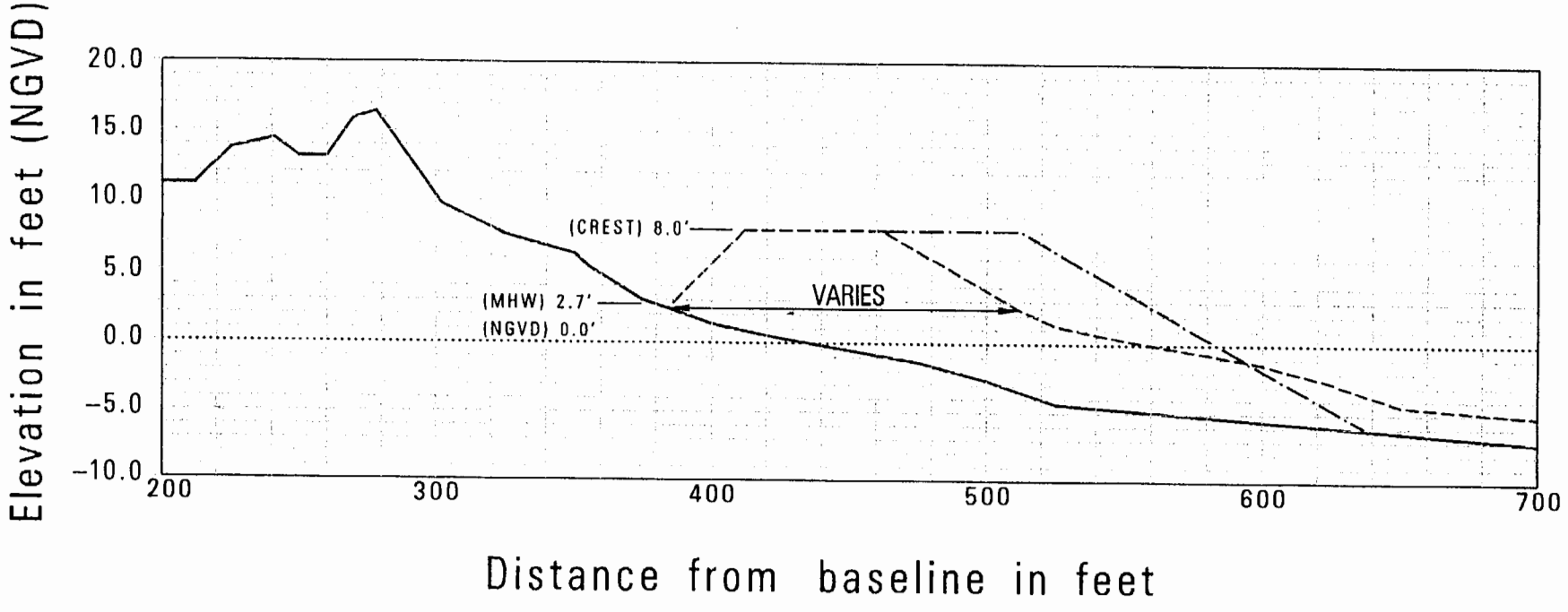


FIGURE 5

Brunswick County
Typical Beach Disposal Profile
with Exaggerated Scale



LEGEND

- Existing Profile
- Adjusted Design Profile
- Construction Profile

Figure 6

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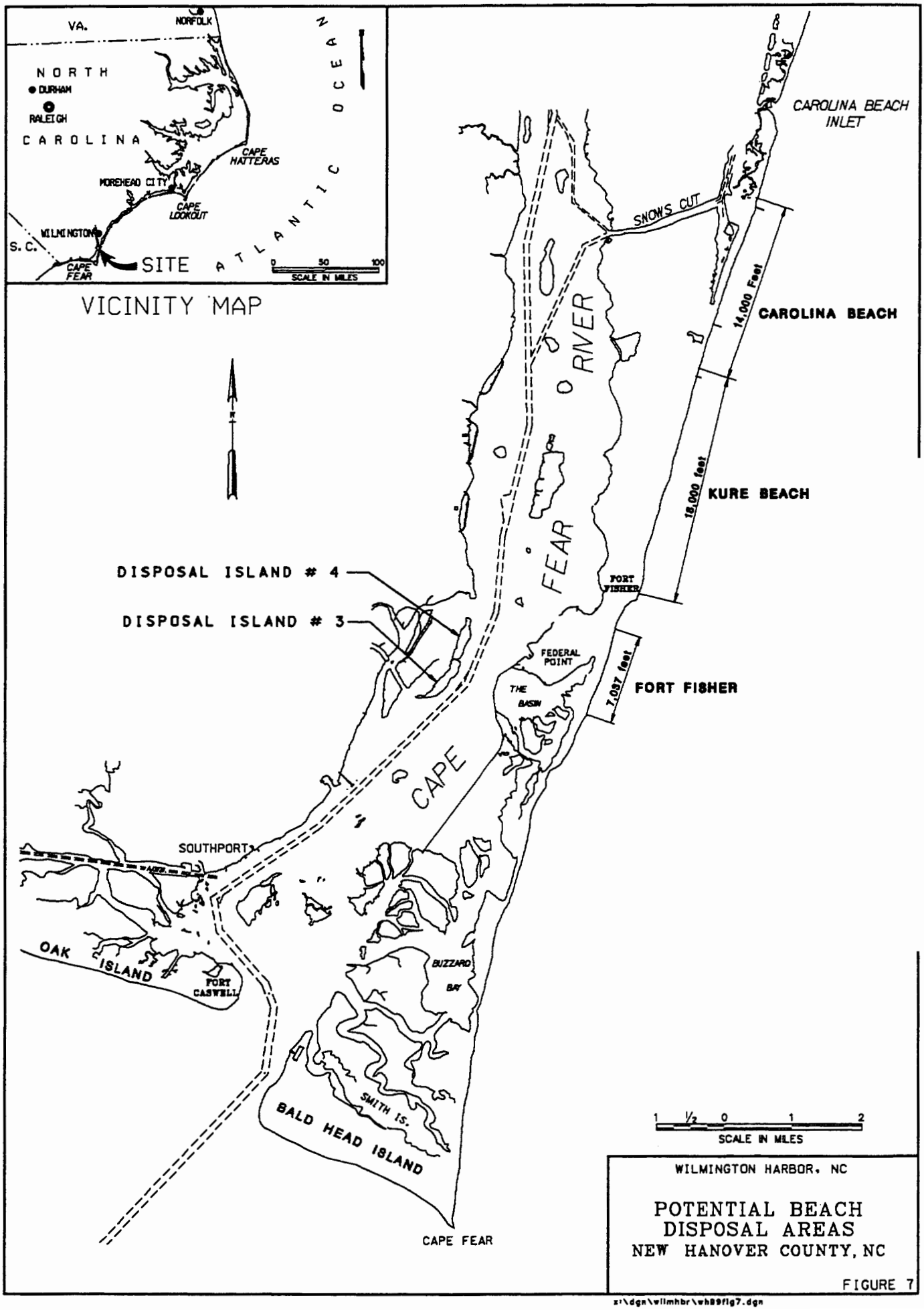

WILMINGTON HARBOR, NC

POTENTIAL BEACH DISPOSAL AREAS
NEW HANOVER COUNTY, NC

FIGURE 7

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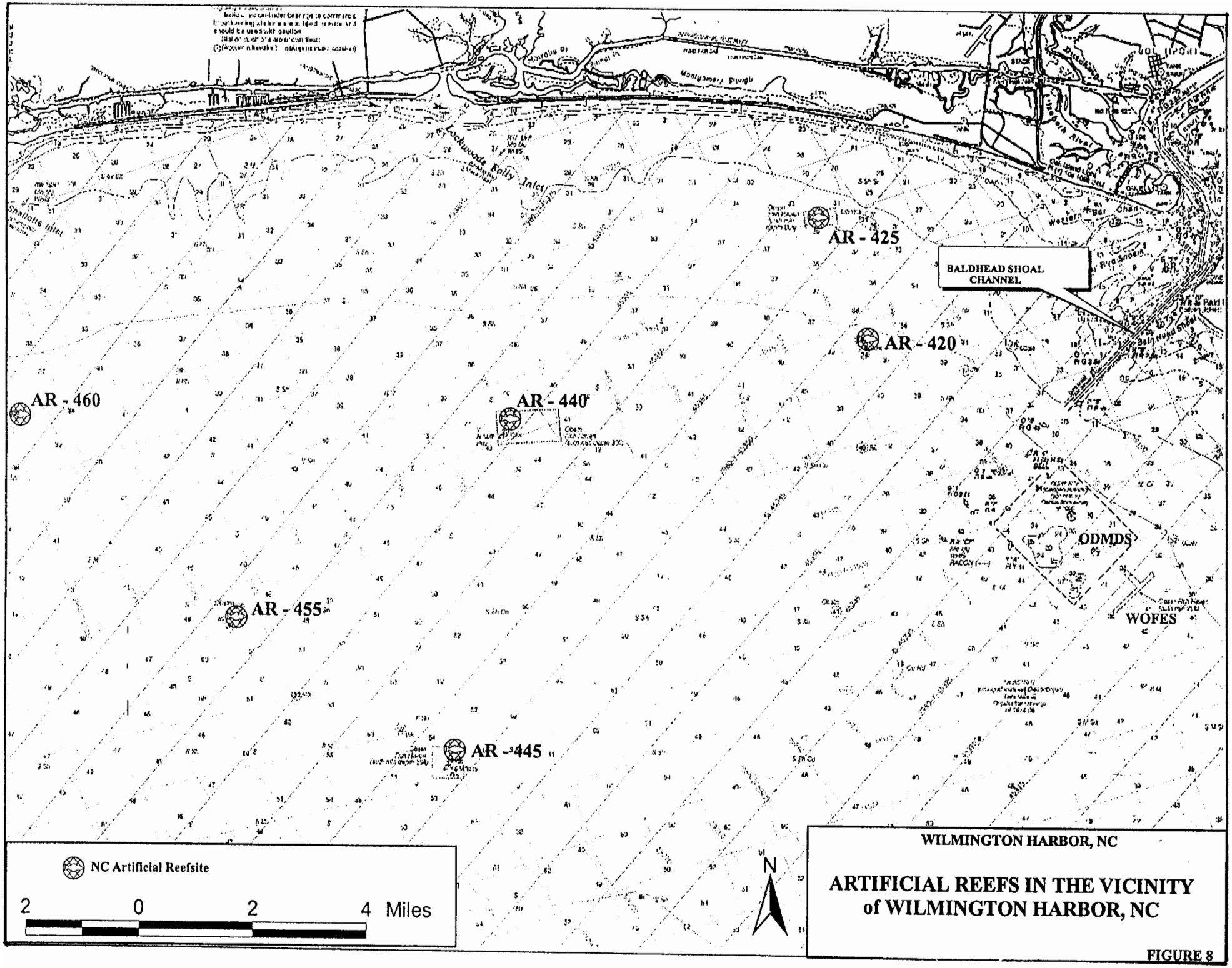
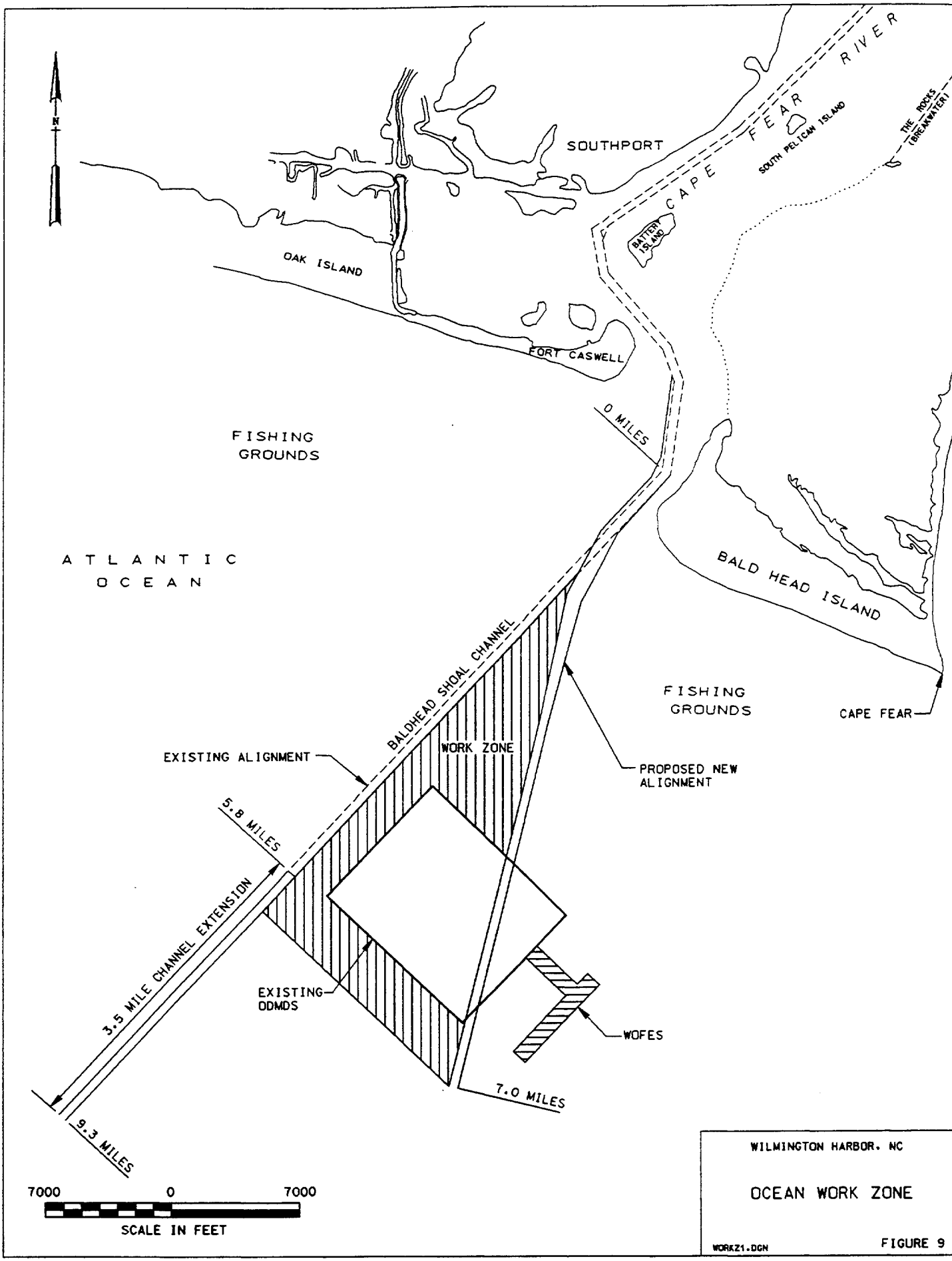

AR - 460
AR - 455
AR - 445
AR - 440
AR - 425
AR - 420
BALDHEAD SHOAL CHANNEL
ODMDS
WOFES
Lockwoods Folly Inlet
Shallotte Inlet
Montgomery Slough
NC Artificial Reefsite
2 0 2 4 Miles
N
WILMINGTON HARBOR, NC
ARTIFICIAL REEFS IN THE VICINITY of WILMINGTON HARBOR, NC
FIGURE 8


N
SOUTHPORT
CAPE FEAR RIVER
SOUTH PELICAN ISLAND
THE ROCKS (BREAKWATER)
BATTERY ISLAND
OAK ISLAND
FORT CASWELL
0 MILES
FISHING GROUNDS
ATLANTIC OCEAN
BALD HEAD ISLAND
FISHING GROUNDS
CAPE FEAR
BALDHEAD SHOAL CHANNEL
WORK ZONE
EXISTING ALIGNMENT
PROPOSED NEW ALIGNMENT
5.8 MILES
3.5 MILE CHANNEL EXTENSION
EXISTING ODMDS
WOFES
7.0 MILES
9.3 MILES
7000
0
7000
SCALE IN FEET
WILMINGTON HARBOR, NC
OCEAN WORK ZONE
WORKZ1.DGN
FIGURE 9

DISPOSAL ISLAND # 4; SHORELINE FACING NAVIGATION CHANNEL.

(From north end looking south on December 19, 1997. Shoreline of Disposal Island # 3 is similar.)

FIGURE 10

APPENDICES

APPENDIX A

SAND MANAGEMENT PLAN

WILMINGTON HARBOR

SAND MANAGEMENT PLAN
OCEAN ENTRANCE CHANNELS AND INNER HARBOR FROM SNOWS MARSH THROUGH HORSESHOE SHOAL CHANNELS

1. **General.** Deepening of Wilmington Harbor will involve the removal of large quantities of material including beach quality sand. Most of the beach quality material to be removed during deepening will come from the Ocean Entrance Channels consisting of the following ranges: Baldhead Shoal; Smith Island; Baldhead – Caswell; Southport; Battery Island, and Snows Marsh seaward of station 10+00. These ranges are shown on *Figure 1*. Beach quality sands will also be removed from portions of the Inner Harbor channel extending from the upper 1000 feet of the Snows Marsh Range through the Horseshoe Shoal Range. These Inner Harbor channel ranges are also shown on *Figure 1*. A maximum of 6.0 million cubic yards of beach quality material will be removed from the lower portion of the Snows Marsh Range seaward through the Baldhead Shoal Range. Approximately 0.6 million cubic yards of beach quality material will be removed from the upper Snows Marsh Range through the Horseshoe Shoal Range. Sand management plans for these two segments of the harbor are developed below for both the new work material; i.e., the beach quality material to be removed during deepening; and future maintenance of these harbor segments that will involve the removal of littoral shoal material.

Ocean Entrance Channels – Sand Management Plan

2. **Introduction**. The sand management plan for the ocean entrance channels addresses dredging and disposal issues associated with the realigned Baldhead Shoal Channel as well as the Smith Island, Baldhead – Caswell, Southport, Battery Island, Lower Swash, and Snows Marsh Channels. Construction of the ocean entrance channels into Wilmington Harbor will entail the removal of approximately 15.5 million cubic yards of material, up to 6.0 million cubic yards of which is beach quality sand. Beach quality sand exists throughout all of the entrance channel except the new Baldhead Shoal Channel. Within the Baldhead Shoal Channel, beach quality sand is located between stations 0+00 and 120+00. Between station 0+00 and approximately 66+00, the entire channel prism is considered to be beach quality material. Between station 66+00 and 120+00, beach quality material is layered with the material lying above elevations ranging from -30 to -41 feet MLLW. Material below these depths contains a high percentage of clay and silt and is not suitable for beach disposal. Seaward of station 120+00, the new work material contains high concentrations of silt and clay and is not suited for placement on the beach. The beach quality material will be dredged primarily from the portion of Jay Bird Shoal which overlays the west side of the realigned bar channel and from Baldhead Shoal. Baldhead Shoal forms the east boundary of the existing channel, however, the realigned bar channel will cut across the seaward portion of this shoal. The present alignment of the ocean bar channel and that of the new bar channel are shown on *Figure 1*. As shown on *Figure 1*, the new bar channel passes through the eastern side of the existing Ocean Dredged Material Disposal Site (ODMDS).

3. The Brunswick County beach towns of Bald Head Island, Caswell Beach, Oak Island, and Holden Beach have expressed an interest in receiving the beach quality material. Under Section 933 of the Water Resources Development Act of 1986 (Public Law 99-662), the Federal Government can cost share up to 50 percent of the added cost of depositing the material on the beach providing certain criteria are met. The primary requirement for Federal participation is that any added cost for placing sand on a particular beach segment must be economically justified. A base disposal plan associated with the least costly means of placing the beach quality material and a Section 933 disposal plan are discussed in the following paragraphs. In addition, a disposal plan for the annual maintenance material is presented following the disposal plan for the new work material.

4. **Plan Formulation – Ocean Entrance Channels New Work Material Disposal Plan.** The disposal plan for the new work material contained in the 1996 project feasibility report had all of the material from the Lower Big Island Range through the existing Baldhead Shoal Channel going to the ODMDS. It should be mentioned that the disposal plan in the feasibility report did not include consideration of the realigned Baldhead Shoal Channel. The alignment of the new Baldhead Shoal Channel came from a recommendation contained in a Value Engineering Study that demonstrated significant construction cost savings could be realized by avoiding rock in the existing Baldhead Shoal Channel. In any event, increased utilization of the existing ODMDS for disposal of maintenance and new work material has resulted in the existing ODMDS for Wilmington Harbor approaching full capacity. This combined with the passage of the realigned Baldhead Shoal Channel through the existing ODMDS has necessitated the development of a new ODMDS. The new ODMDS, which is being developed in cooperation with the Environmental Protection Agency (EPA), is located approximately 5 miles offshore of the existing ODMDS as shown on *Figure 1*. The new ODMDS is expected to be available for use by the end of 2001, consequently, the existing ODMDS must have sufficient capacity to accommodate the new work and maintenance material expected to be removed though the year 2001.

5. The remaining capacity of the existing ODMDS was estimated assuming that the area could be filled to an average elevation of 26 feet below mean lower low water (mllw). All future placement of dredge material in the existing ODMDS will take place west of the new channel alignment. In addition, no material would be placed in a 2,500-foot wide corridor parallel to and west of the new entrance channel in order to reduce the chance deposited material will move into and shoal the new channel (see *Figure 1*). The size of the corridor through the ODMDS is needed to prevent the return of deposited material into the channel and was based on the distance between the western toe of the existing ODMDS and the existing ocean entrance channel, which, as shown on *Figure 1*, is about 2,500 feet. Based on these assumptions, the remaining capacity of the existing ODMDS is approximately 17.8 million cubic yards.

6. Deepening of the Wilmington Harbor project is scheduled to begin in May 2000 with the award of a contract to construct the offshore portion of the Baldhead Shoal Channel seaward of station 120+00. The material to be removed from this segment of the new channel, which totals about 6.6 million cubic yards, contains significant quantities of silt and clay and will have to be deposited in the existing ODMDS. The contract for the

landward segment of Baldhead Shoal Channel and the other ocean entrance channels, which will include up to 6.0 million cubic yards of beach quality sand and 2.8 million cubic yards of material not suited for placement on the beach, will be awarded near the end of calendar year 2000. Work on the inner portions of the project from upper Snows Marsh Range to Horseshoe Shoal Range that contains 0.6 million cubic yards will also be performed in early 2001. The economic and engineering viability of options for the disposal of the beach quality material to be removed from upper Snows Marsh to Horseshoe Shoal is presented later in the section of this report entitled " Inner Harbor – Sand Management Plan." Finally, a contract for removal of rock and other sediments from the Big Island Range will be awarded in 2000 as a test to help determine contract scopes for rock removal from other sections of the harbor. All of the material from the Big Island Range (approximately 2.2 million cubic yards) will be deposited in the ODMDS. In summary, construction of the deeper channel between 2000 and 2001 will involve the removal of approximately 18.2 million cubic yards of material with all of this material scheduled to be placed in the existing ODMDS.

7. During the new ocean entrance channel construction period, periodic maintenance of the existing ocean entrance channel will have to continue as will the maintenance of the interior portions of the harbor. This maintenance material, which averages around 800,000 cubic yards per year from the entrance channel and 300,000 cubic yards from the interior channels, is normally placed in the ODMDS. In addition to the Wilmington Harbor maintenance material, material removed for maintenance of the Military Ocean Terminal at Sunny Point (MOTSU) is also normally placed in the ODMDS. Maintenance of MOTSU averages 1 million cubic yards per year. Thus, the combined volume of new work and maintenance material to be removed from Wilmington Harbor and MOTSU between 2000 and 2001 could total 22.4 million cubic yards, exceeding the remaining capacity of the existing ODMDS by more than 4.6 million cubic yards.

8. **Base Disposal Plan-New Work Material**. With the capacity of the existing ODMDS insufficient to accommodate the dredged material disposal volume requirements through 2001, the logical solution is to place up to 6.0 million cubic yards of beach quality material on adjacent beaches. The only other option would be to delay the construction of the harbor deepening project by at least one year which is not acceptable to the State of North Carolina, the project sponsor. Placement of up to 6.0 million cubic yards of new work material on the beach would reduce the volume of material to be placed in the existing ODMDS through the year 2001 to 16.4 million cubic yards, effectively depleting the remaining capacity of the existing ODMDS. Once the new ODMDS becomes operational, all future dredge material requiring ocean disposal will be placed in the new area.

9. The disposal of up to 6.0 million cubic yards of new work beach quality material would be distributed along 16,000 feet on Bald Head Island and 25,000 feet on Oak Island-Caswell Beach. Deposition on Bald Head Island would occur along 2,000 feet of West Beach, which faces the Cape Fear River Entrance, and along 14,000 feet of South Beach. Disposal on Oak Island-Caswell Beach would begin at the west boundary of the Fort Caswell Baptist Assembly grounds and proceed west. The 25,000-foot disposal area on Oak Island-Caswell Beach would extend the fill to the east end of the sea turtle habitat area

on Oak Island. These disposal areas are shown on Figure 2. The sea turtle habitat, which is basically a beach fill with a small dune feature to prevent nesting sea turtles from crossing into the ocean front road, will be constructed under authority of Section 1135 of the Water Resources Development Act of 1986. Construction of the sea turtle habitat will be completed in April 2001. The combined total of new work material to be deposited on Bald Head Island under the base plan would be 2,580,000 cubic yards. The balance of the new work beach quality material (up to 3,420,000 cubic yards) would be equally distributed along the 25,000-foot disposal area on Oak Island-Caswell Beach. The base plan beach fill placement characteristics associated with placement of up to 6.0 million cubic yards of new work material are presented in *Table 1*. Based on the characteristics of the sediment to be removed, about 83 percent of the dredged material is expected to remain in place. The lower placement rates used on West Beach and at the west end of South Beach are intended to reduce the possibility of increased sediment transport from the disposal area back into the navigation channel. Following initial adjustments, the deposited material will begin to erode at a rates comparable to or slightly faster than the erosion rates experienced on the existing beach. The base disposal plan addresses provisions for the disposal of up to 6.0 million cubic yards of beach quality material, however, the maximum volume may be reduced by 20 to 30 percent depending on the final quantitative and qualitative sand analysis and actual dredging operations associated with the dredging contractors decisions to obtain the total allowable overdepth.

Table 1
Base Plan Beach Disposal Characteristics

Location	Length along Shoreline (feet)	Disposal Rate (cubic yds per ft)	Initial Placement Width Range (feet)	Adjusted Placement Width Range (feet)	Initial Placement Volume (cubic yds)	Net In-place Volume (cubic yds)
Bald Head Island	16,000				2,580,000	
West Beach	2,000	120	190 to 210	95 to 105	240,000	200,000
South Beach	2,000	120	190 to 210	95 to 105	240,000	200,000
South Beach	12,000	175	280 to 300	140 to 150	2,100,000	1,734,000
Oak Is - Caswell Beach	25,000	137	220 to 240	110 to 120	3,420,000	2,839,000
Totals	41,000				6,000,000	4,973,000

10. **Section 933 Disposal Plan – New Work Material.** The Brunswick County beach towns of Bald Head Island, Caswell Beach, Oak Island, Holden Beach, Ocean Isle, and Sunset Beach formed the Brunswick County Consortium for the purpose of working together to assure that the beach quality material is placed on the beach. Since Ocean Isle has received approval for a Federal Storm Damage Reduction Project, it is not vying for any of the Wilmington Harbor material. Construction of the Ocean Isle project is scheduled to begin in 2000. As mentioned above, a segment of Oak Island, lying between East 26th Street and East 58th Street, has been approved for a Section 1135 sea turtle habitat. The length of shoreline included in the sea turtle habitat consist of an 8,900-foot main section and 1,600-foot transitions on each end of the main fill. Construction of the sea turtle habitat will involve the removal of about 1.6 million cubic yards of material from an existing upland dredged material disposal area located adjacent to the Atlantic Intracoastal Waterway (AIWW). The expected in place volume resulting from this project is 1.34 million cubic yards. Within the main portion of the sea turtle habitat, the placement rate will be approximately 130 cubic yards/foot of beach. Accordingly, no material from the Wilmington Harbor project will be placed in the main portion of the sea turtle habitat. Some harbor material will be placed in the habitat transition areas to make up the difference in the volume that will be placed under Section 1135 and the rate of fill proposed under Section 933. This volume difference is around 25,000 to 30,000 cubic yards. As discussed below, disposal of material from the Wilmington Harbor project along Oak Island could occur at rates varying from 78 to 110 cubic yards/foot of beach. While these placement rates are less than the placement rate within the main portion of the Sea Turtle Habitat project, the relative protrusion in the shoreline resulting from the sea turtle project would be less than that which would have been produced in the absence of the harbor material. The reduction in the relative seaward protrusion of the shoreline within the habitat area resulting from the placement of the harbor material on the beach would also reduce the expected rate of loss from the habitat project due to end losses.

11. The shoreline segments that could receive material from Wilmington Harbor as a result of the Section 933 study include: 16,000 feet on Bald Head Island; 25,000 feet on Caswell Beach and the east end of Oak Island; 25,600 feet on the west end of Oak Island lying west of the sea turtle habitat; and 10,600 feet on the east end of Holden Beach. This represents a total shoreline length of 77,200 feet. These shoreline segments are shown on *Figure 2*. The distribution of available beach quality sand along the Brunswick County beaches will depend on the final results of the Section 933 study, analysis of project engineering and economic constraints, and the desires of the project sponsor and the Brunswick County consortium. To account for variations in sand placement along the Brunswick County beaches under the section 933 authority, *Table 2* presents the maximum beach fill disposal characteristics associated with the maximum beach fill for each beach segment resulting from the various possible distributions of beach quality material. Although the final distribution of the beach quality material for the Section 933 work along the Brunswick County beaches has not been determined, the total placement will not exceed 6.0 million cubic yards. Six million cubic yards of beach quality material to be removed from the channel equates to 5.0 million cubic yards of in place sand on the beach based on a retention rate of 83 percent discussed previously. Following the initial adjustments, erosion of the fill material will occur at rates equal to or slightly higher than the historic erosion

rates. The Section 933 disposal plan addresses provisions for the disposal of up to 6.0 million cubic yards of beach quality material, however, the maximum volume may be reduced by 20 to 30 percent depending on the final quantitative and qualitative sand analysis and actual dredging operations associated with the dredging contractors decisions to obtain the total allowable overdepth.

Table 2
MAXIMUM
Section 933 Disposal Characteristics

Location	Length along Shoreline (feet)	Disposal Rate (cubic yds per ft)	Initial Placement Width Range (feet)	Adjusted Placement Width Range (feet)	Initial Placement Volume (cubic yds)	Net In-place Volume (cubic yds)
Bald Head Island	16,000				2,200,000	1,826,000
West Beach	2,000	120	190 to 210	95 to105	240,000	200,000
South Beach	2,000	120	190 to 210	95 to 105	240,000	200,000
South Beach	12,000	143	220 to 240	110 to 120	1,720,000	1,426,000
Oak Island	50,500				4,740,000	3,933,000
East Oak Island - Caswell Beach	25,000	110	170 to 190	85 to 95	2,750,000	2,283,000
West Oak Island - Caswell Beach	25,600	78	120 to 140	60 to 70	1,990,000	1,650,000
Holden Beach	10,600	78	120 to 140	60 to 70	830,000	690,000

Inner Harbor – Snows Marsh Range to Horseshoe Shoal Range Sand Management Plan

12. **Introduction.** The sand management plan for the inner harbor addresses dredging and disposal issues associated with the Snows Marsh and Horseshoe Shoal channels. An estimated 0.6 million cubic yards of beach quality material will be removed from this

portion of the project. Disposal islands 3 and 4, located near the intersection of Horseshoe and Snows Marsh channels, are at maximum capacity and contain an estimated 1.3 million cubic yards of beach quality material. Maintenance material removed from this area is predominately sand of beach quality. Existing maintenance dredging operations in this area utilizes the offshore disposal area. The removal of the existing material from disposal islands 3 and 4 in conjuction with the new work dredging will facilitate placement of future maintenance material in islands 3 and 4. Future maintenance material placed in islands 3 and 4 would be used to nourish adjacent beaches.

13. **Plan Formulation.** The disposal plan for material presented in the June 1996 Cape Fear-Northeast Cape Fear Rivers project feasibility report proposed the placement of all dredge material from these channel reaches in the offshore disposal area. Subsequent investigations of material characteristics have shown that this material is of beach quality and this valuable resource would be best utilized to meet nourishment needs of the nearby beaches. Placement options for the 0.6 million cubic yards of new work material from the navigation channel includes potential placement of this material on Carolina Beach, Kure Beach, or Fort Fisher for 7,000 feet south of the southern terminus of the rock revetment. Placement options for the new work material from the navigation channel combined with pump out of islands 3 and 4 includes provisions for placement of 1.9 million cubic yards of material on adjacent beaches including Carolina Beach, Kure Beach, the Fort Fisher area, Bald Head Island , or Caswell Beach. Final placement decisions for the new work and maintenance material associated with the inner harbor from the Snows Marsh reach through the Horseshoe Shoal reach will assure that the dredge material disposal occurs in the least costly, environmentally acceptable manor, consistent with engineering requirements established for the project.

Maintenance Material Disposal Plan

14. **Plan Formulation**. Maintenance of the Wilmington Harbor Entrance Channel has historically required the removal of between 850,000 to 1,000,000 cubic yards of material each year. The maintenance material has normally been deposited in the ODMDS. Of the total volume removed each year, about 300,000 to 400,000 cubic yards has been littoral material derived from the adjacent beaches on Oak Island and Bald Head Island. This volume of littoral sediment constitutes 40 to 50 percent of the gross littoral transport along the Brunswick County beaches. Littoral material deposits in the bar channel primarily as a result of the eastward movement of Jay Bird Shoal and the westward movement of Bald Head Shoal into the channel area. The littoral sands generally deposit in channel reaches between channel stations 0+00 and 120+00. Seaward of station 120+00, the shoal material consist primarily of riverine silts and clays. While the new ocean bar channel will have an alignment different from the existing bar channel, shoaling patterns in the new channel, particularly in the vicinity of Jay Bird Shoal and Bald Head Shoal, are expected to be similar to the existing channel. The rate of shoaling of littoral sand in the new channel is estimated to be 545,000 cubic yards per year. The higher rate of deposition of littoral material in the new bar channel compared to the existing is due to channel modifications that would widen the channel to the west along the Smith Island Range and portions of the Baldhead Shoal range and cut across the seaward portions of Bald Head Shoal, as shown

on *Figure 1*. The volume of riverine silts and clays that will shoal the seaward portions of the new entrance channel are projected to be 538,000 cubic yards per year or about the same as that which occurs in the existing entrance channel.

15. The dredged material disposal plan for the entrance channel maintenance material was developed in accordance with U.S. Army Corps of Engineers policy with regard to the disposal of dredged material from Federal navigation channels. The Corps policy is contained in 33 CFR Parts 335-338 reads as follows:

> **"It is the Corps' policy to regulate the discharge of dredged material from its projects to assure that dredged material disposal occurs in the least costly, environmentally acceptable manner, consistent with engineering requirements established for the project."**

The policy further states:

> **"The least costly alternative, consistent with sound engineering practices and selected through the 404(b)(1) guidelines or ocean disposal criteria, will be designated the Federal standard for the proposed project."**
>
> (Note: Section 404 guidelines of the Clean Water Act apply to beach nourishment, island creation, or construction of underwater berms whereas ocean disposal is covered by the Ocean Dumping Act.)

Finally, with specific reference to the disposal of maintenance material, the policy sates (33 CFR Part 337.9):

> **"(a) District engineers should identify and develop dredged material disposal management strategies that satisfy the long-term (greater than 10 years) needs for Corps projects. Full consideration should be given to all practicable alternatives including upland, open water, beach nourishment, within banks disposal, ocean disposal, etc."**

16. The Federal policy notwithstanding, the State of North Carolina adopted a set of policies in 1992 designated to insure that beach quality sand not be removed from the active beach system. The U.S. Department of Commerce, pursuant to the Federal Coastal Zone Management Act of 1972, has incorporated these policies into the North Carolina Coastal Management Program. As a result, the State of North Carolina includes these policies in its consistency review of Federal activities. In 1993, the North Carolina General Assembly enacted a statute that put the coastal management policy into law. While there is continuing legal debate over the applicability of the State Law to Federal projects, the Federal Government is required to be consistent with the State's coastal management program to the maximum extent practicable. Accordingly, the disposal plan for the maintenance material removed from the Wilmington Harbor entrance channel will attempt to satisfy these State requirements.

17. Based on the Corps policy given above, three factors were considered in the development of a dredged material disposal plan for maintenance of the harbor entrance, namely; engineering requirements of the project, environmental impacts, and cost. These factors are discussed below.

18. **Engineering Requirements**. The construction and maintenance of a deep ocean entrance channel through a tidal inlet will have the same impact on the movement of littoral sediment past the entrance as stabilizing structures such as jetties. However, the impacts of a dredge channel on the adjacent shorelines are generally more subtle than the impacts associated with stabilizing structures. In the case of stabilizing structures, there is usually a visible build-up of material adjacent to the updrift structure with corresponding erosion downdrift of the opposite structure. These impacts are normally clearly visible and measurable within distances of thousands of feet of the structures. Navigation projects that include stabilizing structures are generally formulated to include some means to bypass sand from one side of the entrance to the other in order to prevent project induced erosion on the adjacent beaches. Dredged channels, on the other hand, do not cause material to build-up on one side of the inlet or the other, rather, the impact of sediment removal from the dredged channel tends to be diffused throughout the impacted area. Since this diffusion process can extend over miles of shoreline, the erosive impact of the sediment removed from the navigation channel and its deposition outside the active littoral zone is difficult to detect in the short term since the magnitude of the impact may be of the same order as normal temporal fluctuations in the shoreline position. Also, where stabilizing structures generally have a well-defined impact on the predominant downdrift beach, channel projects affect both sides as material is deposited in the navigation channel from both the updrift and downdrift beaches.

19. The Wilmington Harbor project, historically, has not included the disposal of littoral sands on the adjacent beaches or in the active littoral zone. This has been primarily due to the maintenance practices that were established with the inception of the project over 100 years ago. Dredging technology that existed during the early history of the project dictated maintenance procedures and dredged material disposal practices. In this regard, hopper dredges, with hopper doors that opened by swinging down, were highly efficient in removing shoal material from channels but were restricted by their loaded drafts and swinging hopper doors to depositing the dredged material in relatively deep water. As a result, the "Federal Standard" for maintaining navigation projects, like Wilmington Harbor, became the cost and impacts associated with hopper dredging and ocean disposal of the dredged material in water depths of 30 feet or more.

20. The early establishment of the "Federal Standard" for maintenance of Wilmington Harbor did not consider the overall impacts of removing littoral sediment from the littoral system. This was due in part to the limited coastal development that existed when the projects were first constructed, but also due to lack of sufficient scientific understanding of coastal processes and the sand sharing system associated with tidal inlets and adjacent beaches. Years of research by the U.S. Army Corps of Engineers and practical knowledge gained from the operation of the numerous coastal navigation projects around the country has resulted in the realization that littoral material must be conserved. Natural supplies

from rivers and streams are not replenishing littoral sediments, particularly on the East Coast of the United States. Thus, the removal of a cubic yard of littoral sediment from a tidal entrance or inlet with deposition outside the active littoral zone of the beach will ultimately cause a cubic yard deficit somewhere within the sand sharing system affected by that particular entrance or inlet. The impact of the removal of littoral sediment from the active littoral zone through channel maintenance is identified as a major cause of man-induced erosion in the U.S. Army Corps of Engineers Shore Protection Manual. From an engineering perspective, the primary requirement for the Wilmington Harbor maintenance program, apart from assuring that the channel remains open year-round, is to prevent project induced erosion of the adjacent beaches by conserving the limited natural resource, sand, through deposition directly on the adjacent beaches.

21. Wave transformation/sediment transport studies were conducted by the Coastal and Hydraulics Laboratory (CHL), U.S. Army Corps of Engineers, Engineer Research and Development Center, for the Wilmington District, to determine the theoretical rate of longshore sediment transport moving toward the Cape Fear River Entrance. The results of this study are reported in reference 3.

22. The results of the sediment transport analysis for the existing condition near the Cape Fear River entrance found that sediment transport potential to the east off Caswell Beach is 270,000 cubic yards per year while a comparable rate to the west off Bald Head Island is about 527,000 cubic yards per year. Combining these two transport rates results in a gross transport of littoral sediment moving into the entrance of 797,000 cubic yards per year. In terms of percentages, approximately 66 percent of the sediment shoaling the entrance channel comes from Bald Head Island while 34 percent is derived from Caswell Beach. In order to maintain the sediment balance on both islands, littoral material removed from the entrance channel will be placed back on the beach from whence it came. Accordingly, two out of every three cubic yards of littoral shoal material removed from the entrance channel will be placed back on Bald Head Island and the remaining cubic yard placed on East Oak Island-Caswell Beach. The disposal locations on each island will be based on the results of annual beach profile monitoring surveys. In general, the material will be placed primarily along portions of South Beach and West Beach on Bald Head Island and on East Oak Island-Caswell Beach beginning at a point just east of the Carolina Power and Light Company cooling water discharge canal.

23. The distribution of littoral shoal material between Bald Head Island and East Oak Island – Caswell Beach given above will be accomplished by placing material from two consecutive maintenance operations on Bald Head Island with the third operation involving placement on Oak Island-Caswell Beach. Historically, littoral sediment shoaling in the entrance channel has been the highest in the Smith Island Range as a result of the eastward encroachment of Jay Bird Shoal into the channel. In 1991, a 50-foot channel widener was constructed along the west side of the Smith Island Range and was effective in trapping east moving sediment off of Jay Bird Shoal but was not large enough to significantly increase the time between maintenance dredging operations. In 1996, the widener was increased to 100 feet, which increased the maintenance cycle for this segment of the entrance channel to approximately every two years. The design of the deeper

channel into Wilmington Harbor includes a 150-foot channel widener west of the Smith Island Range, as shown on *Figure 1*. Consequently, maintenance dredging of the Smith Island Range and the landward end of the Baldhead Shoal Range should only be required every two years. Based on a two year maintenance cycle, 1,090,000 cubic yards of littoral material will be placed on Bald Head Island in year 2 and year 4 following the initial deepening of the harbor with this same volume placed on Oak Island-Caswell Beach during the 6th year following channel deepening. This disposal cycle is planned for the life of the project. The equivalent annual deposition of material would be 363,000 cubic yards per year to Bald Head Island and 182,000 cubic yards per year to Oak Island-Caswell Beach.

24. **Environmental Impacts**. The dredged material disposal plan for the new work material and that for the sandy maintenance material would not only improve the condition of the beaches adjacent to the harbor entrance but would maintain the beaches in a more stable condition. The wider more stable beaches, particularly along Bald Head Island and the East Oak Island-Caswell Beach disposal areas, would provide improved sea turtle nesting habitat compared to the present condition of these beaches. Even in their present state, the shorelines of East Oak Island, Caswell Beach, and Bald Head Island provide some of the most important sea turtle nesting habitat in North Carolina. In this regard, statistics compiled by the North Carolina Wildlife Resources Commission over the last 6 years (1994 to 1999 inclusive) show that approximately 33 percent of the sea turtle nest in North Carolina occurred on these three beaches. This relative high percentage of the total statewide nests is even more impressive given that these beaches constitute only 5 percent of the entire shoreline of North Carolina.

25. The disposal of material on the beach will have some short term negative impacts including the temporary increase in turbidity during the disposal operation and the smothering or otherwise displacement of organisms that live in or near the beach foreshore. Turbidity caused by the disposal operation normally does not persist more than one or two tidal cycles (12 to 24 hours) following the cessation of the disposal operation. With regard to the smothering or displacement of the nearshore organisms, studies by the University of Virginia for the U.S. Fish and Wildlife Service on Pea Island have shown that the organisms generally return to the area in about one year. The disposal plan for the maintenance material discussed above would involve the placement of material on Bald Head Island in intervals of 2, 4, and 8 years while disposal on Oak Island-Caswell Beach would occur in 6 year intervals. Thus, the nearshore organisms would not be completely eliminated from the area as a result of the disposal operation. In summary, the positive environmental impacts associated with the deposition of the littoral shoal material on the beach versus depositing it in an ocean disposal site far outweigh the negative impacts.

26. **Cost**. The "Federal Standard" for constructing and maintaining navigation channels focuses on the least costly method of disposing the material, even though policy dictates that the environmental and engineering requirements must also be considered. With respect to the disposal plan for the new work entrance channel material, the limited capacity of the existing ODMDS dictates that the beach quality material be placed on the adjacent beaches, otherwise, the construction of the deeper project would have to be

delayed by about a year. Even if the project were to be delayed a year to allow ocean disposal of the beach quality material, cost comparisons indicate that beach disposal would still be the most cost effective disposal option.

27. **Maintenance Material Disposal**. Even if beach disposal of the maintenance material resulted in some additional cost, the Corps of Engineers, under authority of Section 207 of the Water Resources Development Act of 1996, can elect to use a slightly more costly disposal method if there are overriding environmental and erosion control benefits associated with the more costly disposal scheme.

28. Future disposal of maintenance material in the ocean will be in the new ODMDS located 5 miles farther offshore than the existing ODMDS. This additional haul distance almost doubles the cost of ocean disposal. As a result, beach disposal of the beach quality maintenance material becomes the least costly option, particularly if maintenance of the beach quality material is only required every two years. While the intent of the sand management plan is to return littoral material to the beach, the primary purpose of the project is to provide safe navigation through the ocean entrance into Wilmington Harbor. In this regard, there may be occasions during the life of the project when problem shoals occur in the entrance channel between normal 2-year maintenance cycle. In order to prevent disruption of navigation, these shoals must be removed in an expedient manner. If the size of these problem shoals are small (for example less than 100,000 cubic yards), mobilization and demobilization of an ocean certified pipeline dredge may not be economical. Therefore, on these occasions, removal of the shoals could be accomplished with a hopper dredge with disposal of the material in the ODMDS. In any event, a comparison of the cost for ocean disposal versus beach disposal of the littoral material is provided in *Table 3*. This cost comparison is made over a 6 year period which corresponds to the time period associated with the sand sharing formula between Bald Head Island and Oak Island-Caswell Beach.

29. **Summary**. The sand management plan developed for the new work beach quality material and maintenance material to be removed from the entrance channels into Wilmington Harbor includes the following:

(a) Disposal of the new work beach quality material on Bald Head Island and Oak Island-Caswell Beach.

(b) In the absence of Section 933, up to 2,580,000 cubic yards of the new work material would be placed on Bald Head Island and up to 3,420,000 on Oak Island-Caswell Beach.

(c) Under Section 933, the material would be distributed along Bald Head Island, Caswell Beach, Oak Island, and Holden Beach.

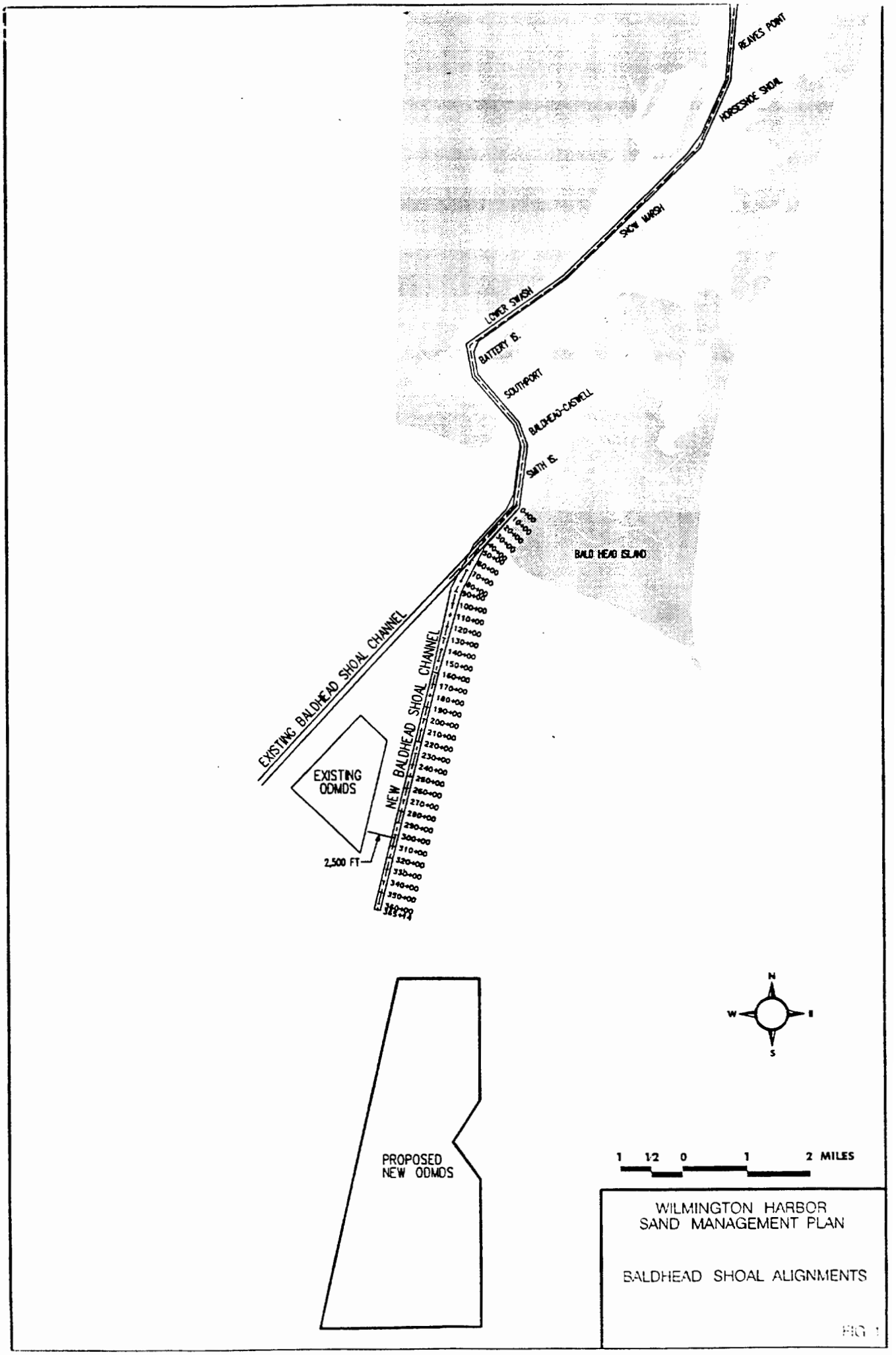
(d) Beach quality maintenance material will be deposited directly on Bald Head Island and Oak Island-Caswell Beach with Bald Head Island receiving 2 yards for every yard placed on Oak Island-Caswell Beach.

Table 3
Cost Comparison – Ocean Disposal versus Beach Disposal
Ocean Entrance Channel Maintenance Material

Item	Quantity	Unit	Unit Cost	Cost
Beach & Ocean Disposal – Maintenance Material				
Year 1: Hopper Dredge Silt & Clay				
Mob & Demob Hopper	1	job	$331,000	$331,000
Dredging w/ Ocean Disposal	538,000	CY	$4.00	$2,152,000
Total Year 1 Dredging Cost				**$2,483,000**
Year 2: Hopper Dredge Silt & Clay				
Mob & Demob Hopper	1	job	$331,000	$331,000
Dredging w/ Ocean Disposal	538,000	CY	$4.00	$2,152,000
Mob & Demob Pipeline Dredge	1	job	$948,000	$948,000
Dredging-Disposal on Bald Head	1,090,000	CY	$3.10	$3,379,000
Total Year 2 Dredging Cost				**$6,810,000**
Year 3: Hopper Dredge Silt & Clay				
Mob & Demob Hopper	1	job	$331,000	$331,000
Dredging w/ Ocean Disposal	538,000	CY	$4.00	$2,152,000
Total Year 3 Dredging Cost				**$2,483,000**
Year 4: Hopper Dredge Silt & Clay				
Mob & Demob Hopper	1	job	$331,000	$331,000
Dredging w/ Ocean Disposal	538,000	CY	$4.00	$2,152,000
Mob & Demob Pipeline Dredge	1	job	$948,000	$948,000
Dredging-Disposal on Bald Head	1,090,000	CY	$3.10	$3,379,000
Total Year 4 Dredging Cost				**$6,810,000**
Year 5: Hopper Dredge Silt & Clay				
Mob & Demob Hopper	1	job	$331,000	$331,000
Dredging w/ Ocean Disposal	538,000	CY	$4.00	$2,152,000
Total Year 5 Dredging Cost				**$2,483,000**
Year 6: Hopper Dredge Silt & Clay				
Mob & Demob Hopper	1	job	$331,000	$331,000
Dredging w/ Ocean Disposal	538,000	CY	$4.00	$2,152,000
Mob & Demob Pipeline Dredge	1	job	$1,275,000	$1,275,000
Dredging-Disposal on Oak Island-Caswell	1,090,000	CY	$4.60	$5,014,000
Total Year 6 Dredging Cost				**$8,772,000**
Total 6-Year Dredging Cost				**$29,841,000**

Ocean Disposal of All Maintenance Material				
Yearly Hopper Dredge Cost for Ocean				
Disposal of all Maintenance Material				
Mob & Demob	1	job	$331,000	$331,000
Dredging w/ Ocean Disposal	1,083,000	CY	$4.40	$4,765,200
Total Annual Dredging Cost				$5,096,200
Total 6-Year Dredging Cost				**$30,577,200**

Date Revised: 02/04/00-sv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SMITH IS.
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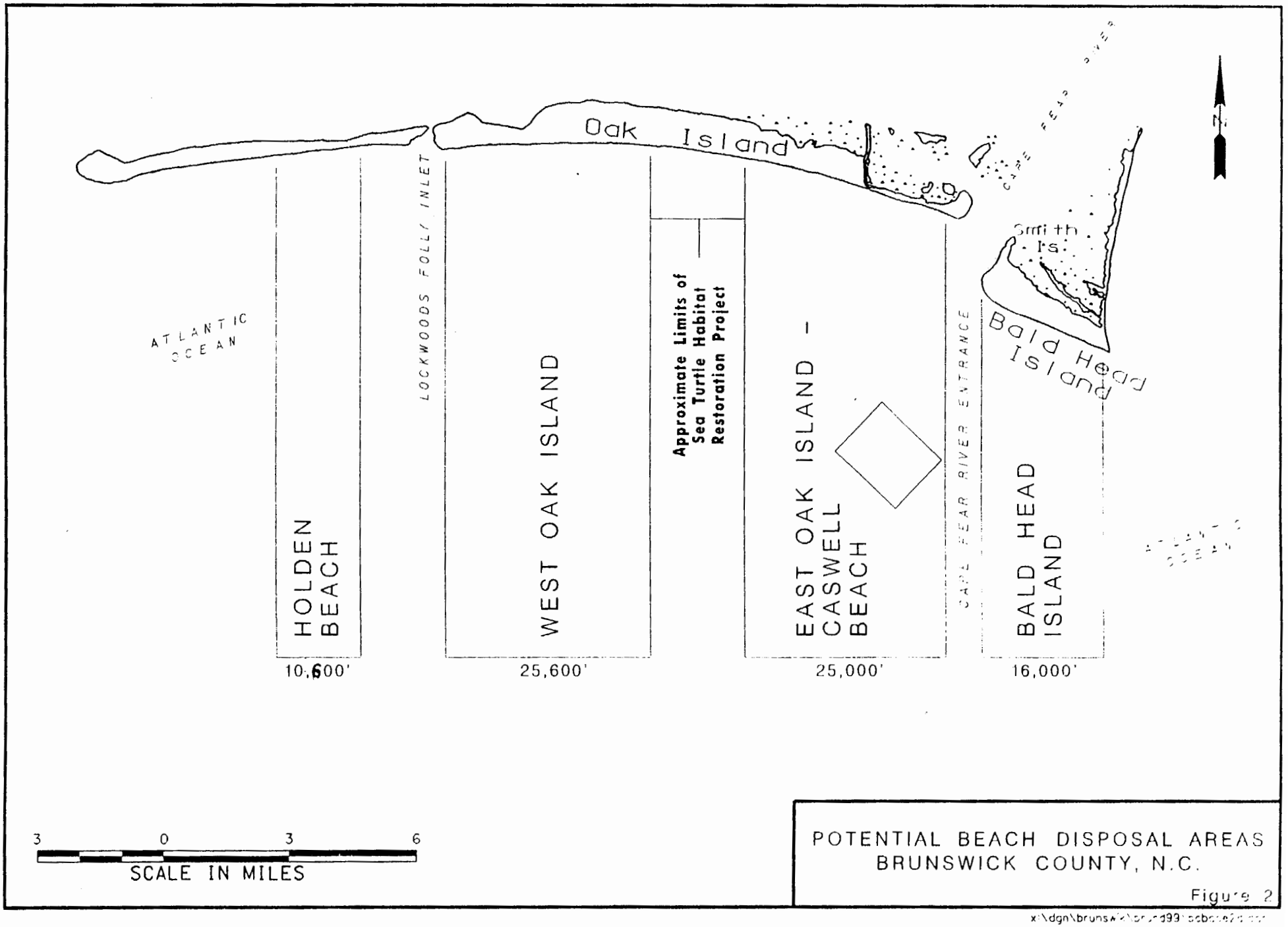
WILMINGTON HARBOR
SAND MANAGEMENT PLAN
BALDHEAD SHOAL ALIGNMENTS
FIG 1



POTENTIAL BEACH DISPOSAL AREAS
BRUNSWICK COUNTY, N.C.

Figure 2

APPENDIX B

ANALYSIS OF TEST BLAST RESULTS

APPENDIX B February 2000

ANALYSIS OF TEST BLAST RESULTS
WILMINGTON HARBOR, NC

Three environmental impact statements (EIS) have been prepared recently for Improvements in Wilmington Harbor, NC. The first was the Final Supplement to the Final EIS Wilmington Harbor-Northeast Cape Fear River (USACE 1990). This project involved widening the Fourth East Jetty Channel to the West 100 feet and deepening the ship channel to 38 feet from the Cape Fear Memorial (CFM) Bridge to 750 feet above the Hilton Railroad Bridge (figure 1 of the EA). The second was the Final Supplement 1 to the Final EIS Wilmington Harbor Channel Widening (USACE1996a). This project involved the widening of five turns and bends by 75 to 200 feet and widening by 200 feet the navigation channel in the lower harbor over a 6.2 mile distance to provide a passing lane. The third was the Final EIS Cape Fear-Northeast Cape Fear Rivers Comprehensive Study (USACE 1996b). The project primarily involved deepening the harbor by 4 feet from the Memorial Bridge downstream with some deepening upstream of the Hilton Railroad Bridge. All three of these projects were combined by Congress in 1996 and subsequently called the Wilmington Harbor 96 Act. Since the integration of the projects several new issues have emerged related to blasting, and other changes have been made to the project. The blasting issues are discussed below and other changes are discussed in the Environmental Assessment Preconstruction Modification of Authorized Improvements, Wilmington Harbor, North Carolina (EA).

Blast Design: To accomplish the changes indicated in the EA, rock will need to be blasted and removed from the harbor. Test Blasting was conducted primarily to test the effectiveness of air curtains in reducing the impacts of blasting. This test blasting was performed from late November 1998 to early January 1999 in an area of the Upper Big Island Channel to be widened (figure 1 of the EA). The production blasts during the test blasting consisted of 32-33 holes (3 rows of 10 to 11 holes with each hole and row 10 feet apart), about 52 to 62 pounds (24 to 28 kg) of explosives per hole, stemming each hole (angular rock in the top of the hole), and an approximate 25 msec delay after each hole. Based on the adequate fracturing of rock during the test blasting, for planning purposes only, a similar arrangement and spacing may be used during future blasting contracts except that 40 to 50 holes may be used per blast. The actual number of holes per blast, hole spacing, number of blasts number of blasts per day, and weight of charge will vary depending on the firm that is awarded the blasting contract. For example depending on the number of drill barges mobilized, 1 to 6 blasts could occur per day. The more blasts per day, the sooner the project would be finished and blast impacts would end. The blasting work will be divided under several contracts with blasting under the first contract scheduled to begin in the Upper and Lower Big Island Channel Areas in the summer of 2000.

USACE 1996 a&b indicated that a typical production blast would involve 80 holes (8 rows of 10 holes each with each row and hole 8 feet apart) with each hole containing 98.5 pounds (45 kg) of explosives. For the combined Wilmington Harbor 96 Act, original estimates were that about 142 acres of rock surface would require blasting with about 927 blasts based on the 80 hole blast design (table 1).

It would appear if the number of holes per blast is cut in about half (from 80 in the EIS's to 40 to 50), then the number of blasts would be about doubled. This is not the case for two reasons. First, for the original 80 hole pattern, the rows and holes were 8 feet apart versus 10 feet apart for the 40-50 hole pattern. Thus more rock surface area per hole would be affected for the latter pattern. Second, since the Final EIS, there have been more detailed field investigations of the rock locations in the harbor downstream of the Memorial Bridge. These investigations generally indicate less area and volume of rock present compared to original estimates (table 1). Therefore, the total number of blasts is estimated to have decreased by about 22 percent (927 to 725 blasts) and

the blast area is estimated to have decreased by about 47 percent (142.0 to 74.8 acres, table 1). However as stated above, the actual number of holes per blast, hole spacing, number of blasts, number of blasts per day, and weight of charge will vary depending on the firm that is awarded the blasting contract.

EIS Blast Impact Model versus Test Blast Survival: USACE 1996 a&b indicated that without an air curtain, the impact area for LD1 (1% or more of the fish would die) for a 0.125 pound fish (2 ounces or about 56 grams) would be 34.5 acres. This equates to a radius of 656 feet from the edge of the blast. The 0.125 pound fish are the smallest fish that could be modeled, and are discussed here because smaller fish are more susceptible than large fish to blast effects. The model in the EIS assumed 25 msec blast delays between each hole and stemming of each hole.

To determine the accuracy of the model predictions during test blasting, generally 50 fish of several species were placed in cages (2 feet diameter by 3 feet long plastic cylinders) 3 feet from the bottom (worst case survival scenario for blast pressure as confirmed by test blast pressure results) at 35, 70, 140, 280 and 560 feet up and downstream of the blast. The air curtain when tested, was 50 feet from the blast. Also, generally 200 fish of each species were held at a control location about ½ mile from the blast location (Moser 1999, USACE 1998). The caged fish consisted of hatchery reared striped bass and shortnose sturgeon (NMFS 1998a) with mean weights of 40 and 55 grams, respectively. Sturgeon cages were enclosed in a 0.6 inch nylon mesh sock to prevent any sturgeon from escaping if the cage was damaged. This was necessary for preservation of the genetic integrity of the resident fish population since the hatchery reared shortnose sturgeon were not the same subspecies as the shortnose sturgeon in the Cape Fear River.

Locally captured fish were also used and consisted of white mullet and killifish that averaged less than 5 grams. All species were placed in separate cages except in cases where collected mullet and killifish had to be combined to comprise a total of 50 fish. All these species were used because they were small and had air bladders, both factors making them more susceptible to blast impacts (O'Keeffe 1984 a&b, Keevin and Hempen 1997, Young 1991), and they were readily available. Aquatic organisms without an air bladder (e.g. shrimp, crabs and clams) are highly resistant to blast impacts (O'Keeffe 1984 a&b, Kevin and Hempen 1997). As indicated above, stemming and an approximate 25 msec delay were used, but 52-62 pounds of explosives were used per hole (versus 98.5 pounds used in the EIS model).

The caged fish were visually inspected for survival just after the blast and after a 24 hour holding period. The survival pattern just after the blast and after the 24 hour holding period were similar. Survival at the monitoring locations 140 feet and beyond just after the blast (with or without air curtain) was not significantly different (figures 1, 2 and 3). The area inside the 140 foot location is about 2.1 acres. Therefore, the EIS model overestimated the impact area by about 94 percent (34.5-2.1/34.5). This percentage and associated area would change little if the number of holes per blast fluctuates because using a delay for each hole creates a series of small blasts versus one large blast. For example, the delay after each hole is approximately 25 msec, while the blast pressure at each hole lasts less than 5 msec.

The reason for the big reduction in blast effect area is probably due to an underestimate in the EIS model of the reduction of blast effects by confining the explosive in rock. Based on investigations by the Corps of Engineers, Waterways Experiment Station (WES), the effect of a blast in rock was calculated to be 0.014 of a blast in open water. In other words a 52 to 62 pound blast in rock is equivalent to a 0.73 to .87 pound blast in open water (USACE 1999a).

A possible factor for this large reduction is that blasting with a delay after each hole may create its own intern shock absorber. When a blast detonates in water, which is not compressible, the pressure wave travels throug water without the pressure being diminished except via distance traveled. However with delays, the first bla creates a mass of gas, which is compressible. Before this gas escapes from the water, the second blast detonated 25 msec later adjacent to the first blast. The pressure wave generated by the second blast can no be partially spent in compression of the gas present. This process is repeated through each delay. Thus, n only do delays reduce the blast to a series of smaller blasts, but each blast provides a shock absorber for eac successive blast.

The average peak pressure and peak impulse pressure at 140 feet without the air curtain (assumed worst case were 75.6 psi and 18.4 psi-msec, respectively. Peak pressure and peak impulse are common pressur measurements indicated in the literature, but peak impulse is generally considered a better indicator of bla impacts than peak pressure (Munday et. al. 1986, Keevin and Hempen 1997). These values are approximatel the same indicated in the literature for threshold of impacts for small fish (Munday et. al 1986, Yelverton et. a 1975).

Air Curtain versus No Air Curtain: In order to reduce the impacts predicted by the EIS's model, the use of a curtains or a physical barrier was proposed in the EISs. The effectiveness of the air curtain was tested during th test blast project. Three blasts were performed with and four blasts without the air curtain with caged fish i place. Blast pressure readings were taken at the same monitoring locations indicated above for the fish cage (35, 70, 140, 280 and 560 feet upstream and downstream from the blast), with pressure measures taken 3 fee from the surface, mid-depth (about 15 feet) and 3 feet from the bottom (about 30 feet). The air curtain wa located 50 feet from the blast (i.e. between the 35 and 70 foot monitoring locations).

Unfortunately, much of the pressure monitoring equipment did not perform properly at the 35 and 70 foo locations. Therefore, an accurate calculation of the pressure reduction potential across the air curtain could no be obtained. However, based on the limited data available, the bubble curtain did not appear to reduce pea water shock pressure or peak impulse. The reason the air curtain was not effective was probably because th strong river current distorted or deflected the configuration of the air curtain.

When the average survival rates of the caged fish at the 70 feet location (just outside the air curtain) with an without the air curtain were compared just after the blast there appeared to be about a 16 percent reduction i apparent survival (loss of equilibrium) with no air curtain for striped bass, mullet and killifish, and 9 percen reduction for shortnose sturgeon (figures 1, 2, and 3). However, the apparent reduction is probably not related t operation of the air curtain (USACE 1999a). The average peak water shock and peak impulse (900 psi and 17 psi-msec, respectively) were higher at the 35 foot location for the non air curtain blasts versus the air curtai blasts (216 psi and 135 psi-msec). This is evident in the lower survival at the 35 foot locations for the non a curtain blasts (figures 1, 2, and 3). These higher pressures at the 35 foot location for non air curtain blasts ar probably just due to chance because of the small sample size (3 caged experiments with air curtain and without). However, it is possible that when the air curtain was operating in the strong river currents, highl aerated water could have passed over the blast and reduced the pressure before it reached the 35 foo monitoring location.

Regardless of why the pressures are different, there was no difference in survival or impulse pressure at d beyond 140 feet with or without the air curtain in operation. In addition as stated above, for the air curtain test where the pressure monitoring results are adequate, the air curtain was not effective in reducing peak wate shock or impulse pressure (USACE 1999a).

Following the 24 hour holding period, some of the apparent mortalities recovered (regained equilibrium). However, these fish and the others that apparently survived unaffected could have died later because of internal injuries that were not fatal within the observation period. Therefore, the condition of the fish and the potential for their future survival was estimated based upon necropsies that were performed on 61 striped bass and 70 shortnose sturgeon surviving after the post-blast 24-hour holding period (Moser 1999). Most of the necropsies were performed on fish from the 35-foot distance (inside the air curtain). Of those that survived at the 35-foot distance, 34 and 88 percent of the striped bass and shortnose sturgeon, respectively, would probably have survived even with internal injures. Survival would be expected to be less for striped bass than for sturgeon since the striped bass were smaller and more laterally compressed making them more susceptible to blast injuries (Department of the Navy 1998). Another possibility is that sturgeon have a free connection from the air bladder to the esophagus perhaps allowing gas to be expelled rapidly during a blast (Moser 1999). Striped bass do not have this connection. However, since blast pressure changes occur so rapidly, there is disagreement in the literature on the benefit of a bladder/esophagus connection (Yelverton et. al. 1975, Keevin and Hempen 1997). Long-term survival even with ruptured air bladders has been documented (Yelverton et. al. 1975, Munday et. al. 1986), and sturgeon exposed to this test blasting that were later placed in holding tanks exhibited no greater long-term mortality (two months) than sturgeon not exposed to blasting (Moser 1999).

Necropsies were performed on 10 shortnose sturgeon at 70 feet without the air curtain in use. All of these fish would probably have survived the blast (Moser 1999). In hindsight, we should have requested more necropsies on all species at the 70 foot distance and beyond. However, assuming all the fish survived as well at the 140 foot distance as the shortnose sturgeon did at the 70 foot location, then the 24-hour holding period would be adequate to determine survival at 140 feet and beyond.

Due to various problems, the impacts of blast pressure on larvae were not determined during the test blasting. As with other size fish, peak impulse should be the best measure for impacts on larvae. The only literature available on impacts of blasting on larvae measures pressure in peak impulse. The LD1 for larval fish with air bladders is around 1 psi-msec (Yelverton et. al. 1975). Such pressures occurred at the edge of the monitored area (560 feet from the blast) with or without the air curtain. However, the blasts are to be restricted to the NC Division of Marine Fisheries dredging window (1 August through 31 January) when larval fish abundance and recruitment are the lowest (CP&L 1980, 1985, and 1994). Also, peak impulse values are similar with or without the air curtain from 140 feet on out. Since these values are similar, air curtains would not be expected to provide a benefit for larvae.

We originally requested approval to blast from 1 August through 31 January, the entire NC Division of Marine Fisheries Dredging window. However due to concerns of potential impacts of blasting on anadromous fish, primarily shortnose sturgeon, January was eliminated. The data indicate that the blast impact area is much smaller than anticipated, and shortnose sturgeon appear resistant to blasting effects. Therefore, we are again requesting concurrence that blasting may be conducted in January.

Prior to the test blasting, the use of air curtains was estimated to be about $20 million for the project. During the test blasting, the air curtain was difficult to use because of the strong currents, deep water, and frequent repairs required. Because of these difficulties encountered, blasting is expected to take longer and cost more than originally anticipated. Due to the higher costs and minimal, if any, documented benefits of the air curtain during test blasting, we propose elimination of its use for Wilmington Harbor blasting. Stemming, delays between holes, and the environmental monitoring discussed below would still be implemented.

Potential use of a physical barrier as indicated in the Final EIS was not tested during the test blast, but would nc have been practical due to the strong currents in the river.

Marine Mammals and Seaturtles: Bottlenose dolphin, manatees, and whales are protected under the Marin Mammal Protection Act (MMPA) of 1972, as amended, and manatees, whales, and sea turtles are protecte under the Endangered Species Act of 1973, as amended. Of these species, only bottlenose dolphin, manatees and seaturtles have been observed in the Cape Fear River. Dolphin and manatees have been observed at an upstream of Wilmington (located about mile 25 to 27) whereas sea turtles have been observed only as fa upstream as mile 15 (NMFS 1996). Blasting will occur from approximately river mile 18 upstream. Since th farthest downstream blast area for the Wilmington Harbor project is approximately 18 miles upstream of th ocean, whales should not be affected.

USACE 1996b indicated that pre and post blast surveys would be made for marine mammals (includin bottlenose dolphins and manatees) and sea turtles. Coordination after the Final EIS related to the test blastin program, resulted in a recommended survey area 1,000 feet upstream and downstream of the blast area. Thi area was surveyed for all test blasts and no marine mammals or sea turtles were observed.

Marine mammals and sea turtles can be physically damaged by blasts pressures, and affected by noise levels Some injury can occur to bottlenose dolphins at or above 1.17 in-lb/in^2 (energy flux density)(Department of th Navy 1998) or above 5 psi-msec for impulse pressure (Yelverton 1973). The threshold of impacts for sea turtle is probably similar to that for bottlenose dolphins (Department of the Navy 1998). The maximum test blast valu recorded for energy flux density at 560 feet was 0.195 in-lb/in^2, and for impulse was 5.86 psi-msec. These pressure values recorded during the test blasting at 560 feet are near or below the indicated thresholds.

Several literature models (e.g. Young 1991, Goertner 1982) are available to estimate a blast safety zone (injur safe) for marine mammals and sea turtles. These models are for blasts in open water, not in rock. As indicated above, the effect of a blast in rock is calculated to be 0.014 of a blast in open water. In other words a 52 to 62 pound blast in rock is equivalent to a 0.73 to 0.87 pound blast in open water (USACE 1999a). If 0.87 pounds o explosives were used in the Young 1991 model, the safe range for sea turtles, and bottlenose dolphins (adult and calf) would all be less than 600 feet. Even if 12 pounds of explosives were used for the Goertner 1982 model maximum horizontal extent of slight injuries to manatees (adult and calf) would be 450 feet.

Noise can also impact marine mammals and sea turtles. The Department of the Navy (1998 and 1999) has developed a dual noise level criterion: (1) an energy based Temporary Threshold Shift (TTS) of 192 dB re 1uPa (i.e. 182 dB re 1uPa^2) for bottlenose dolphins derived from Ridgeway et. al. (1997), and (2) 12 psi peak pressure At or below the TTS threshold noise level, bottlenose dolphins will completely recover from any associated noise impacts. These values are considered conservative for sea turtles (Department of the Navy 1998 and 1999), and whales are not likely to be in the blast area since blasting will take place approximately 18 miles or more from the ocean. Noise level impacts on manatees are not well documented, therefore, the following discussion focuses on dolphin and assumes impacts would be similar for manatees.

We did not monitor noise levels during the test blast, but peak pressure was measured and can be converted to dB (Sayigh 1999a, Military Analysis Network 1999). The average and maximum peak pressure at 560 feet during the test blast were 6.2 and 15 psi, respectively, which would equate to 213 and 220 dB re 1uPa respectively. Based on an upper bound curve from the test blast peak pressure data, the distance from the blast where the dB level would be at or below the TTS threshold of 192 dB re 1uPa (approximately 0.5 psi) is about 2,000 feet (Rickman 1999).

Not only is potential injury to marine mammals of concern, but under the Maine Mammal Protection Acts of 1972, harassment is prohibited. This includes the potential to disturb a marine mammal (level B harassment). According to Ridgeway et. al. (1997), this level occurs above 178 dB re 1uPa. Based on the same upper bound curve indicated above, the distance where this threshold would occur is about 3,500 feet. To verify these noise levels, monitoring will be conducted at 3,500 feet with a calibrated hydrophone during all blasting in Wilmington Harbor. Based on this monitoring, adjustments will be made to the radius as necessary. (192 and 178 dB may appear to be high, but a sound wave in water is about 61.5 dB lower than that of a wave of equivalent pressure in air (Department of the Navy 1998 and 1999)).

Pre-blast surveys for sea turtles, manatees, and dolphins will be conducted one hour before the blast to ensure no turtles or manatees or other marine mammals are within the blasting zone (3,500-foot radius). The surveys will be conducted from at least 2 surface vessels by personnel experienced in marine mammal observations. If a sea turtle, manatee, or dolphin is within the blast zone, blasting will be delayed until the animals depart the blasting zone voluntarily. Post-blast surveys will be conducted for 1/2 hour after each blast to determine if any sea turtles, manatees, or dolphins are injured. With these procedures in place, we do not anticipate a "take" under the Marine Mammal Protection Act of 1972, as amended. This would include no level B harassment (potential to disturb a marine mammal).

Mitigation: Mitigation for the loss of fisheries habitat was discussed in detail in the EISs related to the Wilmington Harbor 96 Act (USACE 1990, 1994a&b, 1996a&b) and in the Final Mitigation Plan for the 96 Act (USACE 1999b). This included consideration of loss of bottom habitat where blasting would occur. No mitigation was proposed for the act of blasting because blasting in and of itself will not result in a permanent additional loss of habitat. Blasting will impact organisms in the water column near each blast during the short time each blast occurs (1.25 seconds = 25 msec between holes x 50 holes per blast). However in USACE (1996a&b), impacts of each blast were minimized to the extent feasible by using air curtains, a delay after each hole, stemming, and blasting only during the NC Division of Marine Fisheries dredging window (1 August through 31 January). The differences proposed or that would occur now are:

1. the elimination of air curtains because they were not effective in reducing blasting impacts,

2. the impact area per blast is about 94 percent less without an air curtain than predicted in the EISs (USACE 1996a&b),

3. the number of predicted blasts is estimated to have decreased by 22 percent, and

4. the total predicted area of rock to be blasted is estimated to have decreased by about 47 percent.

Environmental Commitment and Monitoring: All the environmental commitments made in USACE 1996a&b remain in force except as modified below.

As indicated above, pressure measurements were taken during the test blasting at several locations. With or without the air curtain, there were no impacts to caged fish beyond the 140-foot locations. The peak pressure values recorded at this location without the air curtain averaged about 75 psi with a maximum of 131 psi. Therefore an average of 70 psi and a maximum of 120 psi should be reasonable thresholds at 140 feet that should not be exceeded during production blasting in order to protect marine life. These thresholds would be

used for each series of 5 blasts. Peak pressure would be recorded versus peak impulse, because peak pressur is easier to measure.

No caged fish will be monitored, and except for the threshold pressure readings indicated above at 140 feet fo each blast, no other pressure readings are proposed during production blasting. However the following action conducted during the test blasting (with any modifications indicated) would be continued during productio blasting.

1. Blasting was restricted to the months of August through December, inclusive.

   January was originally eliminated potential over impact concerns to shortnose sturgeon. Followin coordination of preliminary results of minimal impacts to sturgeon, blasting into early January wa allowed (NMFS 1998b). Based on the final results indicated in this EA that shortnose sturgeon don appear to be greatly affected by blasting with or without air curtains, and extensive gill netting indicate below should preclude them from entering the blast site, blasting in January is proposed again.

2. Before each blast, four (4) sinking gillnets (5.5 inch mesh, 100 meters long) were set to surround th blast area as near as feasible. These nets were in place for at least 3 hours and none of the nets wer removed any sooner than 3 hours before the blast. This required overnight sets. The nets were manne continuously to prevent obstructing the channel to ship traffic. Each sturgeon removed (shortnose o Atlantic) was tagged with a t-bar tag, and the sturgeon released in the Brunswick River within 100 meter of the bridge.

   The same netting procedure is proposed except ..." the nets will not be removed any sooner than 1 hou before the blast." Only one sturgeon (Atlantic) was captured during test blasting and it was tagged an released in the Brunswick River. This same sturgeon was recaptured later in the test blast area.

3. An approximate 25 msec delay per hole and stemming each hole will still be required.

4. Within 10 minutes of each blast, a large mesh (1-2 inch mesh) channel net was set immediatel downstream of the blast area to capture sturgeon that were injured or killed during blasting. To test th efficacy of the channel net, for each blast involving caged fish, a group of 30 dead sturgeon were marke uniquely and the sturgeon released on the river bottom upcurrent of the net.

   None of the released dead sturgeon were captured by the channel net. This was probably because th set had to be over 600 feet from the blast due to all the monitoring equipment present. The channel ne should be set within about 300 feet during production blasting. Setting it any closer would violate safet regulations. The efficacy of the channel net to catch fish injured by blasting will be retested by releas of locally captured species (e.g. spot, croaker or similar species).

5. Pre-blast surveys (vessel) for sea turtles, manatees, and dolphins were conducted one hour before th blast to ensure no turtles or manatees or other marine mammals were within the blasting zone (1,000 foot radius). If a sea turtle, manatee, or dolphin was within 1,000 feet of the blast site, blasting woul have been delayed until the animal departed the blasting zone. Post-blast surveys were also conducte for 1/2 hour after each blast to determine if any sea turtles, manatees, or dolphins were injured.

No sea turtles, manatees, or dolphins were observed during the test blasts. The radius will be expanded to 3,500 feet, and noise levels will be monitored at 3,500 feet to assure they are at or below 178 dB re 1uPa. Based on this monitoring, adjustments in 500 feet increments to the radius (outward) will be made if necessary. Pre-blast surveys for sea turtles, manatees, and dolphins will be conducted one hour before the blast to ensure no turtles or manatees or other marine mammals are within the blasting zone (3,500-foot radius). The surveys will be conducted from at least 2 surface vessels by personnel experienced in marine mammal observations. If a sea turtle, manatee, or dolphin is within the blast zone, blasting will be delayed until the animals depart the blasting zone voluntarily. Post-blast surveys will be conducted for 1/2 hour after each blast to determine if any sea turtles, manatees, or dolphins are injured. With these procedures in place, we do not anticipate a "take" under the Marine Mammal Protection Act of 1972, as amended. This would include no level B harassment (potential to disturb a marine mammal).

6. Scare charges were used for each blast. A scare charge is a small charge of explosives detonated immediately prior to a blast for the purpose of scaring aquatic organisms away from the location of an impending blast. Two scare charges were used for each blast. The detonation of the first scare charge was at 45 seconds prior to the blast, with the second scare charge detonated 30 seconds prior to the blast. Some marine mammals and fish may not locate the origin of the first scare charge. The second scare charge allows these creatures to better locate the source of the charge and maneuver away from the source.

   We could not measure how effective the scare charges were during test blasting, but did notice that anchovies jumped from the water near where the charges were detonated.

7. Electronic surveillance of the test area was conducted using boat-mounted sonar fish finders. Surveillance took place within the last twenty minutes prior to the blast, and consisted of 2,000-foot long transects (1,000 feet up-current and 1,000 feet down-current of the blast area). Each transect was parallel to the centerline of the navigation channel and the transects were 100 feet apart. If a school of fish was located, the blast would have been delayed until the school left the 2,000-foot area.

   Blasting did not need to be delayed because of presence of schools of fish. We plan to reduce the surveillance area to a 500-foot radius since the test blasting results indicated that potential impact area to fish is not as large as originally thought.

Recommendations: Based on the information gained from the test blasting program, we propose the following changes to the information indicated in USACE 1996 a&b.

1. Eliminate the use of air curtains and physical barriers during blasting. Air curtains did not provide protection to marine resources when compared to no air curtain use. The use of physical barriers in the river is not practicable due to strong currents.

2. Extend the current blasting window by one month (January) for the entire NC Division of Marine Fisheries Dredging Window. January was originally eliminated over impact concerns to shortnose sturgeon. Since they don't appear to be greatly affected by blasting with or without air curtains, and extensive gill netting should preclude them from entering the blast site, blasting in January should not impact the species.

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Table 1. Preconstruction Modification of Authorized Improvements, Wilmington Harbor, North Carolina. Approximate rock surface area, volume, and number of blasts for project components (assumes project depth + 1 foot of required overdepth in rock + 1 foot of allowable overdepth). The actual number of holes per blast, hole spacing, number of blasts, number of blasts per day, and weight of charge will vary depending on the firm that is awarded the blasting contract.

Project	Acres of Rock Blasting		Volume Thousands of cubic yards		No. of Blasts	
	EIS's	Now	EIS's	Now	EIS's[2]	Now[3]
Wilmington Harbor-NE Cape Fear River USACE 1990&1994	32.5	32.5	406	406	210	315
Wilmington Harbor Channel Widening USACE 1996a	20.2		70		122	
		42.3[1]		275[1]		410[1]
Cape Fear-NE Cape Fear Rivers Comprehensive Study USACE 1996b	89.3		601		595	
TOTAL: Wilmington Harbor Project	142.0	74.8	1,077	681	927	725
Percent Reduction	47%		37%		22%	

(1) USACE 1996a&b combined

(2) Based on 80 hole pattern with 8 foot spacing between holes and rows.

(3) Based on 45 hole pattern with 10 foot spacing between holes and rows.

FIGURE 1. STRIPED BASS MEAN %SURVIVAL WITH AND WITHOUT AIR CURTAIN JUST AFTER THE BLAST

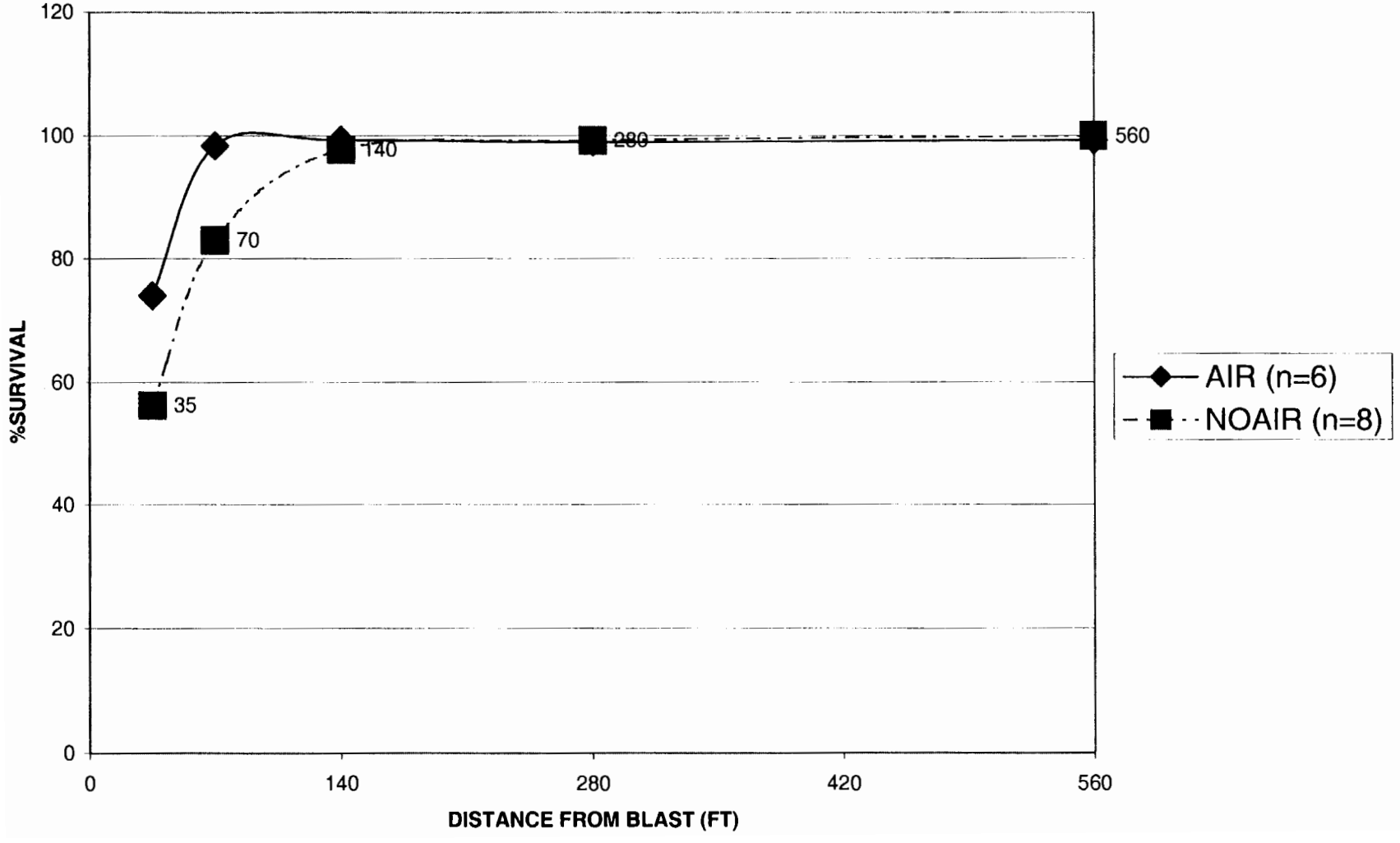


FIGURE 2. MULLET/KILLIFISH MEAN %SURVIVAL WITH AND WITHOUT AIR CURTAIN JUST AFTER THE BLAST

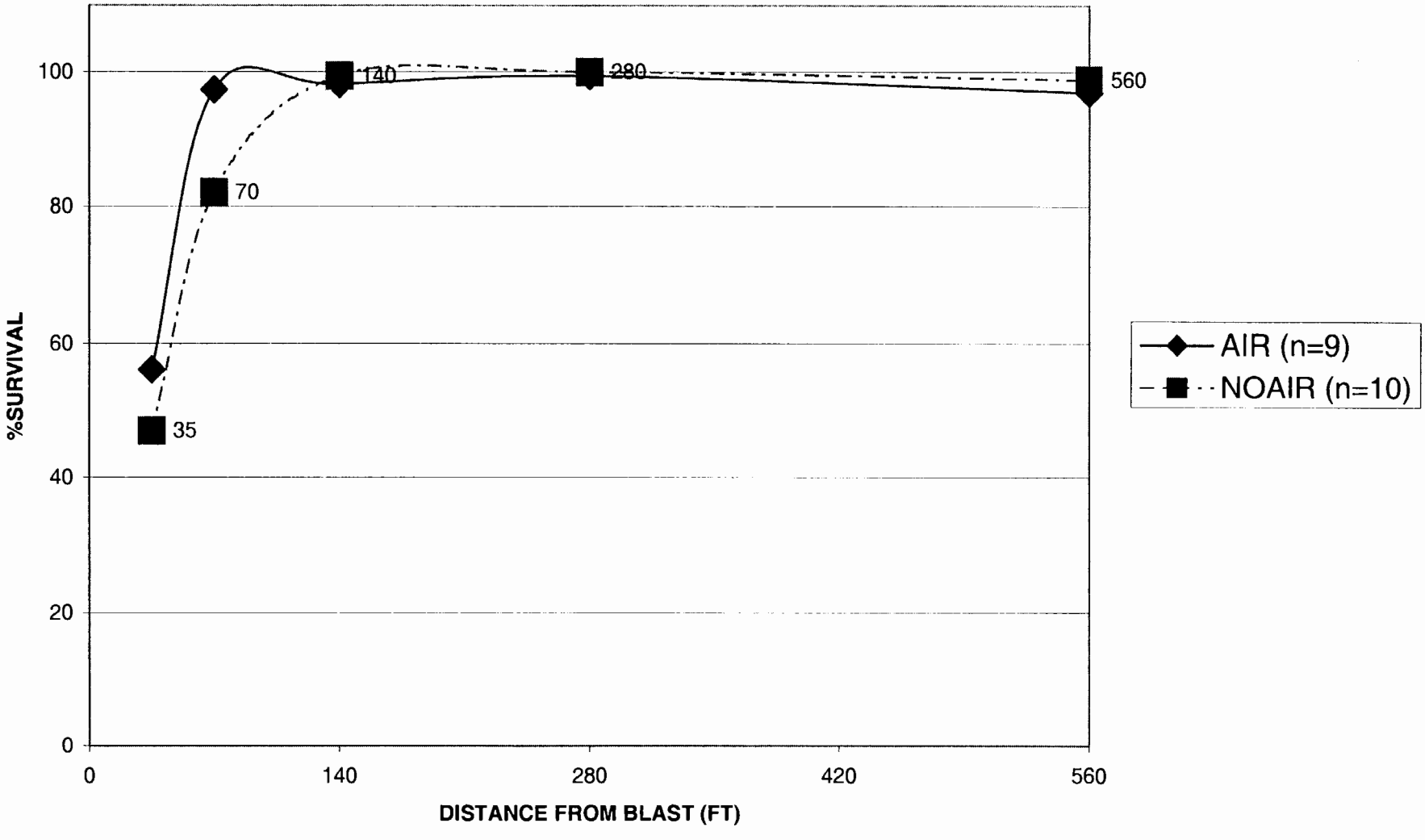
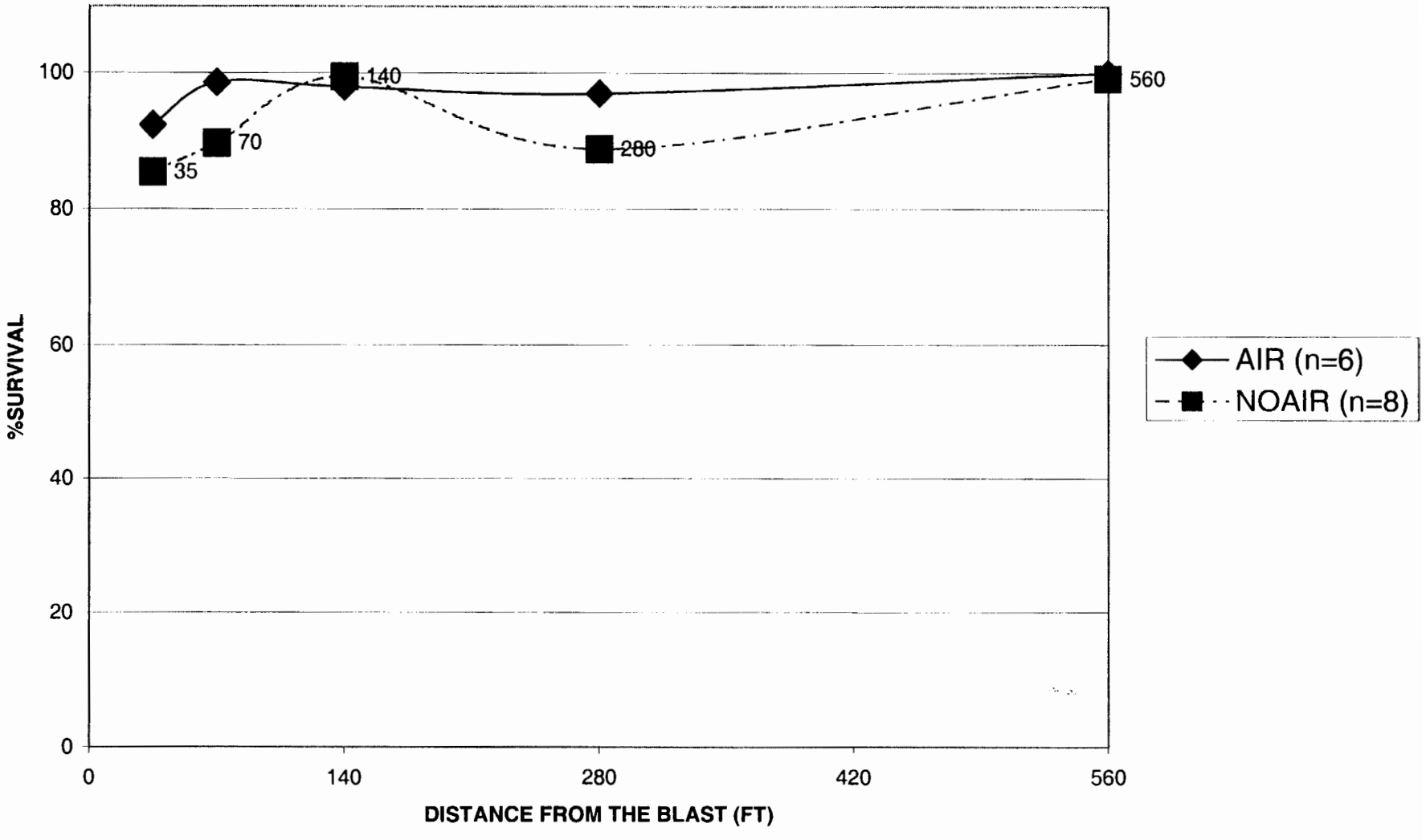


FIGURE 3. STURGEON MEAN %SURVIVAL WITH AND WITHOUT AIR CURTAIN JUST AFTER THE BLAST



APPENDIX C

MONITORING PLAN FOR HOPPER DREDGE OVERFLOW

MONITORING PLAN TO DETERMINE POTENTIAL EFFECTS OF TURBIDITY AND SUSPENDED SOLIDS PLUME ASSOCIATED WITH HOPPER DREDGE OVERFLOW IN THE WILMINGTON HARBOR, NORTH CAROLINA

Prepared For:
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July 1998

MONITORING PLAN TO DETERMINE POTENTIAL EFFECTS OF TURBIDITY AND SUSPENDED SOLIDS PLUME ASSOCIATED WITH HOPPER DREDGE OVERFLOW IN THE WILMINGTON HARBOR, NORTH CAROLINA

1. INTRODUCTION / BACKGROUND

Disposal area capacity for the routine maintenance dredging of Wilmington Harbor is limited in the Cape Fear River downstream of Eagle Island. Therefore, most of the maintenance material dredged from the harbor downstream of Eagle Island is disposed in the ocean at the Wilmington Harbor Ocean Dredged Material Disposal Site (ODMDS). One method for harbor maintenance and disposal at the ODMDS is using a hopper dredge with overflow. Use of a hopper dredge with overflow as an additional maintenance dredging method for portions of Wilmington Harbor was addressed in an Environmental Assessment (July 1997) and a Finding of No Significant Impact (November 1997) prepared by the U.S. Army Corps of Engineers, Wilmington District. Approval has recently been obtained to use this method in the harbor downstream of Eagle Island, but monitoring of the overflow plume in portions of the harbor has been required as a part of the North Carolina Division of Water Quality's (DWQ) Section 401 Water Quality Certificate No. 3157 issued 26 September 1997 and North Carolina Division of Coastal Management's (DCM) Letter dated 6 October 1997 (Appendices A and B, respectively).

The purpose of this monitoring plan is to address methods that will identify potential adverse impacts to the water quality and natural resources that could result from overflow dredging methods. The primary focus of additional hopper dredge monitoring will be to determine if dredged material overflow will be contained within the limits of the ship channel or deposited in the adjacent shallow waters of primary nursery areas (PNA). PNAs are often used by fish during post-larval development. If the overflow from hopper dredging results in fine sediments leaving the channel and accumulating in adjacent PNAs, the area of bottom affected and the depth of sediment accumulation will be determined. Detecting impacts will be determined by monitoring turbidity, suspended solids, sediment deposition, and benthic macroinvertebrates. This monitoring plan has been developed in accordance with the following conditions:

DWQ's Section 401 Water Quality Certification (No. 3157):

1) If dredging [with overflow] is done in locations with less than 90% sand, water quality data shall be collected by the U.S. Army Corps of Engineers for total and suspended residue and turbidity to determine the lateral extent of the sediment plume above background levels into adjacent PNA as well as the extent and thickness of the sediment redeposition on the channel flanks.

2) If the sediment plume extends above background levels into the PNA, the effect of sediment redeposition on benthic organisms in the PNA shall be documented by the U.S. Corps of Engineers by monitoring pre- and post benthic abundance and diversity in areas adjacent to the channel in the adjacent PNA where redeposition is observed. The monitoring shall be at intervals for up to 1-1/2 years or until background levels of benthic organisms are achieved. Written approval from DWQ is required for the monitoring plan before dredging utilizing hopper dredge when overflow is implemented.

3) If results from water quality and monitoring reveal significant environmental impacts, this 401 Certification may be modified to reflect these impacts. Similarly if the monitoring reveals a lack of environmental impact, this certification may be modified to remove these monitoring requirements.

DCM's consistency letter:

1) All conditions of the 401 Water Quality Certification issued by the N.C. Division of Water Quality are met. This Certification must remain active for hopper dredge with overflow to be used within portions of the channel authorized herein.

2) The Division of Coastal Management shall be provided the opportunity to review and comment on any monitoring plans that are implemented as prescribed by the conditions of the 401 Water Quality Certification. The Division of Coastal Management will be provided a copy of the results of any monitoring for review.

3) Aerial photography shall be obtained to monitor the movement and dissipation of the sediment plume as part of the project. Aerial photography will provide valuable visual data to complement water quality observations and or sampling. Site conditions for flight should be coordinated with the Division of Water Quality and Jim Gregson of the Division of Coastal Management (919/395-3900).

4) Discharge within the mixing zone must not result in acute toxicity to aquatic life or prevent the free passage of aquatic organisms.

5) The Corps of Engineers will continue its efforts to develop a Dredged Material Management Plan for the Cape Fear-Northeast Cape Fear and Wilmington Harbor Project.

6) All other conditions for consistency of this project remain in effect.

2. STUDY SITES

The focus of hopper dredge overflow monitoring will occur within two channel sections of the harbor (Upper Brunswick and Keg Island) where sand comprises less than 90 percent of the sediment and PNAs occur adjacent to the channel. The PNAs occur within an area 300 yards east and west of the main shipping channel to the shoreline. The main shipping channel is approximately 400 feet wide and 38 feet deep. Depth of waters in the PNAs adjacent to the channel is variable but often less than 4 to 8 feet. The average tidal range in the estuary below Wilmington is about 4 feet. Salinity of the area is variable (generally less than 15 ppt) and often stratified, depending on river discharge and the distance from the river mouth.

The Upper Brunswick channel range begins just south of Eagle Island at the mouth of the Brunswick River and extends south for approximately 1.7 miles. This area is approximately 23 miles north of the mouth of the Cape Fear River. The width of the river in this area varies between 4,000 and 9,000 feet and the open water area of this portion is approximately 600 acres. Surface sediments of the channel are comprised of 57 percent sand and 43 percent silt and clay.

The Keg Island channel range begins just south of the mouth of Town Creek and extends south for approximately 2.2 miles. This area is approximately 19 miles from the mouth of the Cape Fear River. Campbell Island (approximately 270 acres) and several small dredge spoil islands occur in this range and the width of the river in this area is about 1.3 miles. The open water area of this portion of the river is approximately 930 acres. Surface sediments of the channel are comprised of 63 percent sand and 37 percent silt and clay.

3. MONITORING THE EXTENT OF THE OVERFLOW PLUME

Monitoring of the sediment plume created by the hopper dredge will be conducted via collection of aerial photographs in conjunction with concurrent observations of water quality data.

Sampling Design. Two monitoring boats using different sampling strategies (one stationary boat and one roaming boat) will be used for obtaining water quality measurements. One stationary boat will be positioned at the down-current edge of the plume and the other boat will collect data along transects from the dredged area to determine the maximum extent of the lateral edge of the plume. The side of the plume that has the greater width will be determined visually by personnel in the plane being used for photography.

Collection of Global Positioning System (GPS) Data. GPS equipment on board each monitoring boat and the dredge will allow accurate determinations of sampling site locations and relative positions between monitoring boats and the dredge. Field personnel will also use portable rangefinders as a secondary source of mapping locations. GPS positions will be differentially corrected and accurate to within ± 5 meters.

Collection of Water Quality Data. The following water quality parameters will be monitored: 1) turbidity (NTU), 2) suspended solids (mg/l), 3) salinity (ppt), 4) dissolved oxygen (mg/l), and 5) temperature (°C). Water quality parameters will be measured to the nearest tenth (0.1), at the edge of the plume (2 locations), and at a background/control location. All measurements will be taken at a depth of 6 inches below the water surface. Suspended solids will be determined by a laboratory from collected water samples. All other parameters will be measured in situ or by taking discrete water samples and measuring the parameters with portable equipment on board the monitoring vessel. The monitoring equipment must be EPA-approved and properly calibrated and used by experienced personnel. The edge of the plume created by hopper dredge overflow is defined as the location where turbidity is 25 NTUs (a range of 20 to 30 NTUs will be assumed to be at the 25 NTU boundary).

Monitoring the Downstream Edge of the Plume. The boat monitoring the down-current edge of the plume will collect water quality measurements from three monitoring events, while anchored at approximately 1,000 feet, 2,000 feet, and 3,000 feet from the overflowing dredge. Water quality parameters will be monitored from a depth of 6 inches below the surface on 15-minute intervals for a 30-minute period (to include three sample times per site). Collection of water quality data will begin 5 minutes after overflow begins. The position of the dredge and dredging operations will be noted at the time of all sample collections. The distance between the dredge and the monitoring boat will be determined with a range finder and GPS equipment. Background water quality measurements will be taken prior to each plume monitoring event at a location approximately 1,000 feet up-current of the nearest dredging location.

Monitoring the Lateral Extent of the Surface Plume. The boat monitoring the lateral extent of the plume will collect the same water quality parameters as the down-current boat. The boat will traverse from the center of the overflow plume toward the shore while collecting water quality data. By recording the time and distance to the dredged area, the edge of the plume will be located and mapped. The distance between the dredge and the monitoring boat will be determined with a range finder and GPS equipment.

Aerial Photography. Photography will be taken from a fixed-wing aircraft using a 35-mm camera with a polarized lens. Photographs will be taken over the center of the plume with the entire plume, dredge, and monitoring vessels occupying the center of each photograph. Photographs will be taken as near vertical as reasonable, but tilt control equipment is not required for the camera. Photographs will be taken through an open window or door, not through glass or plastic.

At least three photographs (one set) will be taken in rapid succession each time a plume is monitored. Color print film will be used with an ASA of 100. Ten 8-inch by 10-inch prints will be made from the best negative of each set. The best negative includes a combination of least tilt and clearest visibility of the plume. An estimated scale (to the nearest 10 feet) will be provided for each of the best photographs. The scale will be estimated based on the known length of the hopper dredge, and by use of the GPS and range finder data. Monitoring will not occur if conditions are not favorable for aerial photography. Photographs will not be taken if white caps are present, surface background turbidity exceeds 20 NTUs, or sun glare or cloud shadows are present in the vicinity of the subject area.

Two sets of photographs will be taken during each of an ebb tide and flood tide (total of 4 sets). To minimize cost and time, the two sets of photographs will be taken during the same ebb tide and flood tide cycle. This is possible since the dredge will make several passes over the same shoal while overflowing before going to the ocean to dispose of the dredged material. Each pass will generally last 15 to 30 minutes. The dredge will then take 10 to 30 minutes to reposition at the beginning of the shoal and then dredge the next pass for another 10 to 30 minutes. This process is repeated (generally 2 to 3 times) until an economic load is obtained.

Photographs and water quality measurements of the plume will be taken when the plume has reached its probable maximum extent during each pass. This should occur at the time when dredging stops. To capture this moment, a member of the dredge crew designated by the captain will inform the monitoring crew 5 minutes before the pass is complete. This will allow the plane and monitoring boats time to be in position for the photographs. Personnel in the plane should be able to assist the monitoring boats by describing the position of the visible edge of the plume. To assist with data interpretation, the time will be recorded with each set of photographs and during the period of water quality observations.

4. MONITORING THE EXTENT AND THICKNESS OF PLUME DEPOSITION IN THE PRIMARY NURSERY AREAS

A review of available methods to measure narrow layers of sediment deposition in a dynamic aquatic environment resulted in the selection of sediment profile imaging (SPI) technology. Traditional aquatic sediment traps lack accurate resolution in environments with variable currents, can be easily disturbed by boat traffic, require more field equipment and careful deployment, and often require data collection over a longer period in order to characterize background conditions (Gardner 1980, Baker et al. 1988, Rosa et al. 1994). SPI is the most efficient technology for measuring thin layers of recently deposited sediment from dredging operations because many sites can be accurately sampled within a narrow time period (Diaz 1990).

Sediment profile cameras have been used since the 1970s to collect data on sediments at and below the sediment-water interface. The in situ view of surface sediments that SPI cameras photograph allows measurement of layers to millimeter (mm) accuracy. Recently deposited dredged material is often detected as a thin layer with different color tones and texture when compared to undisturbed natural sediments. Nichols et al. (1990) demonstrated how effective SPI techniques could be in detecting thin layers of sediment deposited from hopper dredge overflow. SPI is also effective for mapping the distribution of thin layers of dredged material from open-water disposal operations [(For example: Mobile Bay, Diaz and Schaffner (1988); Mississippi Sound, Diaz et al. (1987); Long Island Sound, Morton et al. (1985)].

The most reliable approach to monitoring thin layers of sediment deposited from hopper dredge overflow would be to sample during overflow operations or immediately after (within 48 hours). This approach would assure detection of the thinnest layers of dredged material. Previous work has indicated that layers less than 1 or 2 cm are quickly reworked by storms or infauna (Nichols et al. 1990).

Sampling Design. The short-term distribution of deposited material will be characterized by sampling with the SPI within 48 hours of the end of overflow dredging operations. The most effective field design for tracking thin layers of dredged material from overflow would be transects radiating away from the hopper dredge. Transects will be located in the vicinity of transects to be established for benthic macroinvertebrate collections (see Section 5). Transects will start close to the dredged channel and progress perpendicular from the channel toward shallow water or the shore line. SPI samples will be collected at intervals of about 100 to 200 feet and will be located near sites for benthic macroinvertebrate collections. The length of the transects will be sufficient to insure that samples are being collected to a point where no overflow dredged material is observed, or to where the water becomes too shallow for safe operation of the deployment vessel.

The video camera in the sediment profile camera prism will be monitored from the vessel to give a real-time estimate of the presence/absence of recently deposited layers. The end of the transects will be used to characterize areas with no dredged material deposition (i.e. reference conditions). In the event that the perpendicular transects will not run far enough to avoid the influence of the overflow deposition, specific reference transects will be located up-current and down-current of the dredging operation.

The number of stations per transect will vary depending on the length of the transect. A typical transect will have 10 to 20 sampling stations. Five to six transects should be sufficient to characterize overflow deposition from one dredging location. This design will allow approximately 80 to100 sampling stations to be collected in a day.

At each station, the sediment profile camera will be deployed one time. During the entire deployment, a video image can be observed from the vessel and will also be recorded for reevaluation of conditions if needed to support the SPI analysis. The photographic camera will be ~~be set~~ to photograph the sediment surface twice on each deployment, at 4 and 14 seconds after bottom contact. This timing sequence will allow the camera to capture the sediment water interface even in very soft sediments. Fujichrome 100 slide film will be used. Further details on SPI camera operation can be found in Diaz (1990).

Analytical Procedures. The analysis of stations for the presence of recently deposited thin-layers of dredged material will be accomplished by:

1) A digital video camera attached to the profile camera prism which displays the same view of the sediment profile as the 35-mm film camera. The video signal will be sent to the surface via cable so penetration of the prism, benthic habitat type, and the presence/absence of thin layers can be monitored. The initial evaluation will be done on the boat in real-time or between stations by an experienced senior scientist. The video signal will also be recorded for later detailed evaluation and review.

2) Post-field analysis will continue with the processing of the 35-mm film and a reevaluation of the video taped data if needed. After the film is processed (within 48 hours of completion of the field work), a visual analysis including the same parameters as estimated from the video SPI will be conducted. These data will be combined with the video data and the final analysis will be completed within 48 hours of film development. The combination of real-time video and high resolution image captured on film will insure accurate and reliable collection of SPI data.

3) Data from the analysis that will be tabulated and evaluated for thin-layers of dredged material and general benthic habitat characteristics include:

a) sediment grain size;
b) sediment layering, thickness, and type;
c) surface and subsurface fauna and structures;
d) approximate prism penetration;
e) approximate surface relief; and
f) approximate redox potential discontinuity layer.

Data to be logged at each station while in the field will include: station position, date, time, camera counter number, depth of prism penetration as determined from the deployment frame, water depth, and other parameters. Each developed slide will be labeled with a station identification number that will correspond to collected data. The distribution and thickness of overflow material deposition will be detailed in the final written report.

Quality Assurance/Quality Control Plan. Quality assurance and control for the analysis and collection of sediment profile film images (slides/prints) will be conducted at two levels.

1) Field photographic collection of SPI images: Prior to every field deployment, all essential items will be collected and tested for proper operation. Once the SPI system is assembled on board the research vessel, a system check will be initiated that includes all features of the SPI system, from tightening all bolts to testing the profile camera.

After every station or replicate deployment, the film counter will be checked to insure proper system functioning. Any misfires or improper camera operation could then be corrected while on station. Almost any electronic or mechanical failure of the profile camera could be repaired in the field. Spare parts and a complete back-up camera will be available if needed.

2) Film development: Film will be developed only by established and reputable labs. Even with the most careful control on film development, there is often variation in either the film or processing that can create subtle color differences. To correct for this potential problem, the first and last pictures taken each field-day will be a standard color card (Macbeth ColorcheckerTM) with red, green, blue, white, and neutral gray densities. From these color card images any variation in color from day to day or film to film can be detected. Color variations can then be accounted for in the computer image analysis.

Quality assurance and quality control for the analysis and collection of sediment profile video recording will also be conducted at two levels.

1) Field photographic collection of video SPI images: Prior to every field deployment, all video components will be collected and tested for proper operation. Once the video SPI system is assembled on board the research vessel, a system check will be initiated that includes all features of the video SPI system from tightening all bolts and video cable connectors to testing the video camera, and deck video monitor, and recorder.

Prior to and after every station deployment, a station card will be placed in front of the prism and recorded for 5 to 10 seconds. This will put the station data on the video tape for later analysis. Proper system functioning (penetration of prism, flash from film SPI camera) will be monitored in real time on deck via the video monitor. Any misfires or improper film camera operation can then be corrected while on station. Almost any electronic or mechanical failure of the video camera can be repaired in the field. Spare parts and a complete back-up video camera will be available if needed.

2) Video recording: The real-time video image will be monitored on deck and recorded onto Hi8 mm tape. To check for subtle color differences due to lighting variation (prism video lights and ambient light), a standard color card (Macbeth ColorcheckerTM) with red, green, blue, white, and neutral gray densities will be placed in front of the prism and recorded for 5 to 10 seconds in between each station. From these color card images, any variation in colors can be detected and can then be accounted for in the computer image analysis.

5. MONITORING OF BENTHIC ORGANISMS

If the overflow plume (turbidity levels higher than background levels) is observed in the PNAs and deposition (≥2 cm) of dredged material is documented in the PNAs, benthic macroinvertebrates will be evaluated to determine the potential impacts of overflow material deposition to biological organisms. Previous work has indicated that dredged material deposits less than 1 or 2 cm are quickly reworked by storms or infauna and often become difficult to detect after 48 hours of deposition (Nichols et al. 1990). Benthic macroinvertebrates are useful biological monitors because they are less mobile than other biological organisms, are easily collected, and provide a means of estimating the potential trophic support for fisheries resources.

Shallow subtidal areas in the Cape Fear River are subject to frequent disturbances associated with storms, tides, flooding events, siltation, and ship traffic. Estuarine environments are often dominated by opportunistic, resilient, benthic macroinvertebrate species that can tolerate sediment movement (Grant 1983, Dauer 1984, Levin 1984). Major disturbances from sediment deposition (i.e. dredging, siltation) can alter infauna communities, but these impacts are often short term. Nichols et al. (1990) found deposition from hopper dredging operations in the Chesapeake Bay to have little effect on benthic communities despite elevated suspended sediment concentrations and the redeposition of sediments up to 19 cm thick. The lack of adverse impacts to benthic macroinvertebrates from deposition of dredged material in the Chesapeake Bay was attributed to 1) non-contaminated dredged material, 2) grain size of the dredged material was similar to natural background sediments, 3) the low rate of deposition of new material, and 4) the species characterizing the environment were generally short-lived, exhibited flexible life histories, and had relatively high motilities which enabled them to withstand the sediment deposition (Nichols et al. 1990).

Sampling Design. Benthic macroinvertebrates will be sampled and analyzed where appropriate, following the DWQ's *Standard Operating Procedures Biological Monitoring* (1995). Quantitative benthic samples will be collected with a standard Ponar grab. Three replicate samples will be taken at each station. Samples will be preserved in 10 percent formalin and retained until it is determined if a post-

dredging sample will be required. If the overflow plume (turbidity levels higher than background levels) is observed in the PNAs during monitoring and deposition (≥2 cm) of dredged material is documented in the PNAs, benthic macroinvertebrates collected from the stations before and after the dredging event will be sieved through a 0.5 mm mesh screen, sorted, counted, and identified to the lowest possible taxon.

The location of sampling stations will be determined upon review of the specific sites to be dredged when that information becomes available. The level of effort will be comparable to sampling at least 24 stations in the vicinity of a dredging location. For example, if the dredged channel is oriented north/south, then six stations will be located in each of the four directional quadrants (NE, SE, SW, NW). Each quadrant will have two transects oriented east/ west (from the edge of the PNA to the shore). Each transect will have three stations within the primary nursery area spaced between the edge of the PNA and shore. Locations of sampling stations will be recorded using differentially corrected GPS positions. Collection of benthic macroinvertebrates will occur within two weeks prior to dredging and two weeks after completion of dredging at a particular site, if required.

Analytical Procedures. Species will be clumped into functional guilds (based on living position and feeding type). Analyses of guilds often detect community trends that may not be easily observed at the species level (Posey et al. 1996). The abundance of individuals in each guild will be evaluated to determine if significant differences exist between pre- and post-dredging samples using an unpaired t-test or Mann-Whitney Rank Sum Test, depending on normality of the population data. The abundance of individuals from stations with dredged material deposition will be compared to stations without dredged material deposition. In addition, a Sorenson Similarity Index will be calculated to compare benthic samples taken before and after dredging. This index will determine the level of similarity between the pre- and post-dredging samples with regard to dominant taxa. If a significant difference between pre- and post-dredging benthic communities exists, monitoring of benthic macroinvertebrates will occur semiannually for up to 1.5 years or until background levels of benthic organisms are achieved.

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State of North Carolina
Department of Environment,
Health and Natural Resources
Division of Water Quality

James B. Hunt, Jr., Governor
Wayne McDevitt, Secretary
A. Preston Howard, Jr., P.E., Director

DEHNR

September 26, 1997

Mr. Coleman Long
Wilmington District Corps of Engineers
Environmental Resources Section
Post Office Box 1890
Wilmington, North Carolina 28402-1890

Dear Mr. Long,

Re: Certification Pursuant to Section 401 of the Federal Clean Water Act,
Proposed use of hopper dredge with overflow - Wilmington Harbor dredging
WQC Project #970625
New Hanover County

Attached hereto is a copy of Certification No. 3157 issued to U.S. Army Corps of Engineers dated September 26, 1997.

If we can be of further assistance, do not hesitate to contact us.

Sincerely,

A. Preston Howard, Jr. P.E.

Attachments

3157wqc

cc: Wilmington District Corps of Engineers
Corps of Engineers Wilmington, 1997 Field Office
Wilmington DWQ Regional Office
Mr. John Dorney
Mr. John Parker, Division of Coastal Management
Central Files
John Hefner, U.S. Fish and Wildlife Services
Jim Gregson, Wilmington DCM

Appendix A

NORTH CAROLINA 401 WATER QUALITY CERTIFICATION

THIS CERTIFICATION is issued in conformity with the requirements of Section 401 Public Laws 92-500 and 95-217 of the United States and subject to the North Carolina Division of Water Quality (DWQ) Regulations in 15 NCAC 2H, Section .0500 to U.S. Army Corps of Engineers in New Hanover County pursuant to an application filed on the 14th day of July 1997 to utilize a hopper dredge with overflow for the dredging of Wilmington Harbor.

The application provides adequate assurance that the dredging of Cape Fear River will not result in a violation of applicable Water Quality Standards and discharge guidelines. Therefore, the State of North Carolina certifies that this activity will not violate the applicable portions of Sections 301, 302, 303, 306, 307 of PL 92-500 and PL 95-217 if conducted in accordance with the application and conditions hereinafter set forth.

This approval is only valid for the purpose and design that you submitted in your application, as described in the Public Notice or as modified below. If you change your project, you must notify us and you may be required to submit a revised application. For this approval to be valid, you must follow the conditions listed below. In addition, you should get any other federal, state or local permits before you go ahead with your project including (but not limited to) Sediment and Erosion control, Coastal Stormwater, Non-discharge and Water Supply watershed regulations.

Condition(s) of Certification:

1. If dredging is done in locations with less than 90% sand, water quality data shall be collected by the U.S. Army Corps of Engineers for total suspended residue and turbidity to determine the lateral extent of the sediment plume above background levels into the adjacent Primary Nursery Area (PNA) as well as the extent and thickness of the sediment redeposition on the channel flanks.

2. If the sediment plume extends above background levels into the PNA, the effect of sediment redeposition on benthic organisms in the PNA shall be documented by the U.S. Army Corps of Engineers by monitoring pre-and post benthic abundance and diversity in areas adjacent to the channel in the adjacent PNA where redeposition is observed. The monitoring shall be at intervals for up to 1-1/2 years or until background levels of benthic organisms are achieved. Written approval from DWQ is required for the monitoring plan before dredging utilizing the hopper dredge when overflow is implemented.

3. If results from the water quality and monitoring reveal significant environmental impacts, this 401 Certification may be modified to reflect these impacts. Similarly if the monitoring reveals a lack of environmental impact, this certification may be modified to remove these monitoring requirements.

Violations of any condition herein set forth shall result in revocation of this Certification and may result in criminal and/or civil penalties. This Certification shall become null and void unless the above conditions are made conditions of the Federal 404 and/or coastal Area Management Act Permit. This Certification shall expire upon expiration of the 404 or CAMA permit.

If this Certification is unacceptable to you you have the right to an adjudicatory hearing upon written request within sixty (60) days following receipt of this Certification. This

27447, Raleigh, N.C. 27611-7447. If modifications are made to an original Certification, you have the right to an adjudicatory hearing on the modifications upon written request within sixty (60) days following receipt of the Certification. Unless such demands are made, this Certification shall be final and binding.

This the 26th day of September 1997

DIVISION OF WATER QUALITY

A. Preston Howard, Jr. P.E.

WQC 3157

State of North Carolina
Department of Environment,
Health and Natural Resources
Division of Coastal Management

James B. Hunt, Jr., Governor
Wayne McDevitt, Secretary
Roger N. Schecter, Director

October 6, 1997

Colonel Terry R. Youngbluth
District Engineer, Wilmington District
U.S. Army Corps of Engineers
P.O. Box 1890
Wilmington, NC 28402-1890

REFERENCE: CD97-26 Use of Hopper Dredge with Overflow, Wilmington Harbor

Dear Colonel Youngbluth:

The State of North Carolina has completed its review of the referenced proposal for hopper dredging with overflow in Wilmington Harbor, for consistency with the North Carolina Coastal Management Program, pursuant to 15 CFR 930 Subpart C, Consistency for Federal Activities. The document was received in our office September 8, 1997 and assigned the review number DCM97-38. The Corps of Engineers is requesting authorization to use hopper dredging with overflow to maintain two sections totaling 10.8 miles of the Cape Fear - Northeast Cape Fear River/Wilmington Harbor Project. The sediment content in theses portions of the channel is less than 90 percent sand. Currently, the Corps is allowed to use hopper dredge with overflow in areas where sediments are greater than 90 percent sand. The purpose of the proposed change in maintenance methods is to allow the Corps of Engineers to achieve an "economic load" over a greater length of the channel. Based upon our review, we cannot disagree with the Corps determination that the proposal is consistent with the North Carolina Coastal Management, provided the following conditions are met.

1. All conditions of the 401 Water Quality Certification issued by the NC Division of Water Quality are met. This Certification must remain active for hopper dredge with overflow to be used within portions of the channel authorized herein.

2. The Division of Coastal Management shall be provided the opportunity to review and comment on any monitoring plans that are implemented as prescribed by the conditions of the 401 Water Quality Certification. The Division of Coastal Management will be provided a copy of the results of any monitoring for review.

3. Aerial photography shall be obtained to monitor the movement and dissipation of the sediment plume as part of the project. Aerial photography will provide valuable visual data to complement water quality observations and or sampling. Site conditions for flight should

Appendix B

be coordinated with the Division of Water Quality and Jim Gregson of the Division of Coastal Management (910/395-3900).

4. Discharge within the mixing zone must not result in acute toxicity to aquatic life or prevent the free passage of aquatic organisms.

5. The Corps of Engineers will continue its efforts to develop a Dredged Material Management Plan for the Cape Fear-Northeast Cape Fear and Wilmington Harbor Project.

6. All other conditions for consistency of this project remain in effect.

The stated purpose of the project is to allow the Corps of Engineers to achieve an "economic load", to dredge the channel in a more economically efficient manner. While the proposed project modification may provide economic benefit to the Corps, the impacts of hopper dredging with over flow of finer material (< 90 % sand) on the natural resources of the coastal zone are not known. It is known that sensitive areas, including Primary Nursery Areas, are placed at greater risk with increased turbidity and sedimentation. Therefore, monitoring for water quality and biological impacts associated with this project is particularly important. We are hesitant to approve projects and project modifications for economic benefit when it cannot be shown that the work will not adversely impact natural resources of the coastal zone.

If you have any questions regarding our finding, conditions, or recommendations, please contact me or Mr. Steve Benton, Division of Coastal Management, at (919)733-2293. Thank you for your consideration of the North Carolina Coastal Management Program.

Sincerely,

Roger N. Schecter

cc: Bob Stroud, Division of Coastal Management, Wilmington
John Dorney, Division of Water Quality
Preston Pate, Director, Division of Marine Fisheries
Frank Yelverton, US Army Corps of Engineers

APPENDIX D

SECTION 404(b) EVALUATION

SECTION 404(B)(1) (PUBLIC LAW 95-217) EVALUATION
PRECONSTRUCTION MODIFICATIONS
OF
AUTHORIZED IMPROVEMENTS
WILMINGTON HARBOR, NORTH CAROLINA

Evaluation of Section 404(b)(1) Guidelines
40 CFR 230

1. Review of Compliance (230.10(a)-(d)) Review of the NEPA Document indicates:	Preliminary 1/	Final 2/
a. The discharge represents the least environmentally damaging practicable alternative and if in a special aquatic site, the activity associated with the discharge must have direct access or proximity to, or be located in the aquatic ecosystem to fulfill its basic purpose (if no, see section 2 and NEPA document);	YES|_| NO|_|*	YES|X| NO|_|
b. The activity does not: 1) violate applicable State water quality standards or effluent standards prohibited under Section 307 of the CWA; 2) jeopardize the existence of federally listed endangered or threatened species or their habitat; and 3) violate requirements of any federally designated marine sanctuary (if no, see section 2b and check responses from resource and water quality certifying agencies);	YES|_| NO|_|*	YES|X| NO|_|
c. The activity will not cause or contribute to significant degradation of waters of the U.S. including adverse effects on human health, life stages of organisms dependent on the aquatic ecosystem, ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values (if no, see section 2);	YES|_| NO|_|*	YES|X| NO|_|
d. Appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem (if no, see section 5).	YES|_| NO|_|*	YES|X| NO|_|

Proceed to Section 2
*, 1, 2/ See page D-6

2. Technical Evaluation Factors (Subparts C-F)	N/A	Not Significant	Significant*
a. Physical and Chemical Characteristics of the Aquatic Ecosystem (Subpart C)			
(1) Substrate impacts.		X	
(2) Suspended particulates/turbidity impacts.		X	
(3) Water column impacts.		X	
(4) Alteration of current patterns and water circulation.		X	
(5) Alteration of normal water fluctuations/hydroperiod.		X	
(6) Alteration of salinity gradients.		X	
b. Biological Characteristics of the Aquatic Ecosystem (Subpart D)			
(1) Effect on threatened/endangered species and their habitat.		X	
(2) Effect on the aquatic food web.		X	
(3) Effect on other wildlife (mammals, birds, reptiles, and amphibians).		X	
c. Special Aquatic Sites (Subpart E)			
(1) Sanctuaries and refuges.	X		
(2) Wetlands.	X		
(3) Mud flats.	X		
(4) Vegetated shallows.	X		
(5) Coral reefs.	X		
(6) Riffle and pool complexes.	X		
d. Human Use Characteristics (Subpart F)			
(1) Effects on municipal and private water supplies.	x		
(2) Recreational and commercial fisheries impacts.		X	
(3) Effects on water-related recreation.		X	
(4) Aesthetic impacts.		X	
(5) Effects on parks, national and historical monuments, national seashores, wilderness areas, research sites, and similar preserves.	X		

Remarks: Where a mark is placed under the significant category, preparer add explanation below.

Proceed to Section 3

*See page D-6

3. Evaluation of Dredged or Fill Material (Subpart G) 3/

a. The following information has been considered in evaluating the biological availability of possible contaminants in dredged or fill material. (Mark only those appropriate.)

(1) Physical characteristics . . . . . |X|
(2) Hydrography in relation to known or anticipated sources of contaminants . . . . . |X|
(3) Results from previous testing of the material or similar material in the vicinity of the project . . . . . |X|
(4) Known, significant sources of persistent pesticides from land runoff or percolation. . . . . |_|
(5) Spill records for petroleum products or designated (Section 311 of CWA) hazardous substances. . . . . |X|
(6) Other public records of significant introduction of contaminants from industries, municipalities, or other sources . . . . . |X|
(7) Known existence of substantial material deposits of substances which could be released in harmful quantities to the aquatic environment by man-induced discharge activities . . . . . |_|
(8) Other sources (specify) . . . . . |_|

List appropriate references.

Reference: Environment Assessment **Preconstruction Modifications Of Authorized Improvements** Wilmington Harbor, North Carolina

b. An evaluation of the appropriate information in 3a above indicates that there is reason to believe the proposed dredge or fill material is not a carrier of contaminants, or that levels of contaminants are substantively similar at extraction and disposal sites and not likely to result in degradation of the disposal site. The material meets the testing exclusion criteria. YES |X| NO |_|*

Proceed to Section 4

*, 3/, see page D-6

4. Disposal Site Determinations (230.11(f)).

a. The following factors as appropriate, have been considered in evaluating the disposal site.

(1) Depth of water at disposal site . . . . . |X|

(2) Current velocity, direction, and variability at disposal site . . . . . |X|

(3) Degree of turbulence . . . . . |X|

(4) Water column stratification . . . . . |X|

(5) Discharge vessel speed and direction . . . . . |X|

(6) Rate of discharge . . . . . |X|

(7) Dredged material characteristics (constituents, amount and type of material, settling velocities). . . . . |X|

(8) Number of discharges per unit of time . . . . . |X|

(9) Other factors affecting rates and patterns of mixing (specify)

List appropriate references.

Reference: : Environment Assessment **Preconstruction Modifications Of Authorized Improvements** Wilmington Harbor, North Carolina

b. An evaluation of the appropriate factors in 4a above indicates that the disposal site and/or size of mixing zone are acceptable . . . . YES |X| NO |_|*

5. Actions to Minimize Adverse Effects (Subpart H).

All appropriate and practicable steps have been taken, through application of recommendations of 230.70-230.77, to ensure minimal adverse effects of the proposed discharge. List actions taken. YES |X| NO |_|*

For water resources see Section 5.02 of the EA
For marine and estuarine resources see Section 5.04 of the EA.
For essential fish habitat see Section 5.05 of the EA.
For wetlands see Section 5.07 of the EA.
For threatened and endangered species see Section 5.08 of the EA.

Return to section 1 for final stage of compliance review. See also note 3/, page D-6.

*See page D-6

6. Factual Determinations (230.11).

A review of appropriate information as identified in items 2-5 above indicates that there is minimal potential for short- or long-term environmental effects of the proposed discharge as related to:

a. Physical substrate at the disposal site (review sections 2a, 3, 4, and 5). YES |X| NO |_|*

b. Water circulation, fluctuation, and salinity (review sections 2a, 3, 4, and 5). YES |X| NO |_|*

c. Suspended particulates/turbidity (review sections 2a, 3, 4, and 5). YES |X| NO |_|*

d. Contaminant availability (review sections 2a, 3, and 4). YES |X| NO |_|*

e. Aquatic ecosystem structure and function (review sections 2b and c, 3, and 5). YES |X| NO |_|*

f. Disposal site (review sections 2, 4, and 5). YES |X| NO |_|*

g. Cumulative impact on the aquatic ecosystem. YES |X| NO |_|*

h. Secondary impacts on the aquatic ecosystem. YES |X| NO |_|*

7. Findings.

a. The proposed disposal site for discharge of dredged or fill material complies with the Section 404(b)(1) guidelines. . . . . |X|

b. The proposed disposal site for discharge of dredged or fill material complies with the Section 404(b)(1) guidelines with the inclusion of the following conditions: |_|

*See page D-6

c. The proposed disposal site for discharge of dredged or fill material does not comply with the Section 404(b)(1) guidelines for the following reasons(s):

(1) There is a less damaging practicable alternative. . . . . |_|

(2) The proposed discharge will result in significant degradation of the aquatic ecosystem . . . . . |_|

(3) The proposed discharge does not include all practicable and appropriate measures to minimize potential harm to the aquatic ecosystem . . . . . |_|

8.

W. Coleman Long
Chief, Planning and
Environmental Branch

Date: 2/8/00

Ben F. Wood, PE
Chief, Technical Services Division

Date: 2/8/00

*A negative, significant, or unknown response indicates that the permit application may not be in compliance with the Section 404(b)(1) Guidelines.

1/ Negative responses to three or more of the compliance criteria at this stage indicate that the proposed projects may not be evaluated using this "short form procedure." Care should be used in assessing pertinent portions of the technical information of items 2 a-d, before completing the final review of compliance.

2/ Negative response to one of the compliance criteria at this stage indicates that the proposed project does not comply with the guidelines. If the economics of navigation and anchorage of Section 404(b)(2) are to be evaluated in the decision-making process, the "short form evaluation process is inappropriate."

3/ If the dredged or fill material cannot be excluded from individual testing, the "short-form" evaluation process is inappropriate.

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APPENDIX E

BIOLOGICAL ASSESSMENT – ENDANGERED SPECIES

APPENDIX E

BIOLOGICAL ASSESSMENT
ENDANGERED SPECIES

Environmental Assessment, Preconstruction Modification of Authorized Improvements, Wilmington Harbor, North Carolina

February 2000

1.00 PROPOSED PROJECT

The proposed project is the same as described in detail in the environmental assessment which precedes the appendices.

2.00 PRIOR COORDINATION

Potential impacts on listed species have also been addressed previously for the Wilmington Harbor project. A comprehensive analysis of all impacts associated with the long-term maintenance of Wilmington Harbor was coordinated with NMFS through a Final EIS dated October 1989.

A Biological Assessment was prepared in June 1996 addressing a list of threatened and endangered species provided on October 2, 1995 by the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS). The summary effect determination was that the project may adversely affect the manatee, green sea turtle, loggerhead sea turtle, Kemp's ridley sea turtle, and shortnose sturgeon. On May 17, 1996 the USFWS rendered a Biological Opinion which concluded that the project is not likely to jeopardize the continued existence of the manatee, and that since no critical habitat for the species had been designated in North Carolina, none would be affected. On September 13, 1996 the NMFS rendered a Biological Opinion which concluded that the project is not likely to jeopardize the continued existence of the shortnose sturgeon, green, loggerhead, or Kemp's ridley sea turtles or finback, humpback, or right whales.

3.0 SPECIES CONSIDERED UNDER THIS ASSESSMENT

Updated lists of endangered and threatened (E&T) species for the project area were obtained from NMFS (Southeast Regional Office, St. Petersburg, FL on March 17, 1999) and the USFWS (Field Office, Raleigh, NC on March 23, 1999). These were combined to develop the following composite list, which includes E&T species that could be present in the area based upon their geographic range. However, the actual occurrence of a species in the area would depend upon the availability of suitable habitat, the season of the year relative to a species' temperature tolerance and migratory habits, and other factors.

MAMMALS

Eastern cougar	(*Felis concolor cougar*)	Endangered
Manatee	(*Trichechus manatus*)	Endangered
Blue whale	(*Balaenoptera musculus*)	Endangered
Finback whale	(*Balaenoptera physalus*)	Endangered
Humpback whale	(*Megaptera novaeangliae*)	Endangered
Right whale	(*Eubaleana glacialis*)	Endangered
Sei whale	(*Balaenoptera borealis*)	Endangered
Sperm whale	(*Physeter macrocephalus*)	Endangered

BIRDS

Bald eagle	(*Halieetus leucocephalus*)	Threatened
Peregrine falcon	(*Falco peregrinus anatum*)	Endangered
Piping plover	(*Charadrius melodus*)	Threatened
Red-cockaded woodpecker	(*Picoides borealis*)	Endangered
Wood stork	(*Mycteria americana*)	Endangered

REPTILES

American alligator	(*Alligator mississippiensis*)	Threatened/SA[1]
Green sea turtle	(*Chelonia mydas*)	Threatened[2]
Hawksbill sea turtle	(*Eretmochelys imbricata*)	Endangered
Kemp's ridley sea turtle	(*Lepidochelys kempii*)	Endangered
Leatherback sea turtle	(*Dermochelys coriacea*)	Endangered
Loggerhead sea turtle	(*Caretta caretta*)	Threatened

FISHES

Shortnose sturgeon	(*Acipenser brevirostrum*)	Endangered

PLANTS

Cooley's meadowrue	(*Thalictrum cooleyi*)	Endangered
Rough-leaved loosestrife	(*Lysimachia asperulaefolia*)	Endangered
Seabeach amaranth	(*Amaranthus pumilis*)	Threatened

---

[1]The American alligator is listed as threatened only because of its similarity of appearance to crocodilians which are endangered or threatened and which are tracked for illegal commercial trade in hides or other products. The status of the American alligator is not actually threatened.

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

4.00 ASSESSMENT OF IMPACTS TO LISTED SPECIES

4.01 General Impacts

Dredging and disposal of sediment and blasting have the potential to adversely affect animals and plants in a variety of ways. These include actions of the dredging equipment (i.e., cutting, suction, sediment removal, hydraulic pumping of water and sediment); physical contact with dredging equipment and vessels (i.e., impact); physical barriers imposed by the presence of dredging equipment (i.e., pipelines), placement of dredged material in various disposal locations (i.e., covering, suffocation), and lethal and sublethal impacts of blasting. Potential impacts vary according to the type of equipment used, the nature and location of sediment discharged, the time period in relation to life cycles of organisms that could be affected, the nature of the interaction of a particular species with the dredging activities, and proximity to a blast.

All the proposed work will occur in the Cape Fear and Northeast Cape Fear Rivers (up to about river mile 30.8), in and around confined disposal sites on islands along these rivers, in the nearshore Atlantic Ocean, and along the ocean beaches of Brunswick and southern New Hanover Counties. Any potential impacts on endangered and threatened species would be limited to those species which occur in habitats provided by these areas. Therefore, the proposed work will not affect any listed species which generally reside in forested habitats, including the eastern cougar, red-cockaded woodpecker, wood stork, Cooley's meadowrue, and rough-leafed loosestrife.

Species which could be present in the project area during the proposed action are the peregrine falcon, bald eagle, piping plover, Florida manatee, blue whale, finback whale, humpback whale, right whale, sei whale, sperm whale, green sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, loggerhead sea turtle, American alligator, shortnose sturgeon, and sea-beach amaranth.

Dredging and disposal methods associated with the proposed action are similar to current maintenance dredging methods. These methods, as well as rock removal by blasting, have been addressed in a number of previous environmental documents, including biological assessments and biological opinions rendered regarding endangered and threatened species. The accounts which follow will summarize this information as it applies to pending construction and maintenance activities for Wilmington Harbor.

4.02 Species Accounts

4.02.1 Eastern Cougar, Red-Cockaded Woodpecker, Wood Stork, Cooley's Meadowrue, and Rough-leaved Loosestrife.

These are all terrestrial, woodland species. Since this habitat type is not present in the areas to be affected by project construction and maintenance, these species are unlikely to occur.

Effect Determination. It has been determined that construction and maintenance activities for Wilmington Harbor are not likely to affect any of these species or their habitat.

4.02.2 Bald Eagle and Peregrine Falcon

The bald eagle is a year-round resident of the lower Cape Fear region which could occasionally occur in the project area on foraging forays. Its distribution within the region is largely dependent on availability of a stable supply of fishes and secluded roosting sites. Suitable roosting sites do not occur in areas of the proposed activities. The peregrine falcon is known from the project area only as an occasional migrant or temporary winter resident. Its occurrence in the region is independent of development in the project area, being driven instead by climatic conditions (passages of cold fronts, etc.)

Effect Determination. The proposed project activities should not adversely affect the migratory habitats or availability of food for either of these species. Area beaches are badly eroded and in need of additional sand to help offset continuing erosion. Maintenance of good migratory stopover habitat for these species will be aided by the proposed sand placement on area beaches. For these reasons it has been determined that the project is not likely to adversely affect these species.

4.02.3 Piping Plover

a. **Status**. Threatened

b. **Occurrence in Immediate Project Vicinity**: The piping plover is known to nest sporadically along the North Carolina beaches and occur as both a migrant and as a winter resident. For nesting, this species prefers the upper edges of overwash areas at inlets or large open unvegetated beaches. Three piping plover nests were observed on Holden Beach at the western end of Oak Island during 1992, but these nests were unsuccessful. Four pairs nesting at the western end of Holden Beach in 1993 fledged 1 chick per nest (USFWS 1996a). In 1997 and 1998 2 nests each year were attempted again at the western end of Holden Beach. None of these nests fledged chicks (LeGrand 1999). All these nests were in active inlet areas. The species has also used the beaches for foraging during the winter and during migration.

c. **Current Threatens to Continued Use of the Area**. Field observations during the summer of 1999 suggest that the potential for successful nesting of this species on project-affected beaches would be extremely low because of erosion, heavy recreational use and an abundance of predators, including wild and domestic animals as well as feral cats.

d. **Project Impacts**.

(1) **Habitat**. Most of the historic nesting in the area has occurred in active inlet areas. None of the disposal will be in the active inlet areas and disposal will not take place within about 1 mile of the western end of Holden Beach (figure 4 of EA) where nesting has recently occurred.

(2) **Food Supply**. Foraging area around the inlets should not be affected since no disposal is proposed in these areas. Along other areas of the highly eroded beaches, piping plover foraging may be altered as beach food resources may be affected by sand disposal

events. Beach disposal during construction will be conducted for up to 18 continuous months which would save up to $5.25 million. However, only a portion of the beach is affected at any point in time (approximately one mile per month). Once disposal passes that point, recovery can begin to occur. All of Bald Head Island, the eastern end of Oak Island, the middle of Oak Island (under another project, USACE 1998), and most of the area of Holden Beach to be nourished, will be nourished during the colder months when recruitment of beach organisms on which piping plovers feed is at its lowest. Most of Oak Island will be nourished during the warmer months, but recruitment of beach organisms can occur from the inlet areas where nourishment will not occur, and the eastern and middle areas of Oak Island that will be nourished during the colder months.

Overall beach disposal effects as a result of harbor maintenance will be less than during construction. Maintenance will only be performed during the colder months, and will only occur on Bald Head Island and within the eastern 25,000 feet of Oak Island. Beach nourishment from maintenance will occur every two years. Current plans are for Bald Head Island to receive dredged material from two consecutive maintenance cycles, with Oak Island receiving dredged material from the third maintenance cycle. Future maintenance is expected to continue this cycle. Both beaches will be monitored for erosion, and disposal will occur in the eroded areas. Disposal in these areas should have the least impact on resources due to the instability of the area because of high erosion rates.

(3) **Relationship to Critical Periods in Life Cycle**. Beach placement of sand derived from project construction is expected to occur on a year-round basis. Therefore, it will occur within the nesting season of the piping plover (April 1 through July 31). No disposal is proposed in the active inlet areas (figure 4 of EA) where historic nesting has occurred, and nesting is not expected to occur in the highly eroded beachfront where disposal is planned.

(4) **Effect Determination**. Because beach disposal may temporarily impact foraging habitat and disrupt nesting that may be attempted along the eroded beach front, it has been determined that the project may adversely affect the piping plover.

4.02.2 Manatee

a. Status. Endangered.

b. Occurrence in Immediate Project Vicinity. The coast of North Carolina is within the summer range of the manatee. Historically, the species is known from as far north as New Jersey. All of the presently designated critical habitat for the species is located in Florida.

Manatees are rare visitors to the Cape Fear River Region. From 1952 to 1994, there were only 7 known observations in Cape Fear System (Schwartz, 1995). One of these manatees was dead (1986) but no data were gathered on the cause of death (Schwartz, 1996). Three additional live manatee have been sighted in Wilmington Harbor since the Schwartz publication. One was sighted near Southport in the Fall of 1995, and two (probably a calf and its mother) were sighted near Wilmington in the Spring of 1996. Except for the Spring of 1996, each sighting in the Cape Fear Region has been of a single manatee. During the most frequent period of observations in the river (1993-1996), there was one observation per year except for the 1996 sighting.

The nearest known sighting since 1996 was of a single manatee in the summer of 1999 in a marina near the Atlantic Intracoastal Waterway about 20 miles from Wilmington Harbor. Numbers of manatees using the region are not known but are presumed to be very low. More research is needed to determine the status of the species in North Carolina and identify areas (containing food and freshwater supplies) which are critical for supporting summer populations.

c. **Current Threats to Continued Use of the Area**. Current threats to this species in the Cape Fear River can not be clearly assessed due to our lack of knowledge regarding its population, seasonality, distribution, and the habitat components in the river that may be critical for its continued occupation of the area. Cold winter water temperatures will probably keep the species from overwintering in the project area, except in the vicinity of the warm-water discharge from Carolina Power and Light's nuclear power plant (Clark, 1987).

d. **Project Impacts**.

(1) **Habitat.** Impacts to estuarine and nearshore ocean habitat of the area should be minor and should be similar to those already occurring under the existing maintenance of Wilmington Harbor. The effect of these impacts on the value of the area to the manatee are unknown. With the current state of knowledge on the habitat requirements for the manatee in North Carolina, it is impossible to determine the magnitude of such impacts.

(2) **Food Supply**. Foods which are used by the manatee in North Carolina are unknown. In Florida, their diet consists primarily of vascular plants. Project construction and maintenance will involve minimal change to the physical habitat of the estuary and overall estuarine and nearshore productivity should remain high throughout the project area. Therefore, potential food sources for the manatee should be unaffected.

(3) **Relationship to Critical Periods in Life Cycle**. The manatee is considered to be a occasional summer resident of the North Carolina coast. Construction and maintenance of the proposed project should have little effect on the manatee since its habitat and food supply will not be significantly impacted.

(4) **Effect Determination**. Records for the manatee within the Cape Fear River are spotty with a maximum of 2 individual observed per year, and indicate that the species most frequently occurs in the system during the summer and fall time period.

Little data is available on the impacts of blasts on manatee but they should be similar to bottlenose dolphins. Some injury can occur to bottlenose dolphins at or above 1.17 in-lb/in^2 (energy flux density)(Department of the Navy 1998 and 1999) or above 5 psi-msec for impulse pressure (Yelverton 1973). The maximum pressure value recorded for energy flux density during test blasting in Wilmington harbor during the Fall/Winter of 1998/99 at 560 feet was 0.195 in- lb/in^2, and for impulse was 5.86 psi-msec. These pressure values recorded at 560 feet are near or below the indicated thresholds.

The Goertner 1982 model is available to estimate a blast impact area for manatee. This model is for blasts in open water, not in rock. The effect of a blast in rock has been calculated to be 0.014 of a blast in open water. In other words a 52 to 62 pound blast proposed during construction in rock is equivalent to a 0.73 to 0.87 pound blast in open water (USACE 1999a). Even if 12 pounds of explosives were used for the Goertner 1982 open water model (equivalent to 855 pounds of explosives in rock), maximum horizontal extent of slight injuries to manatees (adult and calf) would be 450 feet.

In order to minimize any potential impacts from rock blasting, pre-blast monitoring is proposed. Pre-blast monitoring will include, at a minimum, deployment of NMFS-approved observers to assure that no manatees are present within a 3,500 foot radius of any blast (This distance was developed to avoid harassment of bottlenose dolphin). Should listed species be observed, blasting will be delayed until the species voluntarily leaves the 3,500 foot radius. After blasting, observers will also examine the area to determine if incidental take of manatees resulted from a blast. In addition, if a manatee is observed within 100 yards of any construction action, any inwater actions will be terminated until the manatee voluntarily leaves the area. Through implementation of such protective measures, it is believed that potential impacts to the manatee can be minimized.

Because of the indicated measures, and rare occurrence of manatees in the harbor, the proposed action in not likely to affect the manatee.

4.02.3 Blue Whale, Finback Whale, Humpback Whale, Right Whale, Sei Whale, and Sperm Whale

a. **Status**. Endangered

b. **Occurrence in Immediate Project Vicinity**. These species all occur infrequently in the ocean off the coast of North Carolina. Their occurrence in the State's waters is usually associated with spring or fall migrations. Whales should not be affected by blasting since the farthest downstream blast area for the Wilmington Harbor project is approximately 18 miles upstream of the ocean. Due to their restriction to oceanic environments, the only aspects of the proposed construction and maintenance dredging of the harbor which might result in an encounter with these species will be the disposal of dredged material in the ODMDS, operation of the hopper dredge in Bald Head Shoal Channel, backfilling of the abandoned ocean bar channel, and transportation of rock to the WOFES..

These species were all assessed by the EPA in its environmental impact statement (USEPA, 1983) for designation of ODMDS at Savannah, Georgia; Charleston, South Carolina; and Wilmington, North Carolina. That assessment determined that use of the Wilmington ODMDS will not have any effect on these species and the NMFS has concurred with that determination (52 FR 127, page 25009).

c. **Current Threats to Continued Use of the Project Area**. None.

d. **Project Impacts**.

(1) **Habitat**. None.

(2) **Food Supply**. Productivity of the nearshore ocean will not be diminished by the proposed dredging; therefore, the food supply of these species should be unaffected.

(3) **Relationship to Critical Periods in Life Cycle**. The presence of a dredged material disposal barge or hopper dredge in the nearshore ocean waters should pose no more of a threat to migrating whales than normal commercial ship traffic. However in order to maximize protection of the right and humpback whales, 100 percent daytime whale observer coverage will be from December 1 through March 31 in accordance with previous biological opinions rendered by NMFS (NMFS 1997).

(4) **Effect Determination**. Since existing habitat conditions and food supplies will be maintained and whale observer coverage will be implemented, it has been determined that the continued maintenance of the harbor will not affect the above listed species of whales.

4.02.4 Hawksbill and Leatherback Sea Turtles

a. **Status**. Endangered

b. **Occurrence in Immediate Project Vicinity**. Neither of these species is known to nest along the Brunswick and New Hanover County beaches (Boettcher 1999). A few nests have been observed at the Cape Lookout and Cape Hatteras National Seashore (NCWRC 1999). In North Carolina, the leatherback and hawksbill are known primarily from oceanic waters and are considered to be residents of North Carolina waters only from the spring through the fall (Lee and Palmer, 1981). This finding is supported by a survey sponsored by the NMFS which found no sea turtles in estuarine areas north of Florida in the winter months (Richardson and Hillestad, 1979). Based on these findings, neither species should occur in the project area.

c. **Effect Determination**. Since these species do not occur in vicinity of the proposed project, it has been determined that the proposed harbor improvements are not likely to affect them.

4.02.5 Green, Loggerhead, and Kemp's Ridley Sea Turtles

a. **Status**. Green and loggerhead, Threatened, Kemp's ridley Endangered

b. **Occurrence in Immediate Project Vicinity.** All of these species have been noted to nest in North Carolina. Along the Brunswick County beaches where disposal may occur, there has been a total of 3,111 nests from 1988 to 1998 (Boettcher 1999), or an average of about 280 nests per year. The loggerhead sea turtle is by far the most common nesting species with 3090 nests (99.3%), green turtle with 16 nest (0.5%), 1 Kemp's ridley (<0.1%), and 4 unknowns (0.1%). Nesting occurs between early May and late August with hatching occurring between late July and early December.

In addition to nesting use, all of these species occasionally enter into the lower Cape Fear River estuary. There are no known records of sea turtles in the river within the area proposed for blasting (approximately18 miles upstream of the river mouth); however, there are no known barriers to prevent their entry into, or use of, this region. It is presumed that their scarcity in this area is a reflection of the lower salinity and different food availability in the area.

c. Current Threats to Continued Use of the Area. The primary threats facing these species worldwide are the same ones facing them in the project area. Of these threats, the most serious seem to be loss of breeding females through accidental drownings by shrimpers (Crouse, et al., 1987) and human encroachment on traditional nesting beaches. Other threats to the loggerhead include excessive natural predation in some areas, utilization of eggs as food by humans, and excavation of dredged material with a hopper dredge. With the exception of hopper dredges, none of the dredge plants proposed for use in the construction or maintenance of this project are known to take sea turtles.

d. Project Impacts.

(1) Habitat. All of the non-beach quality dredged material will be placed either in the approved ODMDS or in diked disposal areas. Most of the predominantly sandy dredged material will be placed on area beaches or littoral zone. For Brunswick County these include the beaches from Bald Head Island westward through the middle of Holden Beach. In New Hanover County sandy dredged material could be placed on beaches that have currently approved erosion control and hurricane protection projects at Carolina and Kure Beaches (i.e. USACE 1993 a&b). Additional disposal could occur adjacent to the revetment at Fort Fisher if shoreline monitoring indicates substantial erosion (USACE 1995).

Loss of nesting habitat is also a threat to sea turtles. Most of the Brunswick County beaches have experienced severe erosion because of frequent hurricanes passing over or near the area since 1996 (Bertha, Fran, Bonnie, Dennis, Floyd and Irene). In many locations the dunes have been eroded away, and no locations are available for nesting. The proposed project would place about 6.0 million cubic yards of sand from the excavated channels onto the beaches which would restore much of the turtle nesting habitat lost. The dredged material to be placed on the beaches averages about 90 percent sand. Most of the remaining 10 percent consists of fine grain particles (silt and clay) which will not remain on the beach. These fines may temporarily lead to a darkening of the beach. If this darkening persisted it could raise the temperature of nests in the area, and change the sex ratio of the hatchlings. However, this condition should quickly disappear due to natural sorting process on the beach. If sand compaction in the renourishment area exceeds 500 cone penetrometer units (CPUs), tilling will be performed, and scarps over 18 inches will be graded.

(2) Food Supply. The principal food sources of these species are crustaceans, mollusks, other invertebrates, fish, and plant material (Schwartz, 1977). Dredging will temporarily remove some of these resources from the channel bottom and blasting will impact the fishes within the immediate blasting area. Impacts on river foraging habitat will be minor as dredging and blasting will only affect a limited portion of the estuary. Most of this area is currently experiencing periodic maintenance dredging. Therefore, the project should not significantly affect the food supply of the species in the river.

The Wilmington Offshore Fisheries Enhancement Structure (WOFES) was created eastward of the existing ocean bar channel from rock excavated from the existing ocean bar channel (USACE 1993c). Additional rock may be added to this structure from rock blasted and removed from the river. The new alternative ocean bar channel will pass within about ½ mile of the WOFES. If the WOFES attracts turtles because of a potential increase in food supply from the reef like community, takes of seaturtles may be increased during construction and maintenance of the alternative ocean bar channel.

(3) Relationship to Critical Periods in Life Cycle. All blasting operations will occur between August 1 and January 31. During the late summer season, these sea turtles could be present within the river system. Should they venture into the upper reaches of the river, they could be within the area subjected to the pressure wave from blasting.

Little data is available on the impacts of blasts on sea turtles but they should be similar to bottlenose dolphins (Department of the Navy 1998 and 1999). Some injury can occur to bottlenose dolphins at or above 1.17 in-lb/in^2 (energy flux density)(Department of the Navy 1998 and 1999) or above 5 psi-msec for impulse pressure (Yelverton 1973). The maximum pressure value recorded for energy flux density during test blasting in Wilmington Harbor during the fall/winter of 1998/99 at 560 feet was 0.195 in-lb/in^2, and for impulse was 5.86 psi-msec. These pressure values recorded at 560 feet are near or below the indicated thresholds.

The Young 1991 model is available to estimate a blast safety zone for sea turtles. This model is for blasts in open water, not in rock. As indicated above, the effect of a blast in rock has been calculated to be 0.014 of a blast in open water. In other words a 52 to 62 pound blast in rock is equivalent to a 0.73 to 0.87 pound blast in open water (USACE 1999a). If 0.87 pounds of explosives were used in the Young 1991 model, the safe range for sea turtles would be less than 600 feet.

In order to minimize any potential impacts from rock blasting, pre-blast monitoring is proposed. Pre-blast monitoring will include, at a minimum, deployment of NMFS-approved observers to assure that no sea turtles are present within a 3,500 foot radius of any blast (This distance was developed to avoid harassment of bottlenose dolphin). Should listed species be observed, blasting will be delayed until the species voluntarily leaves the 3,500 foot radius. After blasting, observers will also examine the area to determine if incidental take of sea turtles resulted from a blast.

Removing sediment (silt and sand) in the lower harbor and new ocean bar channel by dredging during construction would take up to about 18 continuous months. Maintenance of the existing ocean bar channel would also be required during this construction period, but would be abandoned following opening of the new ocean bar channel. Because of 18 month construction period, hopper dredging year round is proposed. Without continuous dredging during construction, costs would increase (up to $5.25 million) due to repeated mobilization and demobilization of dredging equipment. We will abide by the provisions of the September 25, 1997 Regional Biological Opinion for The Continued Hopper Dredging Of Channels And Borrow Areas In The Southeastern United States, but because this is a construction project that will move a large volume of sediment

over a period of up to 18 months, we request a separate incidental take. Without this separate incidental take, potential high takes of turtles during maintenance of other projects in the southeast may cause our construction project to shut down resulting in delays and potential additional mobilization/demobilization costs. Future maintenance of the lower harbor and new ocean bar channel would fully comply with the 1997 Regional Biological Opinion.

Beach disposal during construction will be conducted up to a continuous 18 month period which would save up to $5.25 million. However, only a portion of the beach is affected at any point in time (approximately one mile per month). Once disposal passes that point, recovery can begin to occur. All of Bald Head Island, the eastern end of Oak Island, the middle of Oak Island (under another project, USACE 1998), and most of the area of Holden Beach to be nourished, will be nourished during the colder months when sea turtle nesting does not occur. Most of Oak Island will be nourished during the warmer months; therefore, monitoring of nesting activities in this beach nourishment zone would be required. This will include daily surveys beginning at sunrise from May 1 until September 15. Following established protocols, any nests that require relocation will be moved within 6 hours of nest discovery to an approved location. Information on nest relocation and hatching success of all nests will be recorded.

Overall beach disposal effects as a result of harbor maintenance will be less than during construction. Maintenance will only be performed during the colder months, and will only occur on Bald Head Island and within the eastern 25,000 feet of Oak Island. Beach nourishment from maintenance will occur every two years. Current plans are for Bald Head Island to receive dredged material from two consecutive maintenance cycles, with Oak Island receiving dredged material from the third maintenance cycle. Future maintenance is expected to continue this cycle. Both beaches will be monitored for erosion, and disposal will occur in the eroded areas. Disposal in these areas should have the least impact on resources due to the instability of the area because of high erosion rates.

(4) Effect Determination. While it is unlikely that sea turtles will be present in the vicinity of the blasting area, there are no known barriers to prevent their accessing the area. Because of this possibility, observers will be stationed to monitor sea turtle use of the area and delay blasting, if needed. While this measure represents the best available option, there is still the possibility that submerged sea turtles will go undetected within the area impacted by the blast. In addition, even with precautions taken with hopper dredges turtles may still be taken. Not all turtle nests may be located where beach disposal will occur, and survival of moved eggs may be reduced compared to undisturbed nests. For these reasons, it has been determined that the project may adversely affect the loggerhead, kemp's ridley, and green sea turtles.

4.02.6 Shortnose Sturgeon

a. Status. Endangered

b. Occurrence in Immediate Project Vicinity. This species ranges along the Atlantic seaboard from the Saint John River in New Brunswick, Canada, to the Saint Johns River, Florida. The distribution of the shortnose sturgeon in the Cape Fear River basin is not completely documented.

It is apparent from historical accounts that this species was once fairly abundant throughout the State's coastal waters, including the project area. However, in the recent past, this species was thought to be probably extirpated from North Carolina (Schwartz et al., 1977). During the winter of 1986/87, the capture of about 12 to 15 shortnose sturgeon from the Brunswick River was reported by a shad fisherman. One specimen was turned over to the NCDMF for verification and was subsequently placed in the fish collection of the North Carolina State Museum of Natural Science. All other specimens were returned to the Brunswick River. In response to the information that shortnose sturgeon were in the Cape Fear basin, the NCDMF immediately passed a special regulation prohibiting the taking of sturgeon less than 3 feet in length from all parts of the Brunswick, Cape Fear, Black, and Northeast Cape Fear Rivers. It has been reported that about 12 to 15 shortnose sturgeon were captured and released by a shad fisherman in the Brunswick River again in the winter of 1987/88. In 1991, the prohibition on sturgeon take was extended statewide and covers all sturgeons of any size.

Recently, studies of the shortnose sturgeon population in the Cape Fear River system have been conducted by Moser and Ross (1993). This work consisted of a fishery-independent gillnet survey and sonic tracking study, conducted from May 1990 to September 1992, to establish the distribution and movement patterns of shortnose sturgeon and other anadromous fishes in the Cape Fear River estuary. Intensive gillnet sampling (893 net-days) took place within the study area, but only seven shortnose sturgeon were captured, three of the seven were recaptured. No juvenile shortnose sturgeon have been caught in the Cape Fear River basin, which may mean that this species may not be spawning successfully here (Moser and Ross, 1995).

Historically, the shortnose sturgeon probably spawned in the mainstem of the Cape Fear River well upstream of the project area, possibly as far up as Smiley Falls near Lillington. Moser and Ross (1993) postulated that current upstream migrations may be blocked by Lock and Dam No. 1 because the fish arrive too early in the season to benefit from the locking procedures designed to aid anadromous fish passage (March 20 - May 1). Indeed, blocked migration was noted during their study; however, during the frequent spring flooding events migrating adults may be able to pass over the low-head dam and continue upstream.

Modifications to the locking procedures were made at all three locks and a fish ladder installed at Lock and Dam No. 1 in the late 1990's. Prior to implementation of these changes, it was estimated that approximately one third of the American shad population successfully passed upstream of Lock and Dam No. 1 and fewer numbers passed locks 2 and 3. Monitoring of American shad movement upstream after installation of the fish ladder and modification of the locking procedures indicate about two thirds of the shad now pass upstream. While most of this increase was a result of improved fish passage via the lock chamber, a portion of population (about 8%) are using the fish ladder. No sturgeon are expected to pass through the ladder, but the new locking procedures may improve sturgeon passage.

Moser and Ross (1993) observed that shortnose sturgeon appeared to be most active in the night and early morning. When migrating, this species stayed in mid-channel in the upper to middle portion of the water column. During periods of daytime holding, the shortnose sturgeon preferred deep holes.

All of the general life history information which follows is extracted from Dadswell, et al. (1984), except where noted. The species is known to use three distinct portions of river systems: (1) non-tidal freshwater areas for spawning and occasional overwintering; (2) tidal areas in the vicinity of the fresh/saltwater mixing zone, year-round as juveniles and during the summer months as adults; and (3) high salinity estuarine areas (15 parts per thousand (ppt) salinity or greater) as adults during the winter. Variation from this general scheme does exist, however, due to the wide range of habitats available in the major river systems along the Atlantic seaboard. One population, in Holyoke Pool, Connecticut, is totally landlocked.

Upstream spawning migrations by adults are known to begin when water temperatures are approximately 8 to 9 degrees Celsius. In the Cape Fear system, Moser and Ross (1993) detected the onset of spawning migrations in January. Spawning subsequently takes place at temperatures of 9 to 12 degrees Celsius. Spawning temperatures usually occur in February and March in the project area but can occur as early as January or persist into May. The species spawns above the influence of tides in waters which are totally fresh. Here the demersal eggs adhere to the river bottom. Tidal influence extends to the base of Lock and Dam No. 1 on the Cape Fear River (about 40 miles upstream of Wilmington) and to river mile 50 on the Northeast Cape Fear River (about 50 miles upstream of Wilmington). In the Cape Fear River basin, suitable spawning habitat probably also occurs in the Black River, a tributary to the Cape Fear River about 16 miles upstream of Wilmington. The availability of spawning habitat on the main stem of the Cape Fear River may be reduced due to the blockages imposed by the locks and dams on the river.

Post-spawning adults and juvenile young-of-the-year move downstream to tidal areas and concentrate at, or just upstream of, the salt front during the summer months (June through August). This summer concentration zone in Winyah Bay estuary (South Carolina) corresponds to the area with a salinity of 0.5 to 1.0 ppt. Here the juveniles spend the next 2 to 8 years of life, moving up and down stream with the movements of the salt wedge until they reach a size of approximately 45 centimeters. The Cape Fear River estuary is well mixed with no distinct salt wedge. Salinity throughout the project area is highly variable and dependent on freshwater inflow, but can range from near 0 ppt in the vicinity of Wilmington to near 35 ppt in the ocean.

Based on available data, it is impossible to predict when the salinity in the project area will be within the 0.5-1.0 ppt range. However, it is expected that conditions suitable for the concentration of juvenile shortnose sturgeon and the summer concentration of adults exist periodically within the vicinity of Wilmington. As water temperatures begin to cool, adults will be expected to leave the summer concentration zone and move to the lower estuary where salinities typically exceed 15 ppt. This will be expected to occur in September in the project area. Some adults, however, may move back upstream to the spawning grounds in September, remaining there until after the spawning season. Although spawning does not occur within the project area, adult shortnose sturgeon (coming from wintering areas within or downstream of the project area) may pass through the project area from January to April to reach their spawning areas.

c. Current Threats to Continued Use of the Area. Pollution, blockage of traditional spawning grounds, and over fishing are generally considered to be the principal causes of the

decline of this species. The prohibition on taking any sturgeon in North Carolina should help to protect the species from commercial and recreational fishing pressure.

d. Project Impacts.

(1) Habitat. Spawning habitat for the shortnose sturgeon should lie well outside of the project area and should not be affected by this project. Habitat conditions suitable for juveniles and adults could occur within the project area. Juvenile shortnose sturgeon are known to occupy deep water portions (greater than 27 feet) of rivers. Juveniles will therefore be expected to occur within the river channel while within the project area. Adults are found in shallow to deep water (6 to 30 feet) and will be expected to occupy the river channel during the day and the shallower areas adjacent to the channel during the night.

The 96 Act improvements (not the proposed modifications) will deepen about 22.1 acres of estuarine habitat to greater than 10 feet mllw. This loss will be fully mitigated (USACE 1999b). The rest of the project will be essentially deepen current channel bottoms. Due to the apparent preference by the species for deep water habitat, this will not be considered an adverse effect. Potential habitat within the project area will be temporarily disturbed during project construction and maintenance. However, as deep water areas are already disturbed by maintenance dredging and no increase in the frequency of maintenance is proposed, construction and future maintenance will essentially maintain the status quo.

Based on modeling results, deepening the channel under the 96 Act is not likely to alter the location of the salt wedge and thus habitat locations of the sturgeon are not likely to change (USACE 1996b). However, potential changes in salinity patterns will be monitored over the next 10-years beginning in early 2000.

(2) Food Supply. The shortnose sturgeon is a bottom feeder, consuming various invertebrates and occasionally plant material. Adult foraging activities normally occur at night in shallow water areas adjacent to the deep water areas occupied during the day. Juveniles are not known to leave deep water areas and are expected to feed there.

All estuarine bottoms dredged as a part of 96 Act project construction and maintenance will suffer temporary declines in benthic fauna populations in comparison to adjacent undisturbed areas. Existing channel bottoms will continue to be dredged at the same frequency as under existing conditions and will be expected to continue to support benthic populations similar to the existing populations.

Because most of the available shallow water feeding areas adjacent to the channel will not be affected by the project and channel benthic populations should continue to have their existing levels of production, it is believed that the food supply of the shortnose sturgeon will remain essentially at current levels after project construction.

(3) Relationship to Critical Periods in Life Cycle. Because of the mobility of adult and juvenile shortnose sturgeon and infrequent occurrence in the harbor, direct mortality as a result of dredging is not likely to occur. However during November 1995, a sturgeon (probably

Atlantic sturgeon) was captured by a bucket and barge operation in the lower Cape Fear River (NMFS 1998), and infrequently an Atlantic sturgeon is taken by hopper dredging near the mouth of the river. Hydraulic pipeline dredging has occasionally taken shortnose sturgeon in the Delaware River (NMFS 1998). NMFS 1998 also indicated that an Atlantic sturgeon was taken by a hydraulic pipeline dredge in the Cape Fear River, but we are not aware of this incident.

Blasting will occur between August 1 and January 31. Therefore, it is considered possible that adults and juveniles could occur in the project area during blasting. Any fish within the potential lethal zone of the blast could be killed. This lethal zone is defined as the LD1 boundary: outside this boundary, less than 1 percent of the fish are killed.

To determine the impacts of blasting on shortnose sturgeon and size of the LD1 area, test blasting was performed in Wilmington Harbor in the fall/winter of 1998/99. During test blasting, 50 hatchery reared shortnose sturgeon were placed in cages (2 feet diameter by 3 feet long plastic cylinders) 3 feet from the bottom (worst case survival scenario for blast pressure as confirmed by test blast pressure results) at 35, 70, 140, 280 and 560 feet up and downstream of the blast. Also, 200 caged sturgeon were held at a control location about ½ mile from the blast location. The caged fish had mean weight or 55 grams. Sturgeon cages were enclosed in a 0.6 inch nylon mesh sock to prevent any sturgeon from escaping if the cage was damaged. This was necessary for preservation of the genetic integrity of the resident fish population since the hatchery reared shortnose sturgeon were not the same subspecies as the shortnose sturgeon in the Cape Fear River. Stemming and an approximate 25 msec delay between holes were used, but 52-62 pounds of explosives were used per hole (versus 98.5 pounds used in the EIS model, USACE 1996b).

There were 3 test blasts with an air curtain in operation and 4 without an air curtain in operation. An air curtain is a stream of air bubbles created by a manifold system on the river bottom surrounding the blast. In theory, when the blast occurs the air bubbles are compressed, and the blast pressure is reduced outside the air curtain. The air curtain when tested, was 50 feet from the blast.

The caged fish were visually inspected for survival just after the blast and after a 24 hour holding period. The survival pattern just after the blast and after the 24 hour holding period were similar. Survival at the monitoring locations 140 feet and beyond just after the blast (with or without air curtain) was not significantly different. This 140 foot distance would equal 2.1 acres and would be the edge of the LD1. The model used in USACE 1996 a&b indicated that this zone would be 34.5 acres. Therefore, the model overestimated the impact area by about 94 percent (34.5-2.1/34.5). Necropsies performed on the sturgeon also indicate that the impact area would not exceed 2.1 acres (Moser 1999)

The reason for the large reduction in blast effect area is probably due to an underestimate in the EIS model of the reduction of blast effects by confining the explosive in rock. As indicated above, a blast in the rock has been calculated to be 0.014 of a blast in open water. In other words a 52 to 62 pound blasts in rock is equivalent to a 0.73 to .87 pound blast in open water (USACE 1999a).

Before each blast, four (4) sinking gillnets (5.5 inch mesh, 100 meters long) will be set to surround the blast area as near as feasible. These nets will be in place for at least 3 hours

and none of the nets will be removed any sooner than 1 hour before the blast. This will require overnight sets. Any sturgeon removed (shortnose or Atlantic) will be tagged with a t-bar tag, and the sturgeon released in the Brunswick River within 100 meters of the bridge.

Within 10 minutes of each blast, a large mesh (1-2 inch mesh) channel net will be set immediately downstream of the blast area to capture sturgeon that may be injured or killed during blasting.

(4) Effect Determination. Studies and analysis of the life history of the shortnose sturgeon and the physical character of the Cape Fear River estuary indicate that the project area is used by the species. Project construction and maintenance will not result in significant habitat modification and feeding areas will not be significantly affected. Spawning occurs outside of the project area, but adult and juvenile shortnose sturgeon could be present in the project area during construction and maintenance. Since the shortnose sturgeon which occupy the project area are mobile and occur infrequently, they should not be affected by dredging. Any shortnose sturgeon in the potential lethal zone of any given explosion may be lost. In spite of the impact minimization plan described above, impacts to the species could still occur; therefore, it has been determined that the project may adversely affect the species.

4.02.07 Seabeach Amaranth

a. Status. Threatened

b. Occurrence in Immediate Project Vicinity. Seabeach amaranth is an annual or sometimes perennial plant that usually grows between the seaward toe of the dune and the limit of the wave uprush zone. Greatest concentrations of seabeach amaranth occur near inlet areas of barrier islands, but in favorable years many plants may occur away from inlet areas. It is considered a pioneer species of accreting shorelines and stable foredune areas.

Brunswick County has been a stronghold of seabeach amaranth during the 1980's probably because its south facing beaches had experienced relatively little erosion (USFWS 1996b). However beginning with hurricane Hugo in 1989 and the series of hurricanes in 1996, 1998, and 1999, the beaches of Brunswick County have experienced severe erosion. In many locations, the dunes have been lost and erosion has occurred up to the frontal roads. Seabeach amaranth populations have also fluctuated with this erosion. For example on Long Beach, the lowest population of plants form 1992 to 1996 was 1,983 plants (the 1996 survey was prior to hurricanes Bertha and Fran). Following the hurricanes in 1996, the population on Long Beach in 1997 was only 599 plants. In 1998 prior to hurricane Bonnie the number of plants was 5,367 but during the 1999 survey, prior to hurricane Floyd, only 15 plants were found. Due to the severe beach erosion that occurred in 1999 with hurricane Floyd and since 1998 and 1999 were the only years when back to back hurricanes occurred, few plants are likely to be found during the survey in 2000.

c. Current Threats to Continued Occurrence in the Project Area. Beach erosion is probably the primary threat to the continued presence in the area since the population was thriving prior to the recent frequent occurrence of hurricanes. However beach bulldozing and sand fencing by private interests may have affected the population.

d. **Project Impacts.**

(1) **Habitat**. Beach disposal will not occur in the inlet areas where amaranth most commonly occurs. The area proposed for beach disposal is not currently conducive to the growth of seabeach amaranth due to the high erosion and inundation throughout its habitat. Disposal would restore much of the habitat requirements for seabeach amaranth. Indeed, new populations have been observed to follow sand placement on other beaches where sand has been disposed by the Corps of Engineers.

(2) **Relationship to Critical Periods in Life Cycle**. Beach disposal during construction will be conducted up to a continuous 18 month period which would save up to $5.25 million. However, only a portion of the beach is affected at any point in time (approximately one mile per month). Once disposal passes that point, recovery can begin to occur. All of Bald Head Island, the eastern end of Oak Island, the middle of Oak Island (under another project, USACE 1998), and most of the area of Holden Beach to be nourished, will be nourished during the colder months when the plants have not germinated. Most of Oak Island will be nourished during the warmer months. While such disposal is not an ideal management practice for the species, the restoration of the habitat is of prime importance. The project area would be included in the USACE monitoring program during the seabeach amaranth growing season for the life of the beachfill.

Overall beach disposal effects as a result of harbor maintenance will be less than during construction. Maintenance will only be performed during the colder months, and will only occur on Bald Head Island and within the eastern 25,000 feet of Oak Island. Beach nourishment from maintenance will occur every two years. Current plans are for Bald Head Island to receive dredged material from two consecutive maintenance cycles, with Oak Island receiving dredged material from the third maintenance cycle. Future maintenance is expected to continue this cycle. Both beaches will be monitored for erosion, and disposal will occur in the eroded areas. Disposal in these areas should have the least impact on resources due to the instability of the area because of high erosion rates.

(3) **Effect Determination**. While beach renourishment will restore much of the habitat lost to erosion, disposal on a portion of the beaches in the growing season during project construction may slow population recovery over the short term. Therefore, the project may affect seabeach amaranth.

5.00 COMMITMENTS TO REDUCE IMPACTS TO LISTED SPECIES

The following list is a summary of environmental commitments to protect listed species related to the construction and maintenance of the proposed project. These commitments address agreements with agencies, mitigation measures, and construction practices.

1. Blasting will be restricted to the months of August through January.

2. A blast delay of approximately 25 msec per hole and stemming each hole will still be required.

3. Before each blast, four (4) sinking gillnets (5.5 inch mesh, 100 meters long) will be set to surround the blast area as near as feasible. These nets will be in place for at least 3 hours and none of the nets will be removed any sooner than 1 hour before the blast. This may require overnight sets. Any sturgeon removed (shortnose or Atlantic) will be released in the Brunswick River within 100 meters of the bridge.

4. Within 10 minutes of each blast, a large mesh (1-2 inch mesh) channel net will be set immediately downstream of the blast area to capture fish that were injured or killed during blasting. The efficacy of the channel net to catch fish injured by blasting will be tested by release of locally captured species (e.g. spot, croaker or similar species).

5. Pre-blast surveys (vessel) for sea turtles, manatees, and dolphins will be conducted one hour before the blast to ensure no turtles or manatees or other marine mammals are within the blasting zone (3,500-foot radius). If a sea turtle, manatee, or dolphin is within 3,500 feet of the blast site, blasting will be delayed until the animal voluntarily departs the blasting zone. Post-blast surveys will also be conducted for 1/2 hour after each blast to determine if any sea turtles, manatees, or dolphins were injured.

6. Scare charges will be used for each blast. A scare charge is a small charge of explosives detonated immediately prior to a blast for the purpose of scaring aquatic organisms away from the location of an impending blast. Two scare charges will be used for each blast. The detonation of the first scare charge will be at 45 seconds prior to the blast, with the second scare charge detonated 30 seconds prior to the blast. Some marine mammals and fish may not locate the origin of the first scare charge. The second scare charge allows these creatures to better locate the source of the charge and maneuver away from the source.

7. Hopper dredging activities will comply with the turtle deflecting draghead, observers, and whale protective measures in NMFS 1997.

8. In order to determine the potential taking of shortnose sturgeon and other species by bucket and barge operations, observers will be on board the bucket and barge during for the first full year of construction. To the maximum extent feasible, the observers will record all species captured along with length and weight and any unusual circumstances that might have led to the species capture.

9. If a manatee is observed within 100 yards of dredging operations, all operations will cease until the manatee has left the area.

10. Since disposal on the beaches would occur year round during construction, monitoring of sea turtle nesting activities in beach nourishment areas is required. This will include daily surveys beginning at sunrise from May 1 until September 15. Any nests that require relocation will be moved within 6 hours of nest discovery. Information on nest relocation and hatching success of all nests will be recorded. If sand compaction in the renourishment area exceeds 500 cone penetrometer units (CPUs), tilling will be performed. The beach will be monitored for escarpment formation prior to each nesting season. If an escarpment exceeds 18 inches, then it will be leveled.

6.0 SUMMARY EFFECT DETERMINATION

It has been determined that the project, as currently proposed, may adversely affect the piping plover, green sea turtle, loggerhead sea turtle, Kemp's ridley sea turtle, shortnose sturgeon, and seabeach amaranth.

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APPENDIX F

SCOPING LETTERS & LIST OF RESPONDENTS

DEPARTMENT OF THE ARMY
WILMINGTON DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1890
WILMINGTON, NORTH CAROLINA 28402-1890

IN REPLY REFER TO

28 January 1999

Environmental Resources Section

Dear Sir or Madam:

The Wilmington District, U. S. Army Corps of Engineers, will soon complete the planning and design for congressionally authorized improvements for Wilmington Harbor, North Carolina, that are scheduled to start construction in September 2000. The improvements will reduce shipping costs by alleviating navigation constraints that now require larger vessels to leave the harbor lightloaded or to wait for high tide. Consequently, the economic viability of the port will improve. Details of the improvements have been planned, designed, and coordinated with the public over a period of several years. As a result, the overall plan is comprehensive and addresses the many needs and concerns identified. However, additional engineering, economic, and environmental analysis has led us to propose a new alignment for the entrance channel through the ocean bar (Baldhead Shoal Channel). We are now requesting comments from agencies, interest groups, and the public to identify and discuss significant resources and issues related to selection of a preferred alignment for this entrance channel.

The existing plan integrates harbor improvements that were recommended and approved separately as the (1) Wilmington Harbor - Northeast Cape Fear River project; (2) Wilmington Harbor - Channel Widening project; and (3) Cape Fear - Northeast Cape Fear Rivers project. This plan provides for increasing the authorized navigation depth of the 40-mile-long channel from the Atlantic Ocean to the Port of Wilmington by 4 feet and widening selected portions of the project. It includes authorized project depths to -44 feet mean lower low water (m.l.l.w.) through the ocean bar, then -42 feet m.l.l.w. up the Cape Fear River to and including the Anchorage Basin immediately upriver from the State Ports Authority (SPA) dock, then -38 feet m.l.l.w. upstream into the Northeast Cape Fear River to 750 feet beyond the Hilton Railroad Bridge, and finally -34 feet m.l.l.w. upriver to the turning basin near the upstream limits of the project. In addition, an overdepth zone of 2 feet is allowable for dredging inconsistencies throughout the project length, and 1 foot of additional overdepth is required in areas of rock. Project horizontal expansions include: widening Lower Midnight, Upper Midnight, and Lower Lilliput Channels from 400 to 600 feet over a distance of 6.2 miles; widening five turns and bends by 100 to 200 feet; widening the Fourth East Jetty Channel from 400 to 500 feet over a span of 1.5 miles; extending the Anchorage Basin near the SPA upstream 300 feet; widening the channel in

the Northeast Cape Fear River from 200 to 250 feet, starting 750 feet upstream of the Hilton Railroad Bridge and proceeding upstream to the turning basin near the project limits; and widening this turning basin from 700 to 800 feet. General geographic features of the harbor are shown in *figure 1.*

Sediments dredged from the upper harbor in the vicinity of the SPA and downtown Wilmington will be placed in diked upland sites at Eagle Island and Point Peter. Material from the middle and lower harbor may be transported to a proposed new Ocean Dredged Material Disposal Site (ODMDS) located about 6 to 10 miles offshore from Baldhead Island, or, if the material is beach-compatible sand, it may be deposited on nearby beaches. While the harbor improvements are economically justified based upon this disposal plan, considerable cost savings are likely if a new diked disposal facility could be made available near Snows Cut to accommodate mid-harbor sediment rather than transporting it the long distance to the ocean. Due to the complexity of the issues and the length of time necessary to develop a plan for such a new diked disposal facility, this concept will be addressed in a separate study in the near future. Mr. Frank Yelverton of this office (telephone 910/251-4640) will coordinate that study.

The existing plan for the ocean bar channel is to deepen it along its current alignment and to extend its present length of 5.8 miles to a new total length of 9.3 miles seaward from the inlet. However, this path passes through very hard rock bottom. During 1996 and 1997, we attempted to deepen the existing channel to -40 feet m.l.l.w. by rock dredging but achieved only limited success. We have determined that further deepening would require extensive blasting and would be very slow and expensive. In addition, ocean bottom surveys conducted in 1998 revealed that the seaward extension of the present channel would pass through a substantial amount of live coral and other valuable live hard bottoms. We have searched for a more cost effective and environmentally acceptable alternative and have identified a new channel corridor that avoids rock and coral/live bottoms and reaches deep water of the Atlantic Ocean in a shorter distance (*figure 2*). We are now conducting studies and analyses to assist in the refinement of this channel alignment. Ship simulation studies are being conducted, with assistance from the river pilots to help determine the optimal location and angle for a new channel bend that may be required. Sediment budgets are being developed and will be used with wave and current studies to evaluate the impacts of various channel alignments on littoral processes over time. Assessments will also be made of the effects of channel alignment on erosion rates at nearby beaches and whether mitigation may be required to offset associated sand losses. The answers to these and other pertinent questions will be developed over the next several months.

Construction of the ocean entrance channel along an alternative alignment is expected to require removal of approximately 10 million cubic yards of sediments consisting of sands, silts, and clays. Approximately 550 acres of existing ocean bottom habitat would be disturbed along the 6.7 mile channel and its side slopes. In addition, annual maintenance dredging would likely produce about 1 million cubic yards of material per year. Depending upon the final alignment selected, these estimated quantities may change. Material dredged from the new channel would be placed at the proposed ODMDS, or if sand of sufficient quality and quantity could be obtained, it may be cost effective to place it on the beach(es) at Bald Head Island and/or Oak Island. Dredging operations may utilize hydraulic pipeline or hopper dredges, bucket and barge dredging, or spider barges.

Channel construction and maintenance could cause adverse impacts on significant resources present in the vicinity. These may include: endangered/threatened species; marine, estuarine, and beach habitat; marine and estuarine life; cultural resources, including important historic shipwrecks; recreational and commercial fisheries; and water quality. In addition, the alternative channel alignment would pass through the existing ODMDS rendering part of it no longer serviceable and requiring a new ODMDS, as noted above. The environmental impacts of the alternative channel alignment would be partially offset by gradual reversion of the existing ocean bar channel to a natural condition after its maintenance dredging ceases. In addition, the plan would be dropped to extend the existing channel 3.5 miles seaward through live coral and other live hard bottom.

In summary, we believe that an alternative channel alignment would be advantageous for a number of reasons. These include: (1) avoiding rock bottom with a resulting estimated saving of over $40 million in channel construction cost; (2) avoiding coral/live hard bottom in the path of extending the existing alignment; (3) shortening the distance to natural deep water (i.e., the -46-foot contour) to about 6.7 miles rather than 9.3 miles on the existing alignment; (4) avoiding the need for rock blasting and its associated environmental impacts; (5) reducing channel construction time; (6) avoiding 1 foot of extra overdepth that would be required in areas where the channel bottom is rock; and (7) locating the channel where future deepening, if required, would not be restricted by rock.

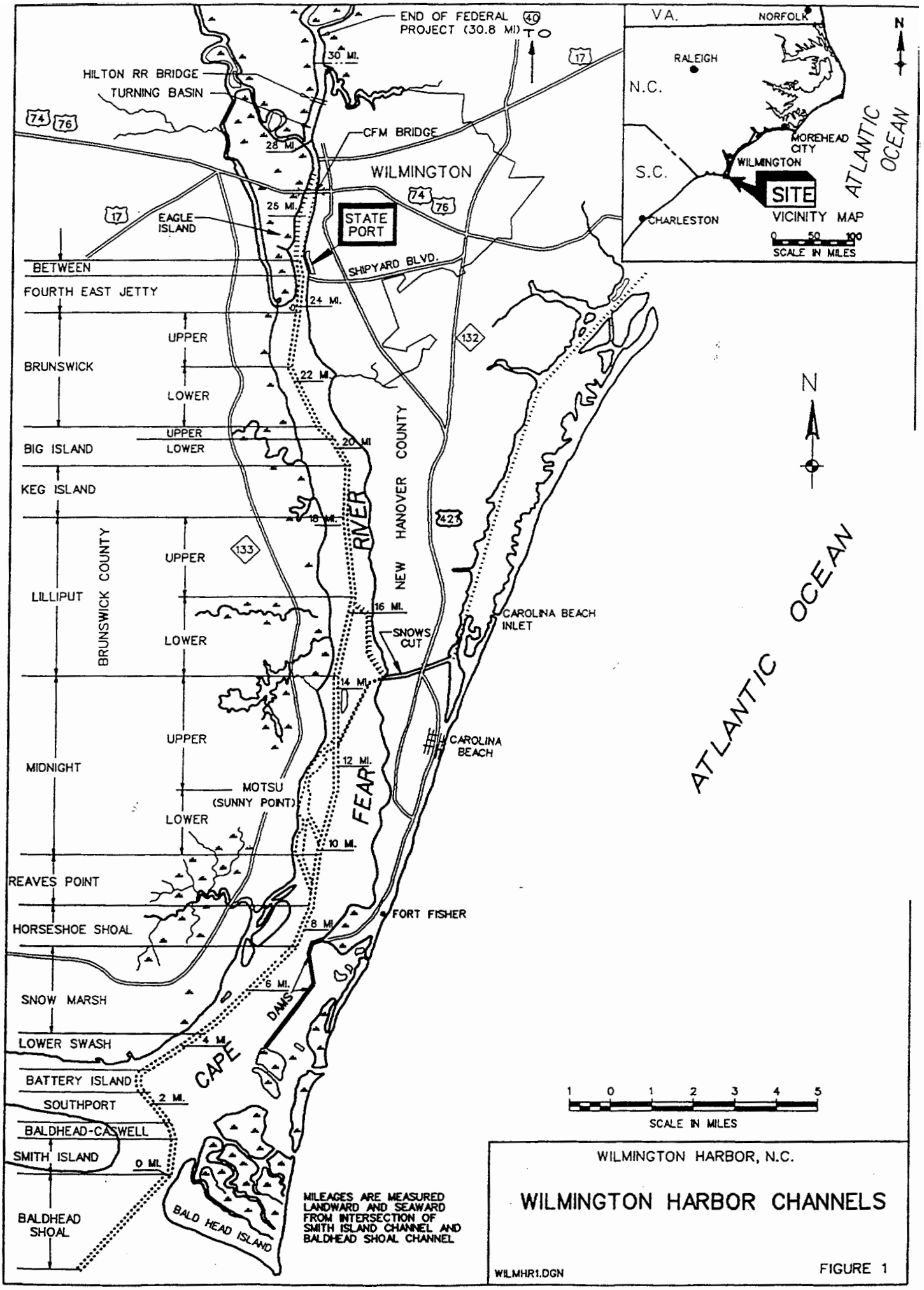
Potential disadvantages of this plan include: (1) creating another channel bend affecting navigation; (2) environmental impacts of dredging along a new path on the ocean floor; (3) potential temporary interruptions of fishing/shrimping activities; (4) alignment of the new channel through the existing ODMDS; and (5) potential alteration of wave and current effects on channel shoaling and/or shoreline erosion at nearby beaches.

Written comments are requested on any of these matters. Responses to this letter will be considered during our selection of a final channel alignment and our assessment of potential impacts on the environment. Significant issues will be addressed, as appropriate, in an Environmental Assessment or Environmental Impact Statement. Letters should be addressed to the District Engineer, Attention: Mr. John Meshaw (CESAW-TS-PE), U.S. Army Corps of Engineers, Wilmington District, Post Office Box 1890, Wilmington, North Carolina 28402-1890. Please send your comments to arrive within 30 days from the date of this letter in order that they may be considered during our evaluations and decision process. If you need additional information, please contact Mr. Meshaw at (910) 251-4175.

Sincerely,

W. COLEMAN LONG
Chief, Planning & Environmental Branch

Enclosure

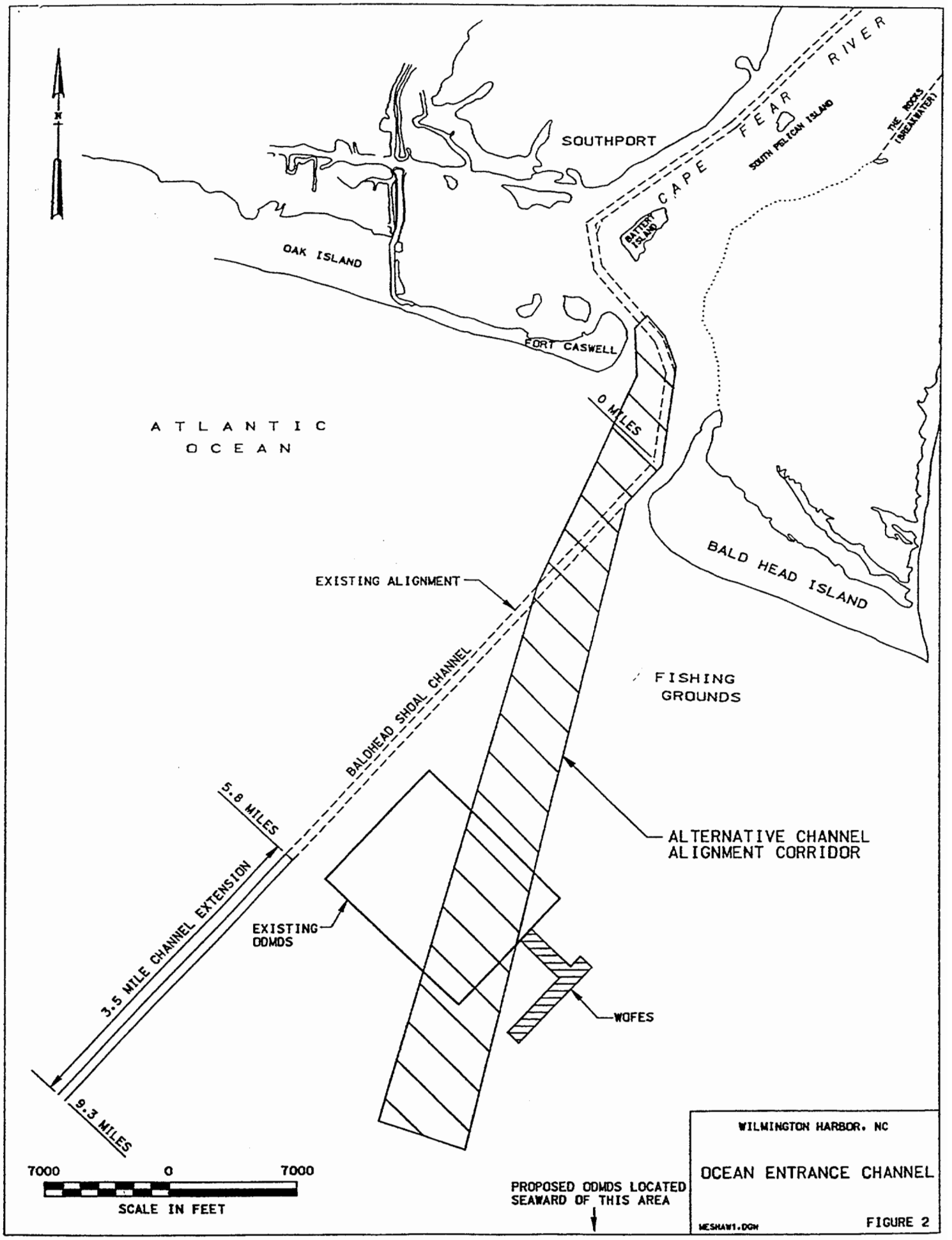


WILMINGTON HARBOR, N.C.

WILMINGTON HARBOR CHANNELS

WILMHR1.DGN

FIGURE 1


N
SOUTHPORT
CAPE FEAR RIVER
SOUTH PELICAN ISLAND
THE ROCKS (BREAKWATER)
BATTERY ISLAND
OAK ISLAND
FORT CASWELL
ATLANTIC OCEAN
0 MILES
BALD HEAD ISLAND
EXISTING ALIGNMENT
BALDHEAD SHOAL CHANNEL
FISHING GROUNDS
5.8 MILES
ALTERNATIVE CHANNEL ALIGNMENT CORRIDOR
3.5 MILE CHANNEL EXTENSION
EXISTING ODMDS
WOFES
9.3 MILES
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SCALE IN FEET
PROPOSED ODMDS LOCATED SEAWARD OF THIS AREA
WILMINGTON HARBOR, NC
OCEAN ENTRANCE CHANNEL
MESHAW1.DGN
FIGURE 2

DEPARTMENT OF THE ARMY
WILMINGTON DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1890
WILMINGTON, NORTH CAROLINA 28402-1890

June 22, 1999

IN REPLY REFER TO

Environmental Resources Section

Dear Sir or Madam:

On January 28, 1999, the U. S. Army Corps of Engineers, Wilmington District, sent a letter to agencies and the public requesting comments regarding our proposed new alignment for the Wilmington Harbor Ocean Bar Channel (figure 1). That letter summarized the economic and environmental factors supporting a new channel alignment. It also stated that construction of the 6.7-mile channel would require removal of approximately 10 million cubic yards of sediments, and that annual maintenance dredging would likely produce about 1 million cubic yards of sediment per year. Area beaches were mentioned as potential sites to receive dredged sediment, if sand of sufficient quality and quantity could be obtained. This letter is to provide updated information regarding potential beneficial uses of sediment to be dredged from the ocean bar channel. We are also requesting comments from agencies, interest groups, and the public on any aspect of these potential beneficial uses.

Several possible channel alignments within the selected corridor are being evaluated relative to navigation safety, construction and maintenance cost, and maintenance requirements. The alternative that currently appears optimal based upon this combination of factors would result in an initial requirement to dredge approximately 12 million cubic yards of sediment, of which the sand portion is estimated to be about 8 million cubic yards. Ongoing studies and coordination for potential beach nourishment projects at Bald Head Island, Caswell Beach, Yaupon Beach, Long Beach, and Holden Beach indicate that all of this sand could be beneficially used by the beaches of Brunswick County (figure 2). This alternative would be preferable to placement of sand in the littoral zone or the Wilmington Ocean Dredged Material Disposal Site (ODMDS), which are the other available alternatives.

Our dredging operations that involve beach placement of sand are usually conducted after November 15 and before March 30, to the extent practicable, in order to avoid the nesting periods of sea turtles and shorebirds. However, the placement of the large volume of sand associated with the channel realignment is estimated to require about 24 consecutive months for a single dredge plant. We are evaluating the costs and logistics for alternative methods of accomplishing this work in order to minimize potential effects on sea turtles and shorebirds. Possible solutions could involve multiple dredge plants, seasonal dredging only, or scheduling summer beach disposal in less sensitive areas. It may be possible that placement of sand on beaches could be limited to the area below the high tide line, which could significantly reduce

potential impacts to sea turtles and nesting shorebirds. Costs, benefits to beaches, and environmental concerns will need to be balanced to achieve an acceptable solution to this problem. Input from Federal and state agencies and the beach communities will be important as plans are developed.

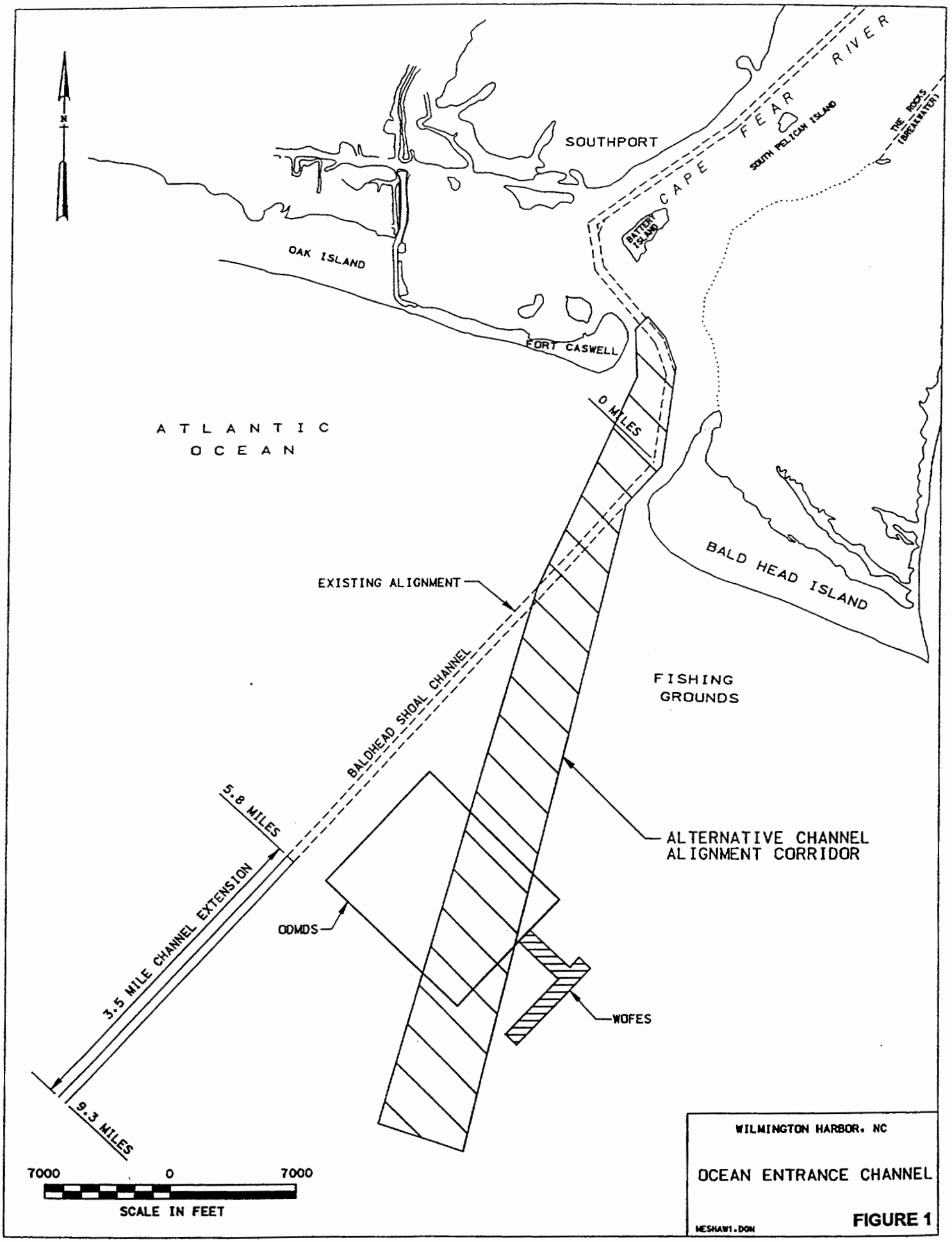
After the Wilmington Harbor Ocean Bar Channel is constructed along its new alignment, its continued annual maintenance is expected to yield sandy sediment suitable for beach placement and silty material that is not of beach quality. Beach quality sand could be made available for placement on area beaches, or be placed within the nearshore littoral zone or the ODMDS. The silty sediments derived from other portions of the new ocean bar channel are proposed to be used beneficially to refill the old ocean bar channel. This refilling process would occur over a period of years and would accelerate the shoaling process which would occur naturally in the abandoned channel. As a result, the ocean bottom would become flatter more quickly. This is expected to benefit the commercial fishing industry because trawling activities could likely be resumed along the old channel alignment.

Written comments are requested regarding any of these matters. Letters should be addressed to the District Engineer, Attention: Mr. John Meshaw (CESAW-TS-PE), U.S. Army Corps of Engineers, Wilmington District, Post Office Box 1890, Wilmington, North Carolina 28402-1890. Please send your comments to arrive within 30 days from the date of this letter in order that they may be considered during our evaluations and decision process. If you need additional information, please contact Mr. Meshaw at (910) 251-4175.

Sincerely,

W. Coleman Long
Chief, Technical Services Division

Enclosures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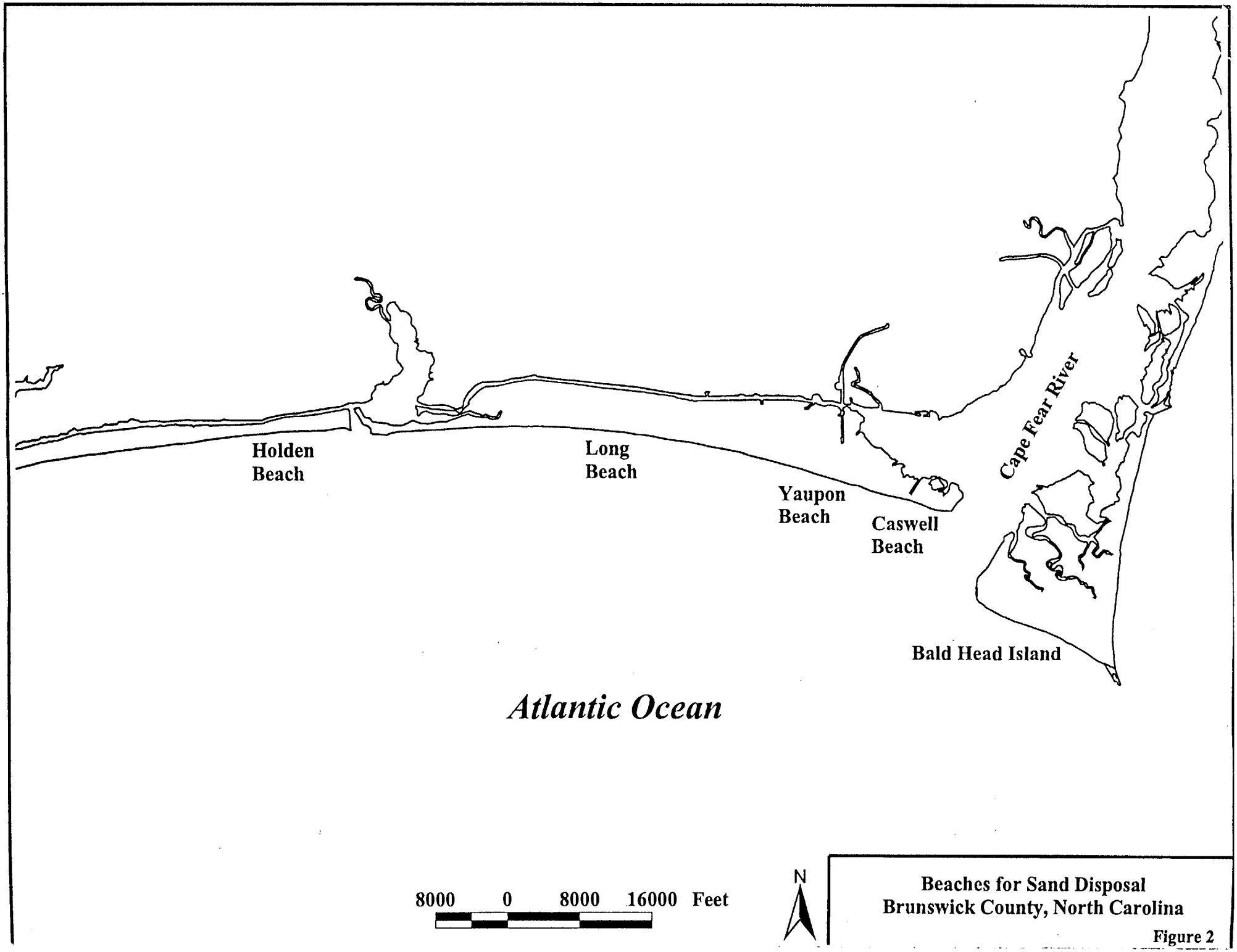
SOUTHPORT
CAPE FEAR RIVER
SOUTH PELICAN ISLAND
THE ROCKS (BREAKWATER)
BATTERY ISLAND
OAK ISLAND
FORT CASWELL
0 MILES
ATLANTIC OCEAN
BALD HEAD ISLAND
EXISTING ALIGNMENT
BALDHEAD SHOAL CHANNEL
FISHING GROUNDS
5.8 MILES
3.5 MILE CHANNEL EXTENSION
ALTERNATIVE CHANNEL ALIGNMENT CORRIDOR
ODMDS
WOFES
9.3 MILES
7000 0 7000
SCALE IN FEET
WILMINGTON HARBOR, NC
OCEAN ENTRANCE CHANNEL
MESHAW1.DGN
FIGURE 1



Beaches for Sand Disposal
Brunswick County, North Carolina

Figure 2

RESPONDENTS TO SCOPING LETTERS

USACE Scoping Letter of 28 January 1999

- Letters of response received from the following:
  - National Marine Fisheries Service, Southeastern Regional Office
  - N.C. Department of Administration (State Clearinghouse)
  - N.C. Department of Environment, Health, and Natural Resources
  - N.C. Division of Coastal Management
  - N.C. Division of Water Quality
  - N.C. State Deputy Historic Preservation Officer
  - N.C. Wildlife Resources Commission
  - Olsen Associates, Inc. (consultant to Village of Bald Head Island, NC)

- Phone Call / Email received from the following:
  - U.S. Fish & Wildlife Service, Raleigh, NC Field Office

USACE Scoping Letter of 22 June 1999

- Letters of response received from the following:
  - Brunswick Beaches Consortium
  - National Marine Fisheries Service, Southeastern Regional Office
  - N.C. Department of Administration (State Clearinghouse)
  - N.C. Department of Cultural Resources
  - N.C. Department of Environment, Health, and Natural Resources
  - N.C. Division of Water Quality
  - N.C. Wildlife Resources Commission, 2 letters
  - Olsen Associates, Inc. (consultant to Village of Bald Head Island, NC), 2 letters
  - U.S. Department of Agriculture. Natural Resources Conservation Service
  - U.S. Fish & Wildlife Service, Raleigh, NC Field Office

- Phone Call / Email received from the following:
  - National Marine Fisheries Service, Beaufort Marine Fisheries Center
  - Town of Carolina Beach, Town Manager
  - U.S. Environmental Protection Agency, Region IV

APPENDIX G

SUPPLEMENTAL
FISH & WILDLIFE COORDINATION ACT REPORT

U.S. DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

WILMINGTON HARBOR, NORTH CAROLINA, 96 ACT
NEW HANOVER AND BRUNSWICK COUNTIES,
NORTH CAROLINA. SUPPLEMENT TO THE FINAL
FISH AND WILDLIFE COORDINATION ACT REPORT

Raleigh Field Office
551 F Pylon Drive
Post Office Box 33726
Raleigh, North Carolina 27636-3726

WILMINGTON HARBOR, NORTH CAROLINA, 96 ACT
NEW HANOVER AND BRUNSWICK COUNTIES,
NORTH CAROLINA. SUPPLEMENT TO THE FINAL
FISH AND WILDLIFE COORDINATION ACT REPORT

Prepared by
Tracy M. Rice and Howard F. Hall

Under the Supervision of
Garland B. Pardue
Ecological Services Supervisor

Released by
U. S. Fish and Wildlife Service, Raleigh Field Office
Raleigh, North Carolina

December 1999

EXECUTIVE SUMMARY

Wilmington Harbor is a Federal navigation project which extends from the Atlantic Ocean up the Cape Fear River to points above the City of Wilmington on both the Cape Fear and Northeast Cape Fear Rivers. The State of North Carolina operates a port facility in Wilmington. Local interests expressed concern that existing channel depths are not adequate for ships calling at the port. Current channel depths require some shippers to light-load vessels and wait for tidal advantage to enter the port. Due to these depth constraints, shipping costs are increasing. In order to address these issues, the Committee on Public Works and Transportation, U.S. House of Representatives, authorized a study to investigage the feasibility of improving Wilmington Harbor on September 8, 1988. In response to this authorization; the Wilmington District, U.S. Army Corps of Engineers (Corps) undertook studies on modifications to the navigation project.

This report is provided under authority of Section 2(b) of the Fish and Wildlife Coordination Act (FWCA) of 1958 (48 Stat. 401, as amended; 16 U.S.C. 661-667d). The FWCA established fish and wildlife conservation as a coequal objective of federally funded or permitted water resources development projects. Consultation during project planning is intended to allow state and federal resource agencies to determine the potential adverse impacts on fish and wildlife resources and develop recommendations to avoid, minimize, and/or compensate for detrimental impacts.

The existing Federal project consists of a channel 40 feet deep and 500 feet wide from the Atlantic Ocean through the ocean bar (Bald Head Shoal and Smith Island Channels) and entrance channels (Bald Head-Caswell, Southport, and Battery Island Channels). However, the authorized depth has not been achieved in the ocean bar channel due to dredging inaccuracies and rock obstructions. In the main river channel from Lower Swash Channel to the Cape Fear Memorial Bridge in Wilmington the authorized channel is 38 feet deep and 400 feet wide. From the Cape Fear Memorial Bridge to the Hilton Railroad Bridge over the Northeast Cape Fear River the authorized channel is 32 feet deep and 400 feet wide. From the Hilton Railroad Bridge to a point 1.7 miles up the Northeast Cape Fear the authorized channel is 25 feet deep and 200 feet wide.

This report reviews supplemental modifications to the Wilmington Harbor, North Carolina, 96 Act Project proposed since the Service's most recent report on the project, the Cape Fear-Northeast Cape Fear Rivers Comprehensive Study, New Hanover and Brunswick Counties, North Carolina, Final FWCA Report of May 1996. The six proposed modifications are: (1) construction and maintenance of the harbor entrance channel (Bald Head Shoal Channel) along a new alignment through the ocean bar to the northeast; (2) backfilling the abandoned portion of the old ocean bar channel with material unsuitable for beach or littoral zone placement; (3) placement of sand dredged from the ocean bar channel, riverine channels upstream through Reaves Point channel, and/or the larger sandy disposal islands of the lower Cape Fear River on

area beaches or in the littoral zone; (4) placement in the Offshore Dredged Material Disposal Site (ODMDS) of all dredged sediment that does not go to the beaches, the littoral zone, or abandoned channel; (5) establishment of a clear, comprehensive plan for utilization of all types of dredging equipment and disposal alternatives that are appropriate for use in each specific portion of the project; and (6) reduction in the area requiring blasting, number of blasts, and size of each blast, plus elimination of the bubble curtain to protect aquatic resources during blasting.

The proposed modifications would occur in four general ecological communities. These are: (1) the offshore marine areas where a new channel would be constructed and sediments would be disposed; (2) the beaches where sand would be deposited; (3) nearshore marine communities, including hardbottoms, that would be impacted by beach disposal; and, (4) riverine areas where the existing channel would be modified by dredging, blasting, infilling, and the movement of dredged material.

The offshore and nearshore areas in Brunswick and New Hanover Counties are dominated by their underlying geology, with hardbottoms of limestone and sandstone alternately exposed or covered by a thin veneer of sandy or muddy sediments of varying thicknesses. Most of the beaches in the region are barrier islands, some of which are also controlled by their underlying geology. Carolina and Kure Beaches are not on a barrier island, but rather a portion of the mainland that has been separated into an artificial island by the Atlantic Intercoastal Waterway. Rock, peat and mud occasionally outcrop on most of the beaches in the study area. The Cape Fear River estuary supports a variety of fish and wildlife habitats, including spoil islands used by colonial waterbirds, wetlands and aquatic nursery areas.

The major concerns of the Service center on the following potential adverse impacts:

- The new channel alignment may accelerate erosion on nearby beaches by disrupting the existing longshore sediment transport system at the mouth of the Cape Fear River and result in the loss of sea turtle nesting habitat;

- Sediment deposition on area beaches may diminish the habitat quality for nesting sea turtles and adversely affect populations of beach invertebrates;

- Sediment deposition on area beaches may result in turbidity and siltation in nearshore areas that adverse affect important hardbottom habitat;

- The increased extent of overflowing scows or barges carrying sediment may reduce water quality and adversely affect fish and other aquatic organisms as well as estuarine habitats such as primary nursery areas, and;

- The elimination of the bubble curtain around blast areas in the river will kill some fish.

In light of these concerns, the Service proposes the following planning objectives for this project:

1. Construction and maintenance of a new alignment for the harbor entrance channel with a minimum of short- and long-term adverse environmental impacts;

2. Ensure proper timing for beach disposal such that it will not result in significant adverse environmental impacts to marine and estuarine organisms or unique habitats (e. g., hardbottoms).

3. Beach disposal should incorporate design features and construction techniques which would minimize alterations of natural coastal geologic processes and maintain the water quality of the area.

4. All dredging operations and sediment movement procedures should maintain and enhance existing water quality within the project area and adjacent waters of the Cape Fear and Northeast Cape Fear Rivers, including designated primary and secondary nursery areas.

5. If the revised procedures used to modify the existing navigation channel in the Cape Fear River, especially blasting, will result in mortality of aquatic organisms, project plans should include specific mitigation measures to ensure that these resources do not suffer a decline in abundance.

Descriptions of natural resources within the study area and the assessment of project impacts are based on previous studies for similar projects, published literature, and personal communications with knowledgeable individuals.

The estuarine and marine fish fauna within the project area is varied. The Cape Fear River and nearby ocean waters are utilized by a diverse group of invertebrates and fish species. The endangered shortnose sturgeon is found within the Cape Fear River estuary. Offshore bottoms provide habitat for coastal demersal fishes. Hardbottoms found off the North Carolina coasts support a rich diversity of invertebrates such as corals, anemones, and sponges which are refuges for fish and other marine life. There are more than 300 species of reef fish along the South Atlantic and some of these species may expected at hardbottoms off North Carolina.

Hardbottoms with their associated assemblage of benthic flora and fauna can be found throughout the project area. The rock substrate found in these exposed benthic environments provides habitat for many sessile fauna including coral, sponges, algae, sea whips, and anemones. Over 300 species of fish and hundreds of thousands of different invertebrates may be found in hardbottom/reef areas.

Marine mammals occur in offshore and inshore waters of North Carolina. Twenty-nine species of cetaceans have been recorded along the coast of the Carolinas, Virginia, and Maryland. Dredging of the Wilmington Channel in January 1995 encountered several humpback whales. Bottle-nosed dolphins are common in this area.

The West Indian manatee, an endangered species, may move north along the Atlantic Coast and occasionally make their way into the coastal waters of North Carolina. At least five sightings of this endangered species have been documented in the project area since 1952.

All five Atlantic sea turtles may occur in the coastal waters of North Carolina. The presence of sea turtles in nearshore and estuarine waters of North Carolina appears to be seasonal. Sea turtles are present in the offshore water of North Carolina throughout the year and present in inshore waters from April through December. The loggerhead sea turtle is the most common sea turtle along the North Carolina coast. During the twelve-year period of 1988-1999, 3,343 loggerhead nests were reported in the area under consideration for dredge disposal. In addition to the loggerhead nests, 13 green and one Kemp's ridley sea turtle nests have occurred over the same time period in the project area.

Seabeach amaranth habitat exists on the beaches proposed for dredge disposal of sediments. This threatened annual plant prefers overwash areas on accreting barrier island spits. Thousands of individuals have been documented to occur in the project area on an annual basis.

Four pairs of piping plovers nested on Holden Beach near Shallotte Inlet in 1993, just east of the project area. The Service lists the areas of Holden Beach and Long Beach surrounding Lockwood Folly Inlet as actual or potential nesting sites in the 1996 Recovery Plan for this threatened bird.

The dredge spoil islands found in the project area provide nesting, foraging and loafing habitat for many species of colonial waterbirds.

The sandy beaches contain a diverse assemblage of invertebrate species that include the coquina clam, mole crab, ghost crab, and polychaete worms. Shorebirds prey on these invertebrates as well as loaf or nest on the beaches.

Future abundance, quality, and diversity of the study area's fish and wildlife resources will be largely determined by management activities of Federal, State, County, and local regulatory agencies within the study area and within the larger area of the Cape Fear River watershed. In the absence of the proposed project modifications, the original project considered by the Service in the mid-1990s would be implemented.

Each design and construction feature of the original project that was considered for modification has a single change proposed. The single change proposed was adopted as the preferred alternative, or preferred modification.

The selection of each proposed modification was considered separately and the selection criteria varied. The new alignment was selected to reduce cost and to avoid the environmental damage of rock blasting. The backfilling of the abandoned channel was based on both the need for a disposal site and the possibility of creating benthic habitat. The decision to place sediment on

area beaches was a response to the desires of local interests. Future sediment disposal at the ODMDS will essential constitute a continuation of present procedures. The expansion of existing dredging methods is an effort to reduce project costs. The elimination of the bubble curtain resulted from test data that indicate this measure to be ineffective in protective aquatic organisms from underwater blast impacts.

The six major project modifications are described in detail in the appendices of this report. In short, the Corps would:

- construct and maintain the harbor entrance channel (Baldhead Shoal Channel) along a new alignment through the ocean bar;
- place sand dredged from the ocean bar channel, riverine channels upstream through Reaves Point channel, and/or the larger sandy disposal islands of the lower Cape Fear River on area beaches or in the littoral zone;
- backfill the abandoned portion of the old ocean bar channel with material unsuitable for beach or littoral zone placement;
- place all dredged sediment that does not go to the beaches, the littoral zone, or abandoned channel in the ODMDS;
- establish a clear, comprehensive plan for utilization of all types of dredging equipment and disposal alternatives that are appropriate for use in each specific portion of the project; and,
- eliminate the bubble curtain that had been proposed as a protective device around underwater blasts in the Cape Fear River.

The environmental impacts of creating a new alignment for the ocean entrance channel would be similar to those associated with offshore dredging for beach nourishment material. The operation would eliminate shallow marine bottoms and create turbidity that could result in harmful sedimentation on nearby habitats. Allowing the abandoned channel to refill with natural inflows of sediment and placing material too fine for beach disposal in the channel may not create benthic habitat similar to that lost in the construction of the new alignment. If finer-grained material fills in this channel, the physical characteristics of the substrate may not be suitable for the organisms that utilize natural marine bottoms in the area. Sediment placement on area beaches may produce a deterioration of nearshore habitat quality due to long-term turbidity from the artificial beach-dune system; a reduction in beach invertebrate populations, reduced sea turtle nesting success; and disruption of shorebird feeding and roosting. The movement of sediment from existing spoil island may disrupt colonial waterbird nesting. The expansion of dredging methods may increase turbidity and sedimentation within the Cape Fear River that is harmful to fish and other aquatic organisms.

The comparison of impacts involves essentially the impacts of the project as originally proposed and the impacts of the modifications under consideration. The construction of the entrance channel on a new alignment would impact previously undisturbed ocean bottoms. In general, the

Service supports the use of previously disturbed areas rather than the use of new alignments. However, the environmental impacts associated with modifying the existing channel would be substantial if extensive blasting is required.

The original plans would enlarge the existing alignment and the refilling of this channel would not be an issue. If the existing channel is allowed to naturally fill with what is likely to be finer grained material than what occurs locally, the proposed change would produce an overall adverse impact of the marine benthic community. Also, the time to fill in the channel with naturally deposited sediment may take many years, postponing the return of the abandoned channel to more natural conditions. If the abandoned channel is artificially refilled with sediment matching the native grain sizes in adjacent areas, the physical characteristics of the abandoned channel are more likely to resemble current conditions in the undisturbed path of the proposed, new alignment in a shorter period of time.

While beach disposal was under consideration during the mid-1990s, the present proposal includes specific plans to place large quantities of material on project area beaches. Earlier plans suggested that the most cost effective disposal option would be placement in the ODMDS. The use of the ODMDS would have impacted both benthic and pelagic organisms at and near the site, but this area was subject to periodic disposal activities from other projects. The proposed change would produce impacts similar to any beach nourishment project using offshore borrow areas. Such impacts include harm to beach invertebrates, nearshore fishes, organisms on area hardbottoms, shorebirds including the federally threatened piping plover, and sea turtle reproduction. The long-term impacts on beaches such as Bald Head Island could be significant with only a few years between disposals. Such short disposal intervals would leave little time for the recovery of beach invertebrates and may seriously diminish the value of this important sea turtle nesting area by continuous escarpment formation and persistent beach compaction.

There are relatively minor differences between the two alternatives in regard to disposal of sediments in the ODMDS. The original design called for the placement of most of the soft sediment from the seaward portion of the project in the ODMDS. The proposed changes would simply reduce the amount of material by disposing of beach quality sand on project area beaches.

The expansion of the dredging methods would produce some increase in adverse environmental impacts. Such increases may be small, but there would be no increase at all without this project modification. The use of overflow loading of dredges and scows is likely to increase turbidity and siltation. The use of all dredging techniques in areas that previously allowed only certain methods is likely to adverse impact sensitive natural areas, such as fisheries nursery areas. The areas subject to the adverse impacts of overflow loading would be enlarged. Overall, the Corps indicates that these changes are being proposed in order to save money and not on the basis of any new biological data. The Service concludes that fish and wildlife resources would be better served by the retention of these dredging restrictions.

The impact comparison for elimination of the bubble curtain involves relatively little difference in fish mortality. However, the mortality for which this protective device was originally proposed will occur.

If the NEPA process confirms that the current preferred alternative should be constructed, conservation measures should be used to avoid or minimize direct impacts. Elimination of the offshore benthic community in the sediment removed can be minimized, but this community will be lost in the areas used for the new channel alignment.

Based on pre-project survey data, in-kind mitigation should be provided for the loss of benthic habitat along the new alignment. Such mitigation may be possible along the existing channel that would be abandoned if it is backfilled appropriately by the Corps. Backfilling by the Corps with fill sediment that matches native benthic substrate conditions would maximize recovery and recolonization of benthic flora and fauna. Sediment size, composition and organic content should be matched to maximize mitigation success.

Areas of the new alignment that pass through the ODMDS or offshore shoals may be subject to large movements of sediment that could increase shoaling along the new alignment. Fine grained material deposited in the ODMDS is more likely to be pushed by prevailing currents into the new alignment. An increase in shoaling would lead to increased maintenance dredging and create the turbidity and sedimentation associated with such dredging. Regular surveys of the buffer surrounding the new alignment through the ODMDS would detect bathymetric changes that contribute to shoaling in the new channel. The survey area should be extended along the entire alignment since the channel would also pass through nearshore shoals. Such surveys would identify areas of shifting sediment and could suggest areas where future dumping should be avoided in order to minimize maintenance dredging of the new alignment.

In order to fully assess the impacts to benthic habitat, the Corps should sponsor a long-term monitoring program to evaluate the recolonization of the abandoned channel. Such a program is the only method for determining the actual development of benthic habitat as the channel refills with sediment. If benthic organisms fail to become established in the area, it may be necessary to develop new mitigation measures.

The risk of contamination to fish and wildlife resources in all disposal areas needs to be minimized. All of the sediment data provided thus far for this project indicate a significant proportion of fine grain sizes that have a high probability for contaminant adhesion. A Tier One Assessment, performed in accordance with Inland Testing Manual (ITM) guidelines, should be included in the environmental documents for the project. That assessment should include documentation of the significance of contaminant-related risks, and it should identify the need for any additional assessment. Should any sediments contain toxicants that exceed reasonable screening values for contaminant effects (e.g., EPA Region 4 screening guidelines; NOAA and USGS-BRD derived screening guidelines), appropriate measures should be taken to manage the contaminants.

There is no single month, or even a single season, when all adverse impacts to important fish and wildlife resources could be avoided. From a strictly biological point of view, the least harmful six-month period would probably be the months of October through March. It is very difficult to assign relative importance to the various fish and wildlife resources in the project area. Overall biological activity for beach resources is less during the colder months. The least harmful period for beach disposal would be the four months from December through March. This period would avoid the time when sea turtle nests (both the nesting and incubation periods) may be on area beaches, May 1 to November 15. The months April and November include the period when beach invertebrates such as *Donax* spp., *Emerita* spp. and digger amphipods may be on the beaches in high numbers. Piping plovers may begin nesting activities in March and April. However, the Service believes that it is very important to avoid dredging and subsequent beach disposal when sea turtle nests may be on area beaches. Offshore fisheries would be harmed by dredging during the winter. However, mitigation alternatives may be available to these species and from an overall perspective, the least damaging time for dredging and beach disposal is during the colder months of the year.

Beach nourishment should not result in changes in sand density (compaction), beach shear resistance (hardness), beach moisture content, beach slope, sand color, grain size, shape, and mineral composition. These parameters should be similar to the original beach sand. Any changes could result in adverse impacts on sea turtle nest site selection, digging behavior, clutch viability, and emergence by hatchlings. The beach invertebrate populations that live in burrows also would be impacted adversely by such changes.

The placement of sediment on area beaches should be done in a manner to match the shape and slope of the natural beach. Often beach nourishment results in a steep escarpment between the beach fill area and the natural offshore slope. Such a change in beach profile may cause access problems for nesting sea turtles or obstruct hatchling sea turtles on their way to the ocean. Shorebirds and macrofauna feeding in the swash zone would be impaired by scarps that form at the mean high water line as well. Human recreational use of the beach's intertidal zone may also be hampered. Efforts should be made to ensure that the beach profile after nourishment is a natural, gently sloping beach rather than a layered beach with sharp escarpments. If the nourished beach profile develops high escarpments, they should be leveled to grade into the natural profile. A project conservation measure would be a monitoring program to detect the more apparent abnormalities of the artificial beaches. Such programs could also include measures of biological productivity along the beaches.

Heavy equipment used to level scarps may crush nests over which it passes. Such heavy equipment should be kept off the beaches during the nesting and incubation season, May 1 through November 15. Such equipment should not be used to move sediment placed on the beach during this period either. Limiting the number of heavy vehicles on the beach, perhaps to one regular sized bulldozer, would minimize the potential for crushing invertebrate burrows as well as the spatial extent and degree of compaction of sediments. Dredge pipelines should not be

stockpiled on the beach, either, as they impede human and wildlife utilization of the entire beach habitat.

Fish and wildlife resources will benefit from the longest interval possible between placements of sediment on beaches. If the project leads to increased erosion in the deposition areas, the interval between sediment placement will gradually decrease over time. Extended time periods allow beach invertebrates to recover and minimize the turbidity and siltation associated with the movement and disposal of sediment. The ability for invertebrates to return to the sediment placement area is also influenced by the length of the project. Since surviving populations on the edges of the placement area may supply the colonists for the placement area and dispersal may be limited, the shorter the placement area, the greater the opportunity for adjacent populations to reach the entire length of new beach.

Conservation measures to benefit reproduction by colonial waterbirds are primarily related to avoiding disturbances of the birds during the sensitive breeding season. While sand removal from a nesting site is an extreme example, measures must also consider more subtle disturbances such as the noise, fumes, lights, and movements associated with dredging. The activities associated with dredging cause stress and excessive flight responses among breeding birds. Dredging activities near nest sites can ultimately cause the birds to abandon nests. Therefore, dredging activities and sand removal from breeding areas should not occur at or near nesting sites of colonial waterbirds during the breeding season of April 1 through October 31.

Expanding the dredging methods would increase the risk to adversely impact Federally-listed aquatic resources. Impacts to sea turtles would be minimized by restricting the operation of hopper dredges during periods when sea turtles are most abundant in waters of the project area. Monitoring should be conducted during dredging for the presence of other Federally-listed species such as whales and the West Indian manatee, and appropriate conservation measures taken if such species are identified.

The elimination of the protective curtain requires a reconsideration of conservation measures for blasting. The Service recommends that blasting should be restricted to the time of year of lowest biological activity. However, finding a suitable time period for blasting will be difficult because the critical time periods for whales, manatees, sea turtles, larval fish, and adult fish do not coincide. The Service believes that blasting during August and September could harm and/or kill manatees and sea turtles. Therefore, we believe that blasting should be limited to the four-month period from October 1 through January 31. Even within the four-month blast period recommended above, important fisheries resources and sea turtles may be present in the project area.

The Corps should provide contractual opportunities to local universities to conduct aquatic resource surveys before, during and after the project construction period in order to document and gather important data on valuable fish and wildlife resources such as the shortnose sturgeon and impacts to their populations and distributions. This data should be made available to the

Service, NMFS and all interested parties in order to better define dredging windows, types of dredges allowed, and impacts of dredging on aquatic resources.

To mitigate for fish losses due to blasting the Service proposes the Corps provide structural fish passage at Lock and Dams 2 and 3 in addition to the fish locking sequence that is currently employed for anadromous fish and fund a graduate student (Master of Science) to examine the effectiveness of the structures. The Coastal Program of the Service will work with the Corps to provide technical assistance and potentially serve as a funding partner. Dams along the Cape Fear River are a significant impediment to certain fish reaching historical spawning areas. Reproduction would be enhanced if areas upstream from these dams were accessible to the fish. In the Cape Fear River 99 miles of mainstem and a very large mileage of tributary streams (likely over 1,500 miles) exist between Lock and Dam #2 and Buck Horn Dam (next dam upstream).

All of the previous conservation measures and recommendations made by the Service relating to project features that have remained unchanged, such as those related to saltwater intrusion, post-blasting monitoring for killed and injured organisms, and potential increased erosion of riparian shorelines from increased ship wakes, are still valid and should be supplemented by the following recommendations on these project modifications.

1) A Tier One Assessment according to the Inland Testing Manual (ITM) adopted by the Corps and the EPA in 1998 be conducted on all sediments in the project, and such documentation be included in the environmental documents. Sediments to be assessed include those from any disposal islands proposed for pumpout for either beach or offshore disposal. Should any sediments contain contaminants or toxins that exceed EPA standards, appropriate measures should be taken to manage the contaminants.

2) The Corps should address the issue of existing and proposed Essential Fish Habitats (EFH) in the new channel alignment and immediate surrounding areas. If any existing or proposed EFH are located in the new alignment construction area or offshore disposal areas, the Corps should coordinate with the NMFS to take the appropriate conservation measures.

3) Loss of benthic habitat with the creation of a new channel should be mitigated in-kind with backfilling the abandoned channel with identical or very similar substrate grain size, composition and geomorphology as adjacent benthic substrates.

4) The 2500' designated buffer surrounding the channel where it passes through the existing ODMDS should be regularly surveyed for bathymetric changes in order to monitor increased shoaling rates of the channel, which would lead to increased maintenance needs. Additional surveys should be conducted along a similar 2500' corridor for the entire new channel alignment, seaward of station 50+00, in order to monitor for shoaling from other adjacent sediment bodies. Multi-beam or the Corps' SHOALS surveys would yield more accurate bathymetry data than a few scattered soundings and increase spatial resolution and coverage.

5) Sediments used to backfill the abandoned navigational channel should match the native grain size, mineral composition and organic content in order to better mimic the native habitat.

6) Backfilling of the abandoned channel should approximate the natural bathymetric contours and geomorphology of the surrounding areas. Deviation from the natural conditions could prevent or delay re-colonization of the newly filled area by benthic organisms.

7) The backfilled channel should be monitored regularly with both bathymetric surveys (preferably multi-beam or SHOALS) and benthic organism surveys to establish recolonization rates and success or failure. Bathymetric surveys would generate data on changes to the former channel due to altered current or wave patterns, which could suspend portions of the fill and remove it from the channel. Any measured impacts over the life of the project should be mitigated through coordination with the Service, NMFS and other relevant agencies.

8) No disposal of dredge materials should take place on beaches or the littoral zone during the sea turtle nesting and incubation season of May 1 to November 15, which roughly coincides with shorebird nesting and beach invertebrate spawning and recruitment seasons.

9) Fill placement should not create a pronounced hill or mound of sand that could create an obstacle or scarp to wildlife and human resources utilizing the beach.

10) Heavy equipment used to manipulate fill sediments placed on the beach should be kept to a minimum, perhaps only one regular size bulldozer on any given beach at any given time. Night work should use the minimum amount of light necessary (which may require shielding) or low pressure sodium lighting during project construction.
11) Sediments disposed on the beaches or adjacent littoral zones should be *at least* 90% sand, match native grain size ranges and mineral composition, contain as little organic matter as possible and be free of contaminants exceeding safe levels.

12) Beach fill should be monitored for compaction, escarpment formation, and subaerial and subaqueous profiles on a regular basis (perhaps quarterly and after every storm) in order to determine the longevity of the material's placement. Immediately after completion of sand disposal on beaches and prior to sea turtle nesting seasons, monitoring shall be conducted to determine if escarpments are present and escarpments shall be leveled as required to reduce the likelihood of impacting sea turtle nesting and hatching activities.

13) Beaches scheduled to receive maintenance materials (i.e., Bald Head Island and Caswell Beach) should be monitored long-term for increased erosion rates, decreased biological productivity and cumulative impacts to fish and wildlife resources, especially Federally-listed species such as sea turtles, piping plovers, and seabeach amaranth. Any measured impacts over the lifespan of the project and its maintenance should be mitigated through coordination with the Service, NMFS and other relevant agencies.

14) Hopper dredges should not be used during the summer sea turtle nesting season or spring and fall migration periods when species numbers in inland waters are high.

15) Observers should be present on all hopper dredges to monitor for incidental takes of sea turtles year-round. All takes should be documented and reported to the Service and NMFS, and appropriate conservation measures coordinated in the event of excess takes.

16) Dredging activities should not occur adjacent to disposal islands during the colonial waterbird nesting season of April 1 to October 31 in order to minimize disturbance to such nests. Activities should be minimized from disturbing colonial waterbirds with potential noise, lights and fumes at all times of the year. Potential screening/blocking or other appropriate conservation measures should be coordinated with the North Carolina Colonial Waterbird Management Committee and other relevant agencies.

17) Spoil islands should not be pumped out or re-filled during the colonial waterbird nesting season to minimize disturbances to nesting habitat and existing nests.

18) All dredging activities should comply with existing agreements with the National Marine Fisheries Service and the U.S. Fish and Wildlife Service as to timing and types of allowable dredges. The 1995 Biological Opinion and Incidental Take Statement issued by NMFS to the Corps should be fully complied with in particular.

19) The Service recommends mitigation for the loss of fish associated with the blasting of rock during the project. The Service proposes the Corps provide structural fish passage at Lock and Dams 2 and 3 in addition to the fish locking sequence that is currently employed for anadromous fish and fund a graduate student (Master of Science) to examine the effectiveness of the structures.

20) All blasting should avoid times of spawning or known important juvenile stages of fish in the project area.

21) The Corps should provide contractual opportunities to local universities to conduct aquatic resource surveys before, during and after the project construction period in order to document and gather important data on valuable fish and wildlife resources such as the shortnose sturgeon and impacts to their populations and distributions. This data should be made available to the Service, NMFS and all interested parties.

The Wilmington Harbor, North Carolina, 96 Act Project Modifications may result in significant alterations in the diverse ecosystems of the lower Cape Fear River watershed. The planning process to date has adequately documented the economic justification for the proposed modifications, the range of alternatives considered, and the selection of a preferred alternative.

In the past the Service has expressed concern about the environmental impacts of other projects to modify the Wilmington Harbor Ship Channel. The large construction effort needed to accomplish the preferred alternative for the present project modifications has the potential to create significant direct, indirect, and cumulative adverse environmental impacts. However, the Service believes that a thorough consideration of the environment during planning can avoid many of the most severe impacts and minimize others.

With the exception of impacts associated with blasting, the Service believes that the most direct impacts associated with construction will be short-term and rectified in time. However, blasting in the ship channel has the potential to produce significant harm to important fisheries resources and Federally protected species. These impacts may be avoided or minimized by a comprehensive program to restrict the use of blasting, the use of seasonal restrictions on blasting, the proper selection of equipment and blasting procedures, monitoring programs, and programs to contain blast impacts and halt blasting if important resources are detected within scientifically-based, predetermined danger/safety zones. The elimination of the bubble curtain in the proposed modifications fails to meet the Service's concerns regarding containing blast impacts. Mitigation for the loss of fish and other aquatic resources should be provided. The Service recommends improved fish passage at Lock and Dams 2 and 3, and our Coastal Program is willing to coordinate such mitigation activities. Monitoring of the effectiveness of this mitigation could be provided through funding of a Master's student at a local university.

The Service is more concerned about the long-term, secondary impacts of the proposed project modifications. This report has detailed concerns about potential indirect impacts from each of the six modifications. The Service realizes that these impacts may be difficult to predict with a high degree of accuracy. However, the Service is concerned that several of the Corps' efforts to evaluate these impacts have not been completed. There are currently only minimal or no evaluations of the potential impacts to the longshore transport system that influences area beaches, turbidity and siltation effects on nearshore hardbottoms or estuarine nursery areas, contaminants contained within the dredged sediments, grain size compatibility with native beach sediments, cumulative impacts to beach invertebrate populations, and alterations to local water circulation and wave patterns resulting from the new channel alignment, backfilling of the old channel, and filling the existing ODMDS to full capacity. The Service strongly recommends that the Corps fully evaluate all potential, indirect impacts which may be produced by the project, develop long-term monitoring programs where major uncertainties exist, and plan remedial measures for a "worse-case" scenario of each potential impact.

The proposed expansion of dredging methods generates a set of direct and indirect impacts that would adversely affect fish and wildlife resources throughout the project area. Increased turbidity and siltation with overflowing scows could smother important estuarine benthic habitat and nursery areas, suffocate fish and alter the nutrient and oxygen levels of local waters. The year-round use of dredges, some of which have been documented to take Federally-listed species such as sea turtles, would breach previously arranged agreements the Corps has with resource

agencies. The Service cannot support the expansion of dredging methods proposed in this set of project modifications.

The Service believes that some of the proposed project modifications offer opportunities for the enhancement of fish and wildlife resources within the project area. Such measures include: (1) the use of soft sediment which is free of contaminants and properly placed and graded on existing disposal islands to benefit nesting by colonial waterbirds; (2) the use of soft sediment which is free of contaminants, of the appropriate grain size, and properly placed in the littoral zone near the mouth of the Cape Fear River to support area beaches; and (3) the use of sediment which is contaminant-free and properly placed to fill the abandoned navigational channel to restore a more natural benthic habitat. The Service strongly recommends that the Corps fully consider each of these measures.

In summary, the Service has provided recommendations which, in our opinion, will: (1) eliminate, or minimize, most short-term, direct impacts; (2) generate information on potential indirect impacts which are now poorly understood; (3) define those elements of the environment which are susceptible to long-term degradation and which require monitoring and contingency planning for possible remedial actions; and (4) designate actions which could benefit the natural resources of the project area. If the Corps implements each of these recommendations, the Service believes that the proposed project modifications are compatible with the long-term viability of marine, estuarine, and freshwater ecosystems in the project area and the many fish and wildlife resources which they support.

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SECTION 1. INTRODUCTION

Authority

This report is provided under authority of Section 2(b) of the Fish and Wildlife Coordination Act (FWCA) of 1958 (48 Stat. 401, as amended; 16 U.S.C. 661-667d). This Act established two important federal policies which are: (1) fish and wildlife resources are valuable to the nation; and, (2) the development of water resources is potentially damaging to these resources. In light of these principles, the FWCA mandates that:

> ". . . wildlife conservation shall receive equal consideration and be coordinated with other factors of water-resource development programs through effectual and harmonious planning, development, maintenance, and coordination of wildlife conservation and rehabilitation."

The FWCA essentially established fish and wildlife conservation as a coequal purpose or objective of federally funded or permitted water resources development projects.

In order to fully incorporate the conservation of fish and wildlife resources in the planning of water resources development, the FWCA mandates that federal agencies consult with the U. S. Fish and Wildlife Service (Service) and the state agency with the responsibility for fish and wildlife resources in the project area. The state agency with this responsibility is the North Carolina Wildlife Resources Commission (NCWRC).

Consultation during project planning is intended to allow state and federal resource agencies to determine the potential adverse impacts on fish and wildlife resources and develop recommendations to avoid, minimize, and/or compensate for detrimental impacts. Therefore, this report will:

1. Describe the fish and wildlife resources at risk in the project area;

2. Evaluate the potential adverse impacts, both direct and indirect, on these resources;

3. Develop recommendations to avoid, minimize, or compensate for any unavoidable, adverse environmental impacts; and,

4. Present an overall summary of findings and the position of the Service on the project.

This draft report will be submitted to the North Carolina Wildlife Resources Commission for their review and comments. The report, when finalized, will include a letter of concurrence from the NCWRC and will constitute the formal report of the Service under Section 2(b) of the FWCA.

Subject of This Report

Wilmington Harbor is a 37-mile-long Federal navigation project located in southeastern North Carolina along the Cape Fear and Northeast Cape Fear Rivers. It connects deep water of the Atlantic Ocean with the Port of Wilmington. Congressionally-authorized improvements scheduled to start in April 2000 will include deepening the navigation channel by 4 feet and widening portions of the project. Three environmental impact statements (EIS) have been prepared recently for Improvements in Wilmington Harbor, NC. The first was the Final Supplement to the Final EIS Wilmington Harbor-Northeast Cape Fear River (U. S. Army Corps of Engineers [hereafter USACOE] 1990). This project involved widening the Fourth East Jetty Channel to the West 100 feet and deepening the ship channel to 38 feet from the Cape Fear Memorial (CFM) Bridge to 750 feet above the Hilton Railroad Bridge. The second was the Final Supplement I to the Final EIS Wilmington Harbor Channel Widening (USACOE 1996a). This project involved the widening of five turns and bends by 75 to 200 feet, and widening by 200 feet the navigation channel in the lower harbor over a 6.2 mile distance to provide a passing lane. The third was the Final EIS Cape Fear-Northeast Cape Fear Rivers Comprehensive Study (USACOE 1996d). The project primarily involved deepening the harbor by 4 feet from the Memorial Bridge downstream with some deepening upstream of the Hilton Railroad Bridge. All three of these projects were combined by Congress in 1996 and subsequently called the Wilmington Harbor 96 Act.

The Wilmington District, U. S. Army Corps of Engineers (Corps) has contacted the Service regarding several major modifications to the overall project (Table 1). These modifications include a new alignment for the most seaward portion of the navigation channel, new disposal location for dredged material, the relaxation of certain dredging restrictions, and the elimination of a bubble curtain procedure originally proposed to reduce mortality of aquatic organisms during blasting. The subject of this report will be the modifications that have been proposed since the Service's 1996 FWCA Report (U. S. Fish and Wildlife Service [hereafter USFWS] 1996a).

Scope

The scope of the overall project has been expanded by the proposed changes. The original project included the existing navigation channel, certain existing confined disposal facilities, and the offshore Ocean Dredged Material Disposal Site (ODMDS). The proposed changes have added the beaches of Brunswick County (Bald Head Island, Caswell, Yaupon, Long, and Holden) and the southern beaches of New Hanover County (Carolina and Kure). The proposed new alignment for the ocean bar channel would dredge the ocean floor that is, in part, undisturbed.

Table 1. Major changes in design features and construction techniques that are considered in this report.

Original Project Feature	Current/Revised Project Feature	#
Deepen the existing harbor entrance channel.	Construction and maintenance of the harbor entrance channel (Bald Head Shoal Channel) along a new alignment through the ocean bar	1
	Backfilling of the abandoned portion of the old ocean bar channel with material unsuitable for beach or littoral zone placement	2
Disposal of soft sediment from the lower part of the project area in the Ocean Dredged Material Disposal Site (ODMDS)	Placement of sand dredged from the ocean bar channel, riverine channels upstream through Reaves Point channel, and/or the larger sandy disposal islands of the lower Cape Fear River on area beaches or in the littoral zone	3
	Placement in the ODMDS of all dredged sediment that does not go to the beaches, the littoral zone, or abandoned channel	4
Approved dredging methods that placed restrictions on areas where overflow of scows was allowed and areas that could receive certain types of sediment.	Establishment of a clear, comprehensive plan for utilization of all types of dredging equipment and disposal alternatives that are appropriate for use in each specific portion of the project.	5
A bubble curtain and/or a physical barrier would be placed completely around the blast area.	Reduction in area requiring blasting, number of blasts, size of each blast. Bubble curtain eliminated.	6

Prior Studies and Reports

Three environmental impact statements (EIS) have been prepared recently for Improvements in Wilmington Harbor, NC. The first was the Final Supplement to the Final EIS Wilmington Harbor-Northeast Cape Fear River (USACOE 1990). This project involved widening the Fourth East Jetty Channel to the West 100 feet and deepening the ship channel to 38 feet from the Cape Fear Memorial (CFM) Bridge to 750 feet above the Hilton Railroad Bridge. The second was the Final Supplement I to the Final EIS Wilmington Harbor Channel Widening (USACOE 1996a). This project involved the widening of five turns and bends by 75 to 200 feet, and widening by 200 feet the navigation channel in the lower harbor over a 6.2 mile distance to provide a passing lane. The third was the Final EIS Cape Fear-Northeast Cape Fear Rivers Comprehensive Study (USACOE 1996d).

The expansion of the Wilmington Harbor navigation Channel has been the subject of prior reports by the Service. The overall changes to the Wilmington Harbor Navigation Channel were originally considered as a separate project for review under the FWCA. These reports include:

U.S. Fish and Wildlife Service. 1988a. Planning Aid Report - Wilmington Harbor Passing Lane. Raleigh Field Office, Raleigh, NC. 20 pp.

_____. 1988b. Planning Aid Report - Wilmington Bends and Turns. Raleigh Field Office, Raleigh, NC. 29 pp.

_____. 1988c. Final Fish and Wildlife Coordination Act Report. Wilmington Harbor - Northeast Cape Fear River. Raleigh Field Office, Raleigh, NC. 24 pp + App.

_____. 1989. Planning Aid Report. Wilmington Harbor Bends and Turns Feasibility Level Study. Raleigh Field Office, Raleigh, NC. 31 pp.

_____. 1990a. Planning Aid Report - Wilmington Harbor Passing Lane, Feasibility Level Study. Raleigh Field Office, Raleigh, NC. 36 pp.

_____. 1990b. Draft Fish and Wildlife Coordination Act Report. Wilmington Harbor Passing Lane. Raleigh Field Office, Raleigh, NC. 51 pp.

_____. 1991. Draft Fish and Wildlife Coordination Act Report. Wilmington Harbor Turns and Bends. Raleigh Field Office, Raleigh, NC. 55 pp.

_____. 1993a. Draft Fish and Wildlife Coordination Act Report. Wilmington Harbor Ocean Bar Channel Deepening. Raleigh Field Office, Raleigh, NC. 71 pp.

_____. 1993b. Draft Fish and Wildlife Coordination Act Report. Wilmington Channel Widening Project. Raleigh Field Office, Raleigh, NC. 57 pp.

_____. 1993c (August). Final Fish and Wildlife Coordination Act Report. Wilmington Harbor Ocean Bar Channel Deepening. Raleigh Field Office, Raleigh, NC. 39 pp.

_____. 1993d. Final Fish and Wildlife Coordination Act Report. Wilmington Channel Widening Project. Raleigh Field Office, Raleigh, NC. 58 pp.

_____. 1996a (May). Final Fish and Wildlife Coordination Act Report. Cape Fear - Northeast Cape Fear Rivers Comprehensive Study, New Hanover and Brunswick Counties, North Carolina. Raleigh Field Office, Raleigh, NC. 86 pp. + Appendices.

_____. 1996b (May). Supplement I to the Final Fish and Wildlife Coordination Act Report. Wilmington Harbor Channel Widening Project. Raleigh Field Office, Raleigh, NC. 36 pp. + Appendices.

The placement of sand on beaches of both New Hanover and Brunswick Counties, whether as a specific, long-term beach nourishment project or as dredge disposal have also been considered in the past. Service reports addressing sand placement on Brunswick County beaches were prepared for the Ocean Isle Beach Project, which was separated from the larger project for the entire county. These reports include:

_____. 1993e (July). Final Fish and Wildlife Coordination Act Report. Area South of Carolina Beach. Raleigh Field Office, Raleigh, NC. 45 pp.

_____. 1995 (August). Ocean Isle Beach - Beach Erosion control and Hurricane Wave Protection Project. Draft Fish and Wildlife Coordination Act Report. Raleigh Field Office, Raleigh, NC. 40 pp.

SECTION 2. STUDY AREA DESCRIPTION

The proposed modifications would occur in four general ecological communities. These are: (1) the offshore marine areas where a new channel would be constructed; (2) the beaches where sand would be deposited; (3) nearshore marine communities, including hardbottoms, that would be impacted by beach disposal; and, (4) riverine areas where the existing channel would be modified by dredging, blasting, infilling, and the movement of dredged material. The description of the general project area and the major communities have been presented in earlier FWCA Reports prepared by the Service, environmental documents prepared by the Corps, and private individuals, including academics. This supplemental report will limit the study area description to key references from the sources given below.

Offshore Marine Areas

The area of the ocean bar has been described (USFWS 1993a, USFWS 1993c). Salinities around the mouth of the Cape Fear River are generally greater than 10 parts per thousand (ppt) during spring, and they increase to about 32 ppt by fall (Schwartz et al. 1979). The channel is underlain by bedrock. Limestones of either the Eocene Castle Hayne type or the Cretaceous Pee Dee Formation lie at the top of the rock. The precise thickness and extent of these rock types is unknown under the channel. The thickness of the rock types and their hardness may vary considerably across short distances. In some areas the Castle Hayne limestone may be cemented and in other sections it may be softer and more friable (Bill Hoffman, North Carolina Geological Survey, personal communication, August, 1992). The upper layer of the Pee Dee Formation limestone is generally harder than the Castle Hayne Formation (USACOE 1991). Rock from both the Castle Hayne limestone and the Pee Dee Formation has required blasting in other portions of the Cape Fear River.

Hardbottoms are areas with exposed limestone, phosphate, and other sedimentary rock which make up the North Carolina continental shelf. These areas, which may be called "rocky ridges" (Burgess 1993), differ from the more common areas covered by soft sediment. The ocean waters off Cape Fear contain a high number of hardbottom habitats (U.S. Minerals Management Service [hereafter USMMS] 1990). However, due to the small size and patchy distribution of hardbottoms, vibracore borings may not indicate their presence unless the cores are taken very close together (Bob Dickson, National Marine Fisheries Service, Beaufort laboratory, personal communication, July 1992).

Hardbottoms represent one of the most valuable biological communities in the project area. Frankenberg (1997, pp. 191-192) states that these "hardground" habitats:

> ". . . support a community of algae, soft and encrusted coral, sea anemones, sea whips, and recreational important finfish. These rocky outcrops are oases of sea floor life that support a northern extension of the snapper-grouper complex of fish as well as habitat for predators like mackerel and bluefish."

Beaches

While the beaches of New Hanover and Brunswick Counties share some attributes, each beach in the project area has a unique history. The beaches of Brunswick County have been described in great detail (USACOE 1973b). More recent descriptions are provided by Pilkey et al. (1998, pp. 191-202). The beaches of New Hanover County have also been described in association with previous beach nourishment projects (USFWS 1993e). The general shoreline of Brunswick County has been described (Frankenberg 1997, pp. 207-218; Pilkey et al. 1998, pp. 191-202). The history and current conditions of the southern beaches of New Hanover County, Carolina and Kure, are discussed by Pilkey et al. (1998, pp. 187-191) and Frankenberg (1997 pp. 183-194).

Nearshore Marine Areas

The nearshore marine communities have been described in association with both completed and proposed beach nourishment projects. The area near Kure Beach in New Hanover County has been described in associated with the beach nourishment for the Area South of Carolina Beach Project (USFWS 1993e). Cleary (1999) characterizes the nearshore marine environment offshore of Oak Island as containing undulating hardbottoms, low relief scarps, ripple scour depressions and sandy and muddy surficial deposits of various thicknesses.

Riverine Areas

The portion of the project area within the Cape Fear River has been described in association with the Cape Fear Comprehensive Study (USFWS 1996a) and the Wilmington Harbor Channel Widening Project (USFWS 1996b). An excellent summary of the riverine areas has been provided by the Corps (USACOE 1984).

SECTION 3. FISH AND WILDLIFE SERVICE CONCERNS AND PLANNING OBJECTIVES

The involvement of the Service in this planning process is in response to a Congressional mandate through the FWCA which directs that the conservation of fish and wildlife resources shall receive full and equal consideration and be coordinated with other features of federal projects. Fish, wildlife, and their habitats are valuable public resources which are conserved and managed for the people by state and federal governments. If proposed land or water developments may reduce or eliminate the public benefits that are provided by such natural resources, then state and federal resources agencies have a responsibility to recommend means and measures to mitigate such losses. In the interest of serving the public, it is the policy of the Service to seek to mitigate losses of fish, wildlife, and their habitats and to provide information and recommendations that fully support the Nation's needs for fish and wildlife resource conservation as well as sound economic and social development through balanced, multiple use of the Nation's natural resources.

General Fish and Wildlife Service Concerns

The Service is concerned that creation of a new ocean entrance channel will eliminate habitat for benthic organisms and adversely affect other habitats in the vicinity of the new channel. While allowing the old channel to fill in may re-create some of the habitat values, there are no assurances that sediments filling the old channel will have the same physical characteristics of the area along the proposed alignment. The new channel may also create adverse impacts by altering the existing flow of sand along the coast.

The Service is concerned that beach disposal of dredged material may adversely affect fish and wildlife resources on the beach and nearshore zone. The scheduling of sediment disposal would influence the extent of impact on beach invertebrates, nesting sea turtles, foraging shorebirds, and nearshore fisheries. The more extensive use of overflowing barges to transport sediment poses new concerns for water quality in the lower Cape Fear River.

Specific Fish and Wildlife Service Concerns

The Service has the following concerns:

- The new channel alignment may accelerate erosion on nearby beaches by disrupting the existing longshore sediment transport system at the mouth of the Cape Fear River and result in the loss of sea turtle nesting habitat;

- Sediment deposition on area beaches may diminish the habitat quality for nesting sea turtles and adversely affect populations of beach invertebrates;

- Sediment deposition on area beaches may result in turbidity and siltation in nearshore areas that adverse affect important hardbottom habitat;

- The increased extent of overflowing scows or barges carrying sediment may reduce water quality and adversely affect fish and other aquatic organisms as well as estuarine habitats such as primary nursery areas, and;

- The elimination of the bubble curtain around blast areas in the river will kill some fish.

Planning Objectives

Careful planning and a conscientious balancing of economic considerations with environmental concerns can produce projects with minimal, short- and long-term environmental impacts. The Service proposes the following planning objectives:

1. Construction and maintenance of a new alignment for the harbor entrance channel with a minimum of short- and long-term adverse environmental impacts;

2. Ensure proper timing for beach disposal such that it will not result in significant adverse environmental impacts to marine and estuarine organisms or unique habitats (e. g., hardbottoms).

3. Beach disposal should incorporate design features and construction techniques which would minimize alterations of natural coastal geologic processes and maintain the water quality of the area.

4. All dredging operations and sediment movement procedures should maintain and enhance existing water quality within the project area and adjacent waters of the Cape Fear and Northeast Cape Fear Rivers, including designated primary and secondary nursery areas.

5. If the revised procedures used to modify the existing navigation channel in the Cape Fear River, especially blasting, will result in mortality of aquatic organisms, project plans should include specific mitigation measures to ensure that these resources do not suffer a decline in abundance.

In accordance with the FWCA, as amended, these planning objectives should be given full and equal consideration with the economic benefits expected from the project.

SECTION 4. EVALUATION METHODS

Descriptions of natural resources present within the study area and the preliminary assessment of the environmental impacts of the proposed project modifications are based on previous studies for similar projects, published literature, and personal communications with knowledgeable individuals. Published reports and studies were examined to determine their relevance to the proposed project. Material which described potential environmental impacts of similar projects and methods of reducing these impacts are incorporated by reference in this report.

Nomenclature in this report follows Tiner (1993) for coastal plants; Rohde et al. (1994) for freshwater fish; Robins and Ray (1986) for marine fish; Martof et al. (1980) for amphibians and reptiles; Potter et al. (1980) for birds; and Webster et al. (1985) for mammals.

Both common and scientific names from cited literature follow the original publication. If the Service is aware of a widely accepted synonym for the common name, that synonym is given in brackets. If the Service is aware of a change in the scientific name of a given species, the revised nomenclature is included in brackets following the published name.

SECTION 5. EXISTING FISH AND WILDLIFE RESOURCES

Information on the fish and wildlife resources was complied by the Service for the area of the Cape Fear Comprehensive Study (USFWS 1996a) and the prior study on deepening the ocean bar (USFWS 1993c). Resources associated with beach placement of sediments were discussed for the Area South of Carolina Beach (USFWS 1993e) in New Hanover County and Ocean Isle Beach in Brunswick County (USFWS 1995). The material below will be a brief summary of information from previous reports.

Marine Habitats

Trawling surveys conducted as part of a study concerning the effects on aquatic resources of the Carolina Power and Light nuclear power plant in Southport demonstrate that the Cape Fear River and nearby ocean waters are utilized by a diverse group of invertebrates and fish species (Schwartz et al. 1979). The most abundant invertebrate species were arthropods, such as the blue crab (*Callinectus sapidus*), the lesser blue crab (*Callinectus similis*), mantis shrimp (*Squilla empusa*), penaed shrimp (*Penaeus aztecus*, *P.duorarum, P. setiferus*), and grass shrimp (*Palaemonetes* sp.); echinoderms, such as the common sea star (*Asterias forbesi*) and sand dollar (*Mellita quinquiesperforata*); jellyfish (Scyphozoa) and other cnidarians; comb jellies (Ctneophora); and various mollusks such as oysters (*Crassostrea virginica*), Atlantic brief squid (*Lolliguncula brevis*), conchs and whelks (Melongenidae), and mud snails (Nassariidae). Many other invertebrate species were found in smaller numbers.

Huntsman (1994) discusses coastal demersal fishes, species that live on the bottom. This group includes Atlantic croaker, spot, southern flounder, summer flounder, and weakfish.

Hardbottom Marine Communities

Localized areas not covered by unconsolidated sediments, where the ocean floor consists of hard rock, are known as hardbottoms. Hardbottoms are found along the continental shelf off the North Carolina coasts. Hardbottoms are also called "live-bottoms" because they support a rich diversity of invertebrates such as corals, anemones, and sponges which are refuges for fish and other marine life. While hardbottoms are most abundant in southern portions of North Carolina, they are located along the entire coast (USMMS 1990). Data from the Southeast Monitoring and Assessment Program (SEAMAP) indicate that hardbottoms are located in or near the proposed borrow areas (SEAMAP 1998). Cleary (1999) provides data that hardbottoms are present immediately offshore of the beach disposal areas along Oak Island.

Hardbottoms can provide very important habitat for fish and invertebrate species. According to Burgess (1993):

> "Some of these rocky hardbottoms are veritable oases covered with algal meadows, sponges, soft whip corals, tropical fishes and territorial and predatory

> animals. These habitats provide shelter and food to sustain valuable commercial and recreational fish such as groupers and snappers, worth millions of dollars to the state's economy. More than 300 species of fish and hundreds of thousands of invertebrates call these reefs home."

In addition to simple, flat, rocky bottoms, areas with high relief such as underwater channels and cliffs, also provide valuable habitat. Areas of "high-relief scarps" create the most productive of hardbottom habitats (Burgess 1993). Rocks which break off these scarps collect as underwater rubble mounds that provide many nooks and crannies that serve as important hiding places for reef fishes and invertebrates such as the arrow crab (*Stenorhynchus seticornis*) and spiny lobster (*Panulirus argus*). Seaweeds such as brown sargassum (*Saragassum* spp.) and green calcareous algae attach to the rock surfaces.

Van Dolah and Knott (1984) sampled the benthos offshore the South Carolina coast, including some hardbottoms. They found 167 species representing nine major taxa. McCrary and Taylor (1986) studied benthic macrofauna assemblages offshore of Fort Fisher, North Carolina. Their grab samples were taken from between approximately 0.5 to 2 miles offshore. They found many polychaete species, isopods, amphipods, decapods, molluscs, echinoderms, many nematodes, and a few Amphioxus (*Brachiostoma caribaeum*) in the benthic samples. In reference to one of their sampling locations located approximately 0.5 mile offshore, they state that it was obvious that a hardbottom was in the vicinity, although hard substrate was not found in the sediment samples of the site. They found 33 individuals of Chrysopetidae, a family which is predominately associated with coral or other hard substrates.

The benthos inhabiting potential offshore borrow areas serve as food for commercially important species and are essential in marine food chains. For example, adult spot (*Leiostomus zanthurus*) are benthic feeders, primarily eating polychaetes and benthic copepods. Atlantic croaker (*Micropogonias undulatus*) are also bottom feeders, preying on polychaetes and bivalves. Pink (*Penaeus duorarum*) and white (*P. setiferus*) shrimp also prefer benthos.

Huntsman (1994) states that there are more than 300 species of reef fish along the South Atlantic. These are species that might be expected at hardbottoms off North Carolina. Some species within this group are gray triggerfish (*Balistes capriscus*), scamp (*Mycteroperca phenax*), speckled hind (*Epinephelus drummondhayi*), vermilion snapper (*Rhomboplites aurorubens*), white grunt (*Haemulon plumieri*), snowy grouper (*Epinephelus niveatus*), red porgy (*Pagrus pagrus*), red snapper (*Lutjanus campechanus*), and warsaw grouper (*Epinephelus nigritus*). Some of these are extremely overfished (Huntsman 1994).

Beach and Nearshore Habitats

Nearshore

The nearshore zone typically extends out to about 30 feet of water, including the surf zone where waves break (Leatherman 1988). Knott et al. (1983) found 205 benthic macroinvertebrate species in water depths from 1 to 5 meters in South Carolina.

Many fish species are found within the surf zone and some species occur in both offshore and nearshore waters. Huntsman (1994) writes that coastal pelagic species, those living in the nearshore water column, include Atlantic menhaden, Spanish mackerel, King mackerel (*Scomberomorus cavalla*), bluefish, and little tunny (*Euthynnus alletteratus*). Other fishes that may occur in this area are the summer flounder, Atlantic croaker, spot, weakfish, red drum, cobia (*Rachycentron canadum*), black sea bass, spiny dogfish, northern sea robin, and pompano (*Trachinotus carolinus*).

Hackney et al. (1996. p. 52) state that "Apparently, many surf zone fishes not only exhibit ontogenetic changes in diet, but also shift diets in relation to prey availability. . . Such opportunism has great advantages in a variable environment like the surf zone. The ability to modify feeding could also mitigate impacts from beach renourishment."

There are two species of small coastal sharks, the dogfish and spiny dogfish known to occur in the project area (Huntsman 1994).

Beach

Sandy or silty sand beaches support many species of fat, soft-bodied, white, burrowing amphipods in many genera of the family Haustoriidae (Phylum Arthropoda) (Ruppert and Fox 1988, p. 346). High energy, intertidal beaches in the southeastern United States may have 20-30 invertebrate species (Ruppert and Fox 1988, p. 346). Knott et al. (1983) identified 25 Polychaeta, 25 Amphipoda, 13 Pelecypoda, 4 Decapoda, 2 Gastropoda, 5 Isopoda, 3 Echinodermata, 5 Cumacea and six other taxa in the intertidal zones near Murrells Inlet, South Carolina. Invertebrates commonly found on sandy beaches include the beach digger (*Haustorius canadensis*), various polychaete worms (e.g., *Scolelepis squamata*), ghost crab (*Ocypode quadrata*), ghost shrimp (*Callianasa* sp.), the mole crab (*Emerita talpoida*) and coquina clam (*Donax* sp.). The swash zone is dominated by the mole crab and coquina clam.

Shorebirds such as the sanderling (*Crocethia alba*), black-bellied plover (*Squatarola squatarola*), Wilson's plover (*Charadrius wilsonia*), willet (*Catoptrophorus semipalmatus*), ruddy turnstone (*Arenaria interpres*), greater yellowleg (*Tringa melanoleuca*), lesser yellowleg (*Tringa flavipes*), marbled godwit (*Limosa fedoa*), American oystercatcher (*Haematopus palliatus*), laughing gull (*Larus atricilla*), herring gull (*Larus argentatus*), and great black-

backed gull (*Larus marinus*) forage on the algae and invertebrates of beaches in the project area.

Estuarine Waters of the Cape Fear River

The lower Cape Fear River estuary is one of the most important colonial waterbird nesting locations in North Carolina. Dredged material islands within and adjacent to the project area serve as nesting habitat for approximately 14 colonial waterbird species (Dr. James Parnell, University of North Carolina at Wilmington, pers. comm., 1989). Battery Island, located to the northwest of Bald Head Island, is a natural estuarine island owned and managed by the National Audubon Society. The island contains dense maritime shrub thicket vegetation which has supported a mixed-species nesting rookery since at least 1928. It is used by glossy ibis (*Plegadis falcinellus*), white ibis (*Eudocimus albus*), cattle egret (*Bubulcus ibis*), little blue herons (*Egretta caeurlea*), and other waders. Battery Island contains two separate colonies - the north colony and the south colony. Collectively, they form the largest wading bird nesting population in North Carolina (Parnell and Shields 1990). North and South Pelican Islands and Ferry Slip Island are used by brown pelicans (*Pelecanus occidentalis*), royal terns (*Sterna maxima*), and laughing gulls (*Larus atricilla*). Black skimmers (*Rynchops niger*), common terns (*Sterna hirundo*) and gull-billed terns (*Sterna nilotica*) also nest on Ferry Slip Island. South Pelican Island and Ferry Slip Island support nearly one half of the State's brown pelican breeding population (Parnell and Shields 1990).

Ferry Slip Island and South Pelican Island have experienced severe erosion in the past, such that nesting by colonial waterbirds was diminishing, and a large number of nests laid were destroyed. In the winter of 1992, the Corps disposed of material on Ferry Slip and South Pelican Islands, increasing the nesting value of these islands. It is likely that these islands will require additional disposal material in future years (Dr. James Parnell, University of North Carolina at Wilmington, personal communication, March, 1993).

Benthic communities of the Cape Fear River estuary vary in species composition and density (Birkhead et al. 1979; Lawler, Matusky and Skelly Engineers [hereafter LMS] 1975). Approximately 40 benthic taxa were collected in the MOTSU area during the above-cited studies. The benthic community structure was found to be highly dependent on substrate type and salinity regime. Densities of benthic organisms in the Cape Fear River Estuary ranged from 30 organisms/square meter (m^2) on sandy substrate to 500 organisms/m^2 on mud substrate in the Atlantic Ocean (Birkhead et al. 1979). Near the MOTSU, LMS (1975) observed mean densities of 160 organisms/m^2, 110 organisms/m^2, and 55 organisms/m^2 in the Wilmington Harbor navigation channel, west of the channel, and areas east of the channel, respectively.

Nekton is a collective term for aquatic organisms which are not moved passively by currents or gravity, but are able to control their location by active movement. Sampling of the nekton with an otter trawl in the MOTSU basins was performed by the U.S. Army Environmental Hygiene Agency (1977). Data from the MOTSU basin samples were reported simply as species collected without estimates of abundance (Table 2). Invertebrates species included groups such as squid,

Table 2. Nektonic species found at the Military Ocean Terminal, Sunny Point, North Carolina. Sampling was conducted with an otter trawl by the U. S. Army Environmental Hygiene Agency. Source: U. S. Army Environmental Hygiene Agency (1977).

Atlantic menhaden
Gizzard shad
Striped anchovy
Southern kingfish
Bay anchovy
Atlantic croaker
Atlantic silversides
Star drum
Rock sea bass
Southern flounder
Black sea bass
Hogchoker
Bluefish
Blackcheek tonguefish
Atlantic bumper
Squid
Sheepshead
White shrimp
Pinfish
Blue crab
Silver perch
Mantis shrimp
Sand seatrout
Mud crab
Spotted seatrout
Weakfish
Spot

mantis shrimp, mud crabs (Family Xanthidae), and species such as blue crab (*Callinectes sapidus*) and white shrimp (*Penasus setiferus*). Moser (1991) conducted a one-time gill and trammel net survey of the Carolina Beach Borrow Site, across the Cape Fear River form the MOTSU. The only nektonic invertebrate collected was the blue crab.

Federally Protected Species

The proposed modifications would affect areas used by federally protected species. These species include the cetaceans, shortnose sturgeon (*Acipenser brevirostrum*), five species of sea turtles, the West Indian manatee (*Trichechus manatus*), the piping plover (*Charadrius melodus*) and seabeach amaranth (*Amaranthus pumilus*). The level of occurrence and distribution of these species were discussed in the Final FWCA Report for the Cape Fear Comprehensive Project (USFWS 1996a).

Cetaceans

Marine mammals occur in offshore and inshore waters of North Carolina. Twenty-nine species of cetaceans have been recorded along the coast of the Carolinas, Virginia, and Maryland (Webster et al. 1985). Some species occur only in deeper offshore waters beyond the project limits, but other species could occur within the project area. The Federally-endangered right whale (*Balaena glacialis*) and humpback whale (*Megaptera novaeangliae*) are spring and fall migrants off of North Carolina. Both species may be found in nearshore waters, and the right whale appears to prefer shallow waters. The long-finned pilot whale (*Globicephala melaena*) and short-finned pilot whale (*G. macrorhynchus*) are primarily oceanic, but frequently move inshore when food resources are more plentiful there (Webster et al. 1985). The sperm whale (*Physeter macrocephalus*), dwarf sperm whale (*Kogia simus*), and pygmy sperm whale (*K. breviceps*) inhabit the offshore waters of North Carolina. While the sperm whales favor the deeper water off the continental shelf, they may use shallow waters to calve or in times of sickness (Webster et al. 1985). The sperm whale is a year round resident of the shelf edge and pelagic waters off North Carolina. This species probably moves farther offshore during the winter.

Bottle-nosed dolphins (*Tursiops truncatus*) and harbor porpoises (*Phocoena phocoena*) utilize nearshore waters including bays, estuarine creeks, and sounds. They are the most common cetaceans in the area. Bottle-nose dolphins are commonly observed in the estuarine waters between Bald Head Island and Southport.

The August 1995 Biological Opinion of NMFS under the Endangered Species Act Section 7 consultation for hopper dredging of channels and beach nourishment activities in the southeastern United States describes three days of dredging in the Wilmington Channel that encountered humpback whales:

> On January 12, 1995, a humpback whale was observed within a quarter of a mile of the dredge at Wilmington channel and resurfaced near the dredge. An approaching

> humpback on January 13, 1995 was observed ahead of the dredge initially, but resurfaced near the stern after the vessel slowed. Dredging was stopped while the whale, and two other humpbacks nearby, approached within 100 yards, including one passing under the bow. On January 18, still within the Wilmington Harbor channel dredging area, one of a few humpbacks observed feeding surfaced and quickly dove again within 10 meters of the dredge. (NMFS 1995, p. 17)

This data documents the presence of Federally-listed cetaceans within the project area.

Shortnose Sturgeon

Current data indicate that this Federally-endangered fish is found within the Cape Fear River estuary. Dr. Mary Moser and Dr. Steve Ross of the Center for Marine Science Research at the University of North Carolina at Wilmington, studied the shortnose sturgeon in the Cape Fear River from May 1990 until September 1992 (Moser and Ross 1993). During this period, they caught over 100 Atlantic sturgeons and 9 shortnose sturgeons. Thus, the number of shortnose sturgeons within the estuary appears to be very low. The species' distribution within the Cape Fear River has been documented to extend as far up the river as Lock and Dam #1. Whether shortnose sturgeons occur beyond that point is unknown (Dr. Mary Moser, University of North Carolina at Wilmington, personal communication, April 1993).

Both sturgeons are bottom dwellers and prefer deep waters and a soft substrate (Rohde et al. 1994). During spawning these species require freshwater areas with a fast flow and a rough bottom (Rohde et al. 1994). Moser indicated that sturgeon seemed to use the main channel of the river and tend to associate with deep holes. Atlantic sturgeon associate with the deepest parts of the river during the warmest times of the year, and they show a considerable amount of fidelity to deep holes (Dr. Mary Moser, personal communication, April 1993).

West Indian Manatee

This species, also known as the Florida manatee, is a Federally-listed endangered mammal. Although the manatee's principle stronghold in the United States is Florida, it occasionally makes its way into the coastal waters of North Carolina (Webster et al. 1985). Generally, manatees remain in the coastal waters of the Florida peninsula during the winter and disperse during the summer months, some moving north along the Atlantic Coast to North Carolina. Observations of manatees from within the Cape Fear River and surrounding waters are generally reported every year during the summer months. The number of sightings is usually low, but they do occur within the Cape Fear River on a regular basis during the warmer months of the year (David Webster, University of North Carolina at Wilmington, personal communication, May, 1993, and Mary Clark, North Carolina Museum of Natural History, personal communication, May, 1993).

Schwartz (1995) summarized manatee sightings in North Carolina from 1919 through 1994. This report provides information on the occurrence of 68 manatees from 59 sites and notes that the species is known to frequent nearly all North Carolina ocean and inland waters. Recorded

sightings in the vicinity of the project area include one individual near Southport in 1952; one in the lower Cape Fear River during 1972; one near the Carolina Power and Light Plant on the Cape Fear River in August 1976; one in the Cape Fear River near Marker 50 in March 1986; and one at the south end of the State Port at Wilmington in July 1994.

Sea Turtles

All five Atlantic sea turtles may occur in the coastal waters of North Carolina (Epperly et al. 1995). These species are the loggerhead sea turtle (*Caretta caretta*), the green sea turtle (*Chelonia mydas*), Kemp's ridley sea turtle (*Lepidochelys kempi*), the hawksbill sea turtle (*Eretmochelys imbricata*), and the leatherback sea turtle (*Dermochelys coriacea*).

The hawksbill and leatherback are not common in North Carolina waters. Both species are Federally-listed as endangered. However, survey data (Table 3 in USFWS 1996a) in the Cape Fear River from 1980 to 1991 included 7 leatherbacks among 157 total sea turtles (David Webster, University of North Carolina, Wilmington, personal communication, June 1994). Epperly et al. (1995) report the capture of a single leatherback in Pamlico Sound during the 1989-1992 period. A hawksbill was found within the Cape Fear River at the Carolina Power and Light plant near Southport (Sherry Epperly, NMFS, personal communication, April 1993). Epperly et al. (1995) reference State data for the capture of a single hawksbill in Pamlico Sound during the 1989-1992 period.

The Federally-endangered Kemp's ridley sea turtle, the Federally-threatened loggerhead, and Federally-threatened green sea turtle occur within the Cape Fear River estuary, primarily during the warmer months. Among 157 sea turtles reported in the Cape Fear River from 1980 to 1991, there were 135 loggerheads, 11 Kemp's ridleys, and 3 greens (N. L. Grogan and W. D. Webster, University of North Carolina, Wilmington, personal communication, June 1994).

Preliminary analysis of sea turtle sightings and strandings within North Carolina indicate that the Cape Fear River may provide important developmental habitat for green sea turtles (Crouse 1985). From 1989 through 1992, 9 sea turtles were observed in the Cape Fear River by recreational fisherman as reported by the Marine Recreational Fisherman Statistics Survey (Epperly et al. 1995). The NMFS also provided the Service with data which indicate that between 1980 and 1991 approximately 43 loggerheads, 2 greens, 2 leatherbacks, and 2 Kemp's ridleys were reported as stranded within the Cape Fear River area. Although NMFS states that these data are preliminary, they give an indication of the relative abundance of the various species of sea turtles found in the Cape Fear River (National Marine Fisheries Service [hereafter NMFS] 1993).

The presence of sea turtles in nearshore and estuarine waters of North Carolina appears to be seasonal. Epperly et al. (1995) reported that sea turtles were present in the offshore water of North Carolina throughout the year and were present in inshore waters from April through December. Seasonal data on sea turtles in the Cape Fear River and from Bald Head and Oak

Islands which flank the mouth of the Cape Fear River were collected by Grogan and Webster (David Webster, University of North Carolina, Wilmington, personal communication, June 1994) (Table 3 in USFWS 1996a). These data show that sea turtles were found in the Cape Fear River during every month except February. The months with the highest occurrences were April through September. These six months account for 144 (91.7%) of the 157 reports.

Available data indicate that three species of sea turtles nest on beaches that may be used for sediment disposal during this project. Table 3 gives data on recorded nests for the loggerhead sea turtle and green sea turtle. Among the six beaches considered 3,343 loggerhead nests were recorded from 1988 through 1999. The ocean beaches at Bald Head Island are the most highly used beaches for loggerhead nesting in North Carolina. Over 70 nests are recorded each year and 182 nests occurred in 1990.

Nesting by the federally threatened green sea turtle is much less than for the loggerhead with only 13 nests were recorded during these 12 years. This species normally nests in Florida and the Carribean.

On June 17, 1992 a Kemp's ridley sea turtle (*Lepidochelys kempi*), a federally endangered species, nested on Long Beach. This positive identification is the first record of the species nesting in North Carolina. However, two other descriptions of sea turtles nesting in North Carolina during the 1992 season fit the description of the Kemp's ridley turtles (Therese Conant, Sea Turtle Coordinator, N.C. Wildlife Resources Commission, personal communication, August, 1992). This species nest primarily at a single site (Rancho Nuevo) on the Gulf coast of Mexico.

Piping Plover

The piping plover (*Charadrius melodus*) is federally-listed as threatened. The species generally breeds north of the project area. However, there are limited data indicating nesting in southeastern North Carolina. Data collected by the North Carolina Wildlife Resources Commission (NCWRC) during 1993 found that 4 pairs of piping plovers nested on Holden Beach near Shallotte Inlet, just east of the project area (Tom Henson, NCWRC, 1993, personal communication to Janice Nicholls; USFWS 1996). The Service's 1996 recovery plan includes both Holden Beach and Long Beach near Lockwood Folly Inlet as actual or potential nesting sites (USFWS 1996). Piping plovers are regularly seen resting and foraging on the beaches during migration and in the winter. In the winter, the birds prefer expansive sand or mudflats for feeding and areas near sandy beaches for roosting.

The species' decline is attributed to increased development and recreational activities on beaches. Vehicular and foot traffic on beaches can directly crush eggs and chicks or indirectly lower productivity by disrupting territory establishment and breeding behavior. Increased development of beach areas has also resulted in an increase in the number of predators, such as gulls and raccoons, on piping plover chicks and eggs.

Table 3. Recorded nests of the loggerhead sea turtle and green sea turtles from 1988 through 1999 on beaches that may be used for sediment disposal during the the enlargement and maintenance of the Wilmington Ship Channel. Source: North Carolina Wildlife Resources Commission.

	Beach					
Year	Carolina and Kure	Bald Head Island [a]	Caswell	Long [b]	Holden [c]	Total
1988		112			7	119
1989	1	108	28	41	12	190
1990	11	182	81	62	58	394
1991	20	181	70	94	42	407
1992	1	136	68	56	54	315
1993	0	71	19	27	43	160
1994	10	120	100	103	35	368
1995	5	88	35	49	39	216
1996	7	99	70	95	45	316
1997	18	75	50	47	21	211
1998	12	88	46	61	71	278
1999	19	107	86	105	52	369
Total	104	1,367	653	740	479	3,343

[a] During this period, 9 green sea turtle nest were recorded on Bald Head Island

[b] During this period, 2 green sea turtles nests were recorded on Long Beach

[c] During this period, 2 green sea turtle nests were recorded on Holden Beach

Seabeach Amaranth

The beach disposal component of the modifications requires the addition of the threatened seabeach amaranth (*Amaranthus pumilus*). Seabeach amaranth is an annual plant which grows on barrier islands primarily on overwash flats on accreting spits. However, it can sometimes be found on middle portions of islands on upper strands of non-eroding beaches. Seabeach amaranth is a dune building pioneer species and is usually found high on the beach in front of the foredune.

This plant has been extirpated from 75 percent of its historical range and North Carolina is considered seabeach amaranth's present stronghold (Weakley and Bucher 1992). Corps survey data from 1992 to 1996 indicate the following number of seabeach amaranth individuals on the following potential project beaches:

	Number of Individuals				
Community	**1992**	**1993**	**1994**	**1995**	**1996**
Holden Beach	21	52	239	59	99
Long Beach	3148	6103	4409	4628	1983
Bald Head Island	1	26	2	1	37
Fort Fisher	0	0	0	0	0
Carolina and Kure Beaches	9	35	103	579	93

Table 4. Seabeach amaranth Corps survey data for the project area.

Seabeach amaranth plants germinate between April and July and mortality of seedlings can be very high. Flowering begins as soon as the plant is large enough, possibly as early as June. Seed production begins in July or August and usually reaches a peak in September, but continues until the death of the plant. Seed dispersal occurs primarily by wind but tides may also play a role in spread of the seeds. Beach disposal activities will bury these annual plants, resulting in their mortality, and the depth of the disposal material will be such that germination of the seeds the following season may not occur. On the other hand, beach disposal/nourishment projects may benefit the species by providing additional suitable habitat. Beach disposal/nourishment may be compatible with seabeach amaranth provided the timing of beach disposal is appropriate, the material placed on the beach is compatible with the natural sand, and special precautions are adopted to protect seabeach amaranth. Further studies are needed to determine the best methods of beach disposal in seabeach amaranth habitat (Weakley and Bucher 1992).

The shortnose sturgeon, whales, and sea turtles in the water are under the jurisdiction of the NMFS. This agency should be contacted concerning your agency's responsibilities under Section 7 of the Endangered species Act. The address is:

National Marine Fisheries Service
U.S. Department of Commerce
9450 Koger Boulevard
Duval Building
St. Petersburg, Florida 33702

SECTION 6. FUTURE FISH AND WILDLIFE RESOURCES WITHOUT PROPOSED MODIFICATIONS

This section presents the opinion of the Service on the condition of fish and wildlife resources in the project area which could be reasonably anticipated if a proposed modification was not implemented. These conditions would essentially represent the future condition of these resources after they had reacted to the impacts of the original, unmodified project plan.

New Alignment for Ocean Entrance Channel

Without this project modification, the original channel would be lengthened and deepened. If, as expected, modification of the existing channel requires blasting, fish and wildlife resources would be adversely affected by keeping the original design. If the destruction of hardbottoms with corals and other unique marine organisms is avoided by using the new alignment, the habitat values of the offshore ecosystem would be enhanced by the proposed modification. However, creating the new alignment is expected to impact a total of 707 acres as opposed to a total of 657 acres for modifying the existing channel (Table 5). In this respect, the future without this modification would have an additional 50 acres of relatively undisturbed marine bottoms. On balance, the preservation of offshore hardbottoms is very important. If there are exposed hardbottoms along the existing alignment, the future abundance of some fish and wildlife resources is likely to diminish if a new alignment is not used.

Backfilling Abandoned Channel

If the new alignment is not used, the area of the old channel would be deepened and lengthened. The area would be subjected to periodic dredging. With the use of a new alignment this area would be allowed to refill with sediment from the Cape Fear River and the addition of fine material from the new channel. While the extent to which the refilling of this channel would recreate the natural areas lost along the new alignment is uncertain, it is likely that the refilling would have positive impacts on the habitat characteristics of the area. Therefore, without this proposed project modification, the future of fish and wildlife resources in the area of the existing channel would be adversely affected.

Disposal on Beaches of Brunswick and New Hanover Counties

Without these proposed modifications, the beaches and nearshore areas would not be subjected to the placement of dredge spoil material. The invertebrate beach fauna would not be subject to burial and the offshore, aquatic organisms would not be subject to the turbidity and siltation that beach disposal would produce. While the Service understands that the Corps is planning a long-term nourishment project for the Brunswick County Beaches and the beaches of New Hanover County are part of ongoing beach nourishment projects, the addition of the sediment from this project will create adverse impacts and fish and wildlife resources would be adversely affected.

Table 5. Area (in acres) that would be impacted (both bottoms and side slopes) by both the original plan to lengthen and deepen the existing ocean entrance channel and the modified plan to construct the channel partially on new alignment. Source: Wilmington District, U. S. Army Corps of Engineers, Wilmington, North Carolina.

Options for Enlarged Ocean Entrance Channel	Area in Acres (Including Bottom and Side Slopes)				
	Existing Disturbed Area				
	Channel Already Disturbed	ODMDS Path	Channel in Both Align.	New Impacts in Channel	Total
Plan 1 - Use Existing Alignment					
Existing 5.8 mi. Channel	372	0	0	0	372
Deepen Existing Channel		0	0	55	55
3.5 mi. Extension		0	0	230	230
Total for 9.3 mi. Channel	372	0	0	285	657
Plan 2- Create new alignment					
Construct 6.7 mi. Channel		121	147	439	707
Area planned for restoration by backfilling	224				

Disposal at ODMDS

The future without these options is likely to be very similar to the original project plan that called for considerably more disposal at this site. The Service (1996a) noted that dumping of dredged material in either the ODMDS or the WOFES could cause direct injury or death to fish, sea turtles, or marine mammals which are in the path of the released sediment. While these organisms are mobile, the release of an entire barge filled with soft sediment or a rock-soft sediment mix could result in material striking those organisms which are directly beneath the barge. The modifications under consideration would shift a portion of the sediment intended for this area to the beaches of New Hanover and Brunswick Counties.

Overfilling Barges

Without the proposed expansion of dredging options barges would not be overfilled. In this regard the turbidity and siltation associated with the overall project would be less. Overall, the future of fish and wildlife resources would be enhanced by a continuation of the prohibition on overfilling of sediment barges.

Expansion of Dredging Methods

Without the proposed expansion of dredging methods, aquatic organisms would still be exposed to some turbidity and siltation during the enlargement of the navigation channel. However, the generally tighter restrictions on the overflowing of barges and seasonal restrictions would minimize the impacts associated with construction. The Service noted (1996a) that periodic maintenance dredging of the existing ship channel will continue to cause short-term, adverse impacts to benthic organisms in the proposed project area. Dredging for both maintenance and new construction temporarily increases turbidity by increasing the amount of suspended solids. These conditions may result in mortality of aquatic larva and post-larval fish. Sessile and slow-moving benthic and epibenthic species will be lost along the path of the dredge, and minor turbidity and siltation could cause physiological stress for some species. Without the proposed project, the routine, maintenance dredging of the exiting ship channel would continue to periodically increase turbidity. However, the adverse impacts associated with maintenance dredging are likely to be less than those which would be produced by the proposed major construction.

Long-term maintenance dredging of the present Wilmington Harbor channel will necessitate the use of existing dredged material disposal sites within the Cape Fear River basin, including dredged material disposal islands located within the project study area. The rate of water outflow from confined disposal facilities can be controlled by adjustable spillways; therefore, without the proposed project any increase in turbidity in the estuary due to dredged material disposal should be minimal.

Elimination of Bubble Curtain

Data from tests of the bubble curtain during blasts in the Cape Fear River (Appendix C) indicate that this procedure adds little, if any, protection to aquatic organisms, particularly fish. Therefore, the future of fisheries resources would not change appreciably by the absence of the bubble curtain. However, the Service noted (1996a) that blasting may result in the mortality of invertebrates, fish, sea turtles, and marine mammals. The lethal range of the shock waves produced by underwater explosions will vary among different groups of organisms. Furthermore, the lethal range will depend on the type of explosives used and the methods of blasting. The greater the distance between an animal and the explosion, the lower any adverse impacts of the blast. The fact that the bubble curtain adds almost no protection does not eliminate the fact that aquatic organisms will be killed or injured by the blasting.

SECTION 7. ALTERNATIVES CONSIDERED

The alternatives under consideration are essentially those of the original project (USACOE 1996d) and the proposed modifications. These are briefly summarized in this section.

New Alignment for Ocean Entrance Channel

There are two options for the alignment of the ocean entrance channel to the Wilmington Harbor navigation Channel. Either the existing channel would be enlarged and lengthened or a new alignment selected. Figure 1 in Appendix D shows the two channel alignments.

Backfilling Abandoned Channel

If the new alignment is chosen as the preferred alternative, the old channel will be abandoned and filled with sediment. The only alternative to this project modification is to not abandon the old channel, but to enlarge and lengthen it.

Disposal on Beaches of Brunswick and New Hanover Counties

The original disposal plan for the various types of sediment that required disposal was based on the characteristics of the material. The project would generate three broad types of material: (1) rock; (2) soft sediment with greater than 90% sand; and, (3) soft sediment that is 90% or less sand. The proposed modifications do not involve the disposal of rock. All of the materials would be disposed of at the ODMDS or on existing disposal islands.

There are now two options for disposing of the materials suitable for beach disposal on the beaches of Brunswick and New Hanover Counties. The first option is to place all of the beach suitable material on Bald Head Island and the eastern end of Oak Island (up to the Sea Turtle Restoration Project area) (Appendix D, Figure 2). The other option is to dispose of the sand on Bald Head Island, all of Oak Island except the Sea Turtle Restoration Project area, and Holden Beach. Which option is chosen appears to depend upon whether the local communities can use the Section 933 cost-sharing program. Maintenance dredging disposal plans are the same for either alternative, with the sand being deposited on Bald Head Island and Caswell Beach at a 2:1 ratio.

If the first option is chosen to use just Bald Head Island and the east end of Oak Island, a larger quantity of sand will be deposited on those beaches. The alternative to distribute the sand equally amongst Bald Head, all of Oak Island and Holden Beach would reduce the amount of sand any given beach receives but increase the cost of the project (Appendix D, Table 3). The alteration to the width of the beaches post-disposal would be less with the Sec. 933 alternative to spread the 4.8 mcy of material across all the aforementioned communities; the first option would create wider beaches than the second. The second option would widen a higher number of beaches, however.

The only other project option is to not dispose of any sediments on the beach, but deposit them all at the ODMDS. The existing ODMDS does not have enough remaining capacity to hold all of the project's sediments when combined with maintenance dredging at MOTSU, however (Appendix D). If the beach quality sediments were disposed of at the ODMDS, the project would be delayed at least a year while a new ODMDS capable of handling all of the dredge spoil was established.

Disposal at ODMDS

There are no alternatives provided for this aspect of the project.

Expansion of Dredging Methods

There are no alternatives provided for this aspect of the project modifications.

Elimination of Bubble Curtain

The bubble curtain was initially proposed as a mitigation measure for the expected fish mortality resulting from the rock blasting included in the project (USACOE 1996a). No alternative mitigation measures to replace the elimination of this one have been provided.

SECTION 8. SELECTION OF THE PREFERRED MODIFICATIONS

The Service (USFWS 1996a) discussed the selection of the preferred alternative for which modifications have been proposed. The Corps provided the Service with information used in selecting the current preferred alternative.

New Alignment for Ocean Entrance Channel

The Corps decision to propose a new alignment for the ocean bar channel was based upon an assessment of problems with the existing channel. These problems are:

1. Deepening the channel along its present alignment would require the removal of extremely hard rock;

2. Rock removal would require extensive blasting and would be very slow and expensive;

3. Present 5.8-mile channel would be extended 3.5 miles seaward to a new total length of 9.3 miles; and,

4. Seaward channel extension would pass through a substantial amount of live coral and other ecologically valuable, live hard bottoms.

The proposed new channel alignment addresses these problems and the advantages are summarized as:

1. Avoid the need for rock blasting and its associated environmental impacts;

2. Avoid coral/live hard bottom in the path of extending the existing alignment;

3. Shorten distance to natural deep water to about 6.7 miles rather than 9.3 miles on the existing alignment;

4. Save about $40 million in construction costs by avoiding the need for rock removal;

5. Reduce channel construction time;

6. Avoid 1 extra foot of overdepth that would be required when the channel bottom is rock;

7. Route the channel over deeper rock so that future deepening, if necessary, would require less blasting.

Backfilling Abandoned Channel

The advantage of this option is stated in Appendix B. This option is expected to benefit the commercial fishing industry because trawling activities could likely be resumed along the old channel alignment.

Disposal on Beaches of Brunswick and New Hanover Counties

The decision to move beach quality material dredged during the expansion of the navigation channel to area beaches was apparent based on requests from local interests. The Corps states (Appendices B and D) that beach-quality sand dredged during construction and maintenance of the new ocean bar channel will be made available for placement on area beaches, to the extent feasible. Planning for the placement of this sand is being coordinated through the Brunswick County Consortium, which represents the interests of Bald Head Island, Caswell Beach, Oak Island (Yaupon Beach and Long Beach), and Holden Beach in acquiring as much sand as possible from the Wilmington Harbor project (Appendix D). These communities are currently working with Federal and State governments to obtain funding assistance for sand placement, possibly through the authority of Section 933 of the Water Resources Development Act of 1986. Section 933 authorizes 50 percent Federal sharing of the extra costs of using sand dredged from Federal navigation improvements and maintenance for beach nourishment. Sand placed through the use of this authority must provide benefits at least equal to the cost of placement, but future nourishment of the beach is not a project requirement; that is, the beach does not become a Federal shore protection project with a continuing maintenance obligation.

Excavation of the new channel between the Lower Swash Range and the Bald Head Shoal Range is expected to generate 14.8 million cubic yards (mcy) of sediment, with roughly 4.8 mcy of that material suitable for beach disposal. Dredging segments of the channel between Snows Marsh Range and Reaves Point Range is estimated to contain another 1.3 mcy of beach quality material. The former would be disposed of on Brunswick County beaches, while the latter will be added to another 1.3 mcy of beach quality sand pumped out of disposal islands 3 and 4 and placed on Kure, Carolina or Fort Fisher Beaches in New Hanover County, and/or Bald Head Island or Caswell Beach in Brunswick County (Appendix D). Including maintenance dredging at MOTSU, 21 mcy of sediment is expected to require disposal before the end of 2001. The existing ODMDS can only contain roughly 17.8 mcy more before reaching full capacity, however. So disposing of 4.8 mcy of the sediment on nearby beaches prevents the project from exceeding the full capacity of the existing ODMDS.

Placement of sand on the Brunswick County beaches was preliminarily designed to begin at mean high water (elevation +2.5 ft mllw) and to extend seaward during construction. It is anticipated that natural forces will immediately reduce this beach width by 17% after a period of about two to six months. Shoreline erosion rates are expected to be the same or slightly higher than the rates before the fill placement. During placement deposited sand was preliminarily designed not to exceed elevation +8.0 feet. A preliminary design beach profile is shown at true

scale in (Appendix B, Figure 4) and exaggerated scale in (Appendix B, Figure 5). The Sand Management Plan in Appendix D does not provide any fill dimensions, so it does not confirm or revise the preliminary placement designs in Appendix B. Table 6 lists the beach fill characteristics that are known about the two design alternatives.

Should the beach communities not be in a position to accept any or all of the sand generated by construction of the Wilmington Harbor improvements, the excess sand would be placed in the littoral system, to the maximum extent practicable, so as to retain it within the active coastal sand system.

Disposal at ODMDS

This design feature is part of the original project proposal. The Wilmington ODMDS will be available for disposal of any harbor sediments that are not suitable for beach or littoral zone placement (due to > 10 percent silts and clays). In addition, if neither beaches nor littoral zone placement can accommodate all the sand generated by the harbor improvements and maintenance, any remainder may go to the Wilmington ODMDS. Once the ODMDS reaches its full capacity with an additional 17.8 million cubic yards of sediment, a new ODMDS approximately 5 miles seaward of the existing ODMDS is intended to be the disposal site for project and maintenance sediments unsuitable for beach disposal. The existing ODMDS is expected to reach full capacity before the end of 2001, and a new ODMDS currently is being developed with the Environmental Protection Agency (EPA).

Expansion of Dredging Methods

The proposal of this project modification was apparently driven by the desire to reduce project costs. Dredging methods currently approved for use in various sections of Wilmington Harbor include hydraulic pipeline, hopper, and bucket dredges with scow. Overflowing of hopper dredges and scows to achieve economic loading has also been approved for some portions of the harbor, and has been conditionally approved for additional portions subject to monitoring the overflow plume. Approved disposal sites include the ODMDS, confined disposal facilities (CDFs) on islands along the river, and the Eagle Island CDF located near river mile 25. The same dredging methods and disposal sites are planned for future use. However, it is proposed that all dredging methods be allowed throughout the Wilmington Harbor project from its upstream end (mile 31) downstream to and including the ocean bar channel (Baldhead Shoal Channel), providing that their use is consistent with appropriate environmental protection measures, including those imposed to safeguard water quality, fish and wildlife, and endangered and threatened species. It is also proposed that the various types of dredging equipment be allowed to operate by methods that achieve greater economic efficiency (such as overflowing hopper dredges and scows to achieve economic loading) so long as these methods do not violate regulatory restrictions and conditions. Furthermore, it is proposed that placement of dredged material from any portion of the harbor may be at any approved dredged material disposal site, so long as this is in accordance with Section 404 of the Clean Water Act or Section 103 of the

Table 6. Beach disposal plans for each of the communities proposed for fill placement (Appendix D). Note that Option 1 plans for disposal on just Bald Head and the east end of Oak Island are denoted by "A" and Option 2 with Sec. 933 distribution of sediments are denoted by "B". The last column lists the adjusted beach width with an expected retention rate of 83% following reworking of the sediments over a few to several months. Erosion is expected to continue at similar or slightly higher rates.

Community	Fill Length (ft)	Fill Volume (cy/ft)	Estimated Volume (cy)	Estimated Initial Beach Width (ft)	Estimated Width after Adjustment (ft)
Bald Head – South Beach, west end	A: 2,000 B: 2,000	A: 120 B: 62	A: 240,000 B: 125,000	A: 180 B: 100	A: 90 to 100 B: 50
Bald Head – South Beach, east end	A: 12,000 B: 12,000	A: 175 B: 62	A: 2,100,000 B: 750,000	A: 270 B: 100	A: 130 to 140 B: 50
Bald Head – West Beach	A: 2,000 B: 2,000	A: 120 B: 62	A: 240,000 B: 125,000	A: 180 B: 100	A: 90 to 100 B: 50
Oak Island – East	A: 25,000 B: 25,000	A: 90 B: 62	A: 2,220,000 B: 1,550,000	A: 140 to 150 B: 100	A: 70 B: 50
Oak Island – West	B: 25,600	B: 62	B: 1,590,000	B: 100	B: 50
Holden Beach	B: 10,600	B: 62	B: 660,000	B: 100	B: 50

Marine Protection, Research, and Sanctuaries Act as appropriate. Dredging methods already approved and those proposed for approval for all the channel segments of Wilmington Harbor are shown in Appendix B, Figure 6.

Elimination of Bubble Curtain

The decision to eliminate the protective bubble curtain around blasts in the Cape Fear River was based on tests that demonstrated that the procedure provided little, if any, protection. In light of the dubious benefits and high costs of this procedure, the bubble curtain was dropped (Appendix C).

SECTION 9. DESCRIPTION OF THE PREFERRED MODIFICATIONS

The Corps has indicated a number of changes to the original project design. These changes have been supplied to the Service. A description of five of the six proposed changes which constitute the preferred alternative considered by this report are given in Section 1.04 of Appendix B. These changes are:

1. New Alignment for Ocean Entrance Channel
2. Backfilling Abandoned Channel
3. Disposal on Beaches of Brunswick and New Hanover Counties
4. Disposal at ODMDS
5. Expansion of Dredging Methods

The preferred alternative for changes in blasting procedures, primarily the elimination of the protective bubble curtain, is given in Appendix C. The Sand Management Plan with detailed descriptions of the beach disposal and maintenance dredging plans is provided in Appendix D.

SECTION 10. IMPACTS OF THE PREFERRED MODIFICATIONS

A discussion of environmental impact of any construction project can be divided into two broad categories: direct and indirect impacts. Direct impacts refer to those consequences of a given action which occur at generally the same time as the action and in the immediate vicinity of the action. While the proposed modifications may be considered as a one time event, there would be indirect project impacts. In this case indirect impacts would be those that occurred at a distance from the actual work. However, in some cases there may be impacts that occur after the actual construction operation that may also be considered as indirect impacts. For instance, perpetual disposal of sediments from channel maintenance on to the beaches of Bald Head Island and Caswell Beach will create indirect and cumulative impacts to their beaches and nearshore systems.

New Alignment for Ocean Entrance Channel

The environmental impacts of creating a new alignment for the ocean entrance channel would be similar to those associated with offshore dredging for beach nourishment material. The operation would create both direct and indirect impacts.

Offshore dredging will kill the plants and animals within the sand removed from borrow sites. The National Research Council (1995, p. 118) states that "The primary biological effect of dredging borrow sites is the removal of benthic assemblages inhabiting the surficial substrate." Every acre of new channel outside of the existing ODMDS is the loss of an acre of relatively undisturbed benthic habitat, for up to 707 acres.

The preferred alternative would increase turbidity during the dredging of sand at the offshore borrow sites. Silt and clay particles within the borrow material would become suspended by the dredge. The increased turbidity would be harmful to planktonic invertebrates, fish, and marine mammals. The suspended sediment would reduce light penetration beyond the actual area dredged and reduce primary production.

While increased turbidity *per se* is harmful, a closely related event, increased offshore sedimentation, also produces adverse impacts. The suspended particles are carried away from the actual dredging site and eventually settle to the bottom, creating sedimentation. The settling of suspended particles is also referred to as siltation. Bush et al (1996, p. 83) state their belief that the dredging of sand off Boca Raton, Florida, for a new beach released mud that was responsible for killing coral heads more than 20 miles to the north. Hardbottom areas indicated by SEAMAP data (SEAMAP 1998) and Cleary (1999) could be destroyed by sedimentation. It is difficult to forecast the exact magnitude and areal extent of sedimentation produced by dredging. However, sediment with certain characteristics, e.g., high silt and clay content, could flow along currents and cover hardbottom areas many miles from the dredging site with a damaging layer of sediment.

Another indirect impact from the new channel alignment may be increased erosion rates on the shorelines of Bald Head Island and Oak Island, with the former closer to the new channel than the old. The Base New Work Disposal Plan (Appendix D) takes this into account and decreases the volumes of material placed on West Beach and the west end of South Beach along Bald Head Island in order to reduce the speed at which the disposal material re-enters the new channel via longshore transport. Artificially increased erosion rates would accelerate the regression of the islands with rising sea level and alter the geologic fate of the islands. The channel would serve as a sediment sink for longshore transport of littoral sediment from both Bald Head Island and Caswell Beach (Appendix D). As sediment is removed from the comparatively natural longshore system, adjacent shorelines would erode faster, possibly become overwash dominated and thus alter the existing coastal ecosystem to a more dynamic one.

Backfilling Abandoned Channel

Allowing the abandoned channel to refill with natural inflows of sediment and placing material too fine or unsuitable for beach disposal in the channel may not create benthic habitat similar to that lost in the construction of the new alignment. A beach nourishment project that removes sand from offshore borrow areas may permanently alter the physical characteristics of the areas and impact the benthic flora and fauna adapted to existing conditions. The long-term physical alterations produced by sand removal from marine habitats have not been well documented (National Research Council [hereafter NRC] 1995, p. 118). The majority of follow up studies from offshore borrow sites have shown decreases in the mean grain size, including, in some cases, increases in the percentage of silts and clays in the borrow site (NRC 1995, p. 118). Offshore holes may fill with finer grain material (NRC 1995, p. 118). The finer material or other significant alterations in the physical characteristics of the substrate may not be suitable for the organisms that formerly occupied bottom sediment of the borrow area.

Backfilling the channel will dramatically alter the bathymetry of the seafloor in this area. While returning the channel to its previous water depths, any deviation from the surrounding seafloor bathymetric contours or geomorphology may prevent the area from returning to its native habitat pre-navigational channel. Overfilling or underfilling the channel may alter water circulation pathways, wave patterns, and resulting passive fish and wildlife distributions. Underfilling may also create stagnant areas where deep pools persist relative to adjacent geomorphology.

Disposal on Beaches of Brunswick and New Hanover Counties

The placement of sediment on beaches, whether as a formal beach nourishment project or merely a disposal operation, produces a host of both direct and long-term indirect impacts.

There may be a deterioration of nearshore habitat quality due to long-term turbidity from the artificial beach-dune system. Bush et al. (1996, p. 83) state that "Streams of turbid water from the surf zone of Miami Beach are still responsible for killing coral heads 14 years after the beach was emplaced." Goldberg (1985) gives an example of a Florida nourishment project which

resulted in damage to a nearby rocky environment 50 to 60 meters offshore. Material placed on the beach during a nourishment project quickly eroded off the beach and covered nearshore rocks. Seven years after the project, the rocks were still covered in fine sand and silt, and turbidity of the nearshore area remained high.

When a beach is nourished, large volumes of sand are placed within the supralittoral and intertidal zones. Beach invertebrate populations are eliminated or greatly reduced. As noted, the direct, adverse impacts may be dramatic, but longer-term, indirect impacts related to altered beach characteristics and recruitment of a recovery population may have the greater impact on fish and wildlife resources that depend on beach invertebrates as a food source. Sand placement disturbs the indigenous biota inhabiting the subaerial habitats, which in turn affects the foraging patterns of the species that feed on those organisms (NRC 1995, p. 108). Dean (1999, p. 118-119) describes the artificial beach in Miami, Florida, as a quiet area without natural life.

Reilly and Bellis (1978) state that species of beach infauna recruited from pelagic larval stocks, such as mole crabs and coquina clams, will recover if nourishment activity ends before larval recruitment begins in the spring. In the spring, recruitment begins with juveniles and adults approaching the beach. In the Bogue Banks project, nourishment extended from December until June, a time that included the March recruitment period of coquina clams. No increase in coquina clams occurred until July 29, approximately two months after cessation of nourishment, and populations failed to reach pre-nourishment numbers found during the winter. At the control site, coquina clams also decreased during the winter as they moved offshore. However, during March, numbers at the control site increased to high levels. This study indicated that adult coquina clams were probably killed in their offshore wintering environment, and beach nourishment effects, most likely high turbidity, prevented normal pelagic larvae recruitment. The individuals that eventually arrived were post metamorphic adults likely to have diffused from adjacent beaches via littoral drift.

Peterson et al. (1999) documented invertebrate populations following dredge spoil disposal from Bogue Sound placed on the beaches of Bogue Banks to be reduced by 86-99% (compared to control beaches) 5 to 10 weeks following fill placement. The authors conclude that "Failure of *Emerita* and *Donax* to recover from nourishment by mid summer when they serve as a primary prey base for important surf fishes, ghost crabs, and some shorebirds may be a consequence of the poor match in grain size and high shell content of source sediments and/or extension of the project too far into the warm season" (Peterson et al. 1999, p. 2).

Donoghue (1999) found the timing of beach fill placement, the time interval between fill placement episodes, the size and type of fill, and the compatibility of the fill material to the native sediments to be critical to the short- and long-term impacts to beach invertebrate populations. Fill placement during the invertebrate reproduction or recruitment periods in early spring and early fall depressed the populations of mole crabs and coquina clams for several months to years; ghost crab populations were similarly decreased as a result of fill placement on the beaches at Pea Island. The alterations to the geomorphology and sediment characteristics of

the study beaches appear to be more controlling factors on invertebrate recovery periods than direct burial or mortality.

Sand flowing onto the lower portion of the beach during the nourishment operation can increase the beach height in the intertidal zone from several centimeters to more than a meter (NRC 1995, p. 109). This significant change in the character of the intertidal zone can affect habitat suitability and feeding by beach invertebrates beyond the immediate impact of sediment placement.

Thus we are concerned about the impacts of the beach disposal of dredge sediments, both in the short-term and long-term, to the beach invertebrate populations. These populations are a key facet of the coastal food web, and therefore decreased species abundances would reduce the prey base for shorebirds, surf fishes and beach macrofauna. Perpetual beach fill placement of maintenance dredging materials has the potential cumulative impact of permanently depressing beach invertebrate populations, especially at Bald Head Island where two-thirds of the maintenance materials will be deposited.

Bottom habitats in the nearshore surf zone often support a diverse array of biota that are directly or indirectly affected by beach nourishment operations (NRC 1995, p. 112-113). This community may be affected by burial of the bottom habitats, increased sedimentation, changes in nearshore bathymetry and associated wave action, and elevated turbidity.

Dr. William Cleary of the University of North Carolina at Wilmington has studied the movement of sand off recently renourished beaches in New Hanover County, Wrightsville Beach and Carolina Beach. He found that there are many more hardbottom areas in the nearshore zone within 1 or 2 miles of shore than was previously thought and the distribution of rock is very patchy. In some locations, 5 to 6 feet of sand covers the rock at times (Dr. William Cleary, University of North Carolina at Wilmington, personal communication, July 1992). More recently Cleary (1999) found the hardbottom rock outcrops offshore Oak Island to be covered by less than an inch to perhaps six feet of sediment.

Such thin veneers of sediment may be frequently reworked and moved with waves and currents, continually shifting the position of exposed hardbottom habitats. Any increase of sediment to this dynamic system has the potential of reducing the distribution and exposure of hardbottom habitats. The Service is concerned that the perpetual channel maintenance with beach disposal may have cumulative impacts to the hardbottom ecosystem as millions of cubic yards of sediment are introduced to the nearshore system on a regular basis either from turbidity and siltation or from potentially increased erosion rates on adjacent beaches.

Studies have documented only limited or short-term alterations in abundance, diversity, and species composition of nearshore infaunal communities sampled off new beaches (NRC 1995, p. 115). However, several of these studies had inadequate sampling designs that may have precluded detection of significant alterations in the populations or community parameters

measured (Nelson 1991, 1993). The NRC (1995, p. 115) concluded that " . . . efforts should be directed toward obtaining a better understanding of functional changes in the trophic contribution of benthic assemblages to the fish and crustaceans species that rely on the benthos as a major food resource."

Disposal at ODMDS

Open ocean disposal of dredge spoil sediments can have several impacts. The actual dumping of the spoil from the dredge or barge involves three aspects: convective descent of the material, dynamic collapse and the outward spreading of density currents along the seafloor. The finer portions of the spoil will be suspended in the water column, generating areas of increased turbidity as the sediments settle to the bottom. The heavier particles will sink straight to the seafloor. And lastly, layers of dense, turbid mixtures of suspended sediment will be carried away from the disposal area along the ocean floor. These density currents can range up to several meters thick and spread significant distances rather quickly (Drapeau et al. 1999). Current speed and dimensions will decrease with distance from the drop zone and time.

Increased turbidity levels have several potential impacts to fish and wildlife resources. Higher suspended sediment loads decrease light penetration in the water column, reducing biological productivity for a short period of time. If there is a high organic content in the dredge spoil, oxygen levels may become depressed and nutrient levels in the water altered. Fish gills may be clogged by high sediment loads in the water as well. Finally, siltation of the suspended sediments has the indirect impact of burying sessile benthic organisms that are unable to relocate out of the pathway of settling sediments; many of these organisms are filter-feeders, and high suspended sediment loads in the water may suppress their ability to feed.

The dredged sediment that is dumped at the ODMDS will bury any benthic flora and fauna present on the existing seafloor. Any organisms such as fish, mammals or sea turtles present in the water column between the dredge or barge and the ODMDS seafloor may not be able to escape the collapsing material and could be suffocated, killed, maimed or buried alive. These impacts could occur every single time a dredge or barge dumps its load and would be possible for the life of the project or use of the ODMDS. Creation of a new ODMDS would eliminate a completely new and comparatively undisturbed area of seafloor and accompanying benthic habitat. The existing ODMDS has been continually disturbed with maintenance dredging disposal from the existing navigational channel and nearby MOTSU; thus the benthic habitat is perhaps not as mature or well developed as would naturally occur. Usage of a new ODMDS site, therefore, would increase the initial impacts from disposal of project sediments offshore.

The spreading density currents radiating from the ODMDS will enlarge the zone of potential impacts beyond the area immediately surrounding the dredge or barge. Again the utility of a new ODMDS will also enlarge the zone of potential impacts, in this case to a relatively undisturbed section of seafloor. Burial and potential suffocation of benthic flora and fauna would extend for as far as any density currents spread around both ODMDS sites. If any

contaminants are contained within the dredge spoil, the density currents would spread their distribution over a large, uncontained area. While any such contaminants should be diluted as they spread, the repeated usage of the existing and new ODMDS with maintenance dredging could allow for cumulative impacts as contaminants accumulate. Fish and wildlife resources exposed to such contaminants could become affected in the long term.

Dredging the new alignment and disposal of fine-grained material may diminish the habitat values of the Wilmington Offshore Fisheries Enhancement Structure (WOFES), a disposal area for rock removed from the ship channel. The WOFES is located adjacent to the southeastern edge of the ODMDS and covers approximately 165 acres. It was designed to enhance attributes and features that would provide habitat and attract fish (USACOE 1994). The structure was designed to contain a mixture of rock (basketball sized to golf ball sized) and finer grained material to provide habitat complexity and structural stability. This effort sought to replace the low relief, sandy substrate bottom with a rock material substrate having high vertical relief. To the extent that dredging the new channel through the ODMDS and the disposal fine-grained material in the ODMDS produces sediment that moves to the southeast and settles on the WOFES, the intended habitat values of the area would be diminished. Areas of exposed rock could be covered by sediment and the desirable areas of high vertical relief decreased.

Burial of nearby hardbottoms by dredge and fill activities has been shown to reduce the abundance of fish species and individuals in Florida (Lindeman and Snyder 1999). Lindeman and Snyder (1999) state that "Because of behavioral and morphological constraints on flight responses, high mortalities are probably unavoidable for many cryptic [fish] species, newly settled life stages, or other site-associated taxa subjected to direct habitat burial" (p. 520). Nearshore, shallow hardbottoms were found to carry a large number of newly settled stages, and therefore Lindeman and Snyder (1999) conclude that burial as a result of dredge and fill activities may have amplified impacts if conducted just prior to peak larval recruitment, which is in spring and summer in their study area. Thus we are concerned that the timing of open ocean disposal of dredge sediments from this project may be a critical factor in the magnitude and frequency of impacts to adjacent hardbottoms.

Finally there are long-term, relatively permanent alterations to the offshore environment by using an ODMDS for dredge spoil. The bathymetry will be changed, with decreasing water depths as usage of the sites continues. The existing ODMDS at full capacity will have a water depth of 26 feet below mean lower low water. The adjacent natural bathymetry ranges from 34 to 45 feet water depth. This platform of soft sediments could alter water circulation patterns, which could redistribute pelagic larvae, eggs and nutrient patterns and pathways. Waves and currents, especially during storms, could refract or divert around this mound of material. Some of the soft sediments could be resuspended during storms, renewing turbidity and siltation impacts on adjacent fish and wildlife resources. Creation of a new ODMDS could create a similar situation at its location. Over time, the cumulative impacts of these actions would create a permanent alteration to the natural benthic environment by modifying its bathymetry.

Expansion of Dredging Methods

There are several proposed expansions of dredge types and windows of use in this project. When sediments are suitable for beach disposal, hopper dredges are proposed for year-round usage for dredging and disposal of sediments on the beaches or nearshore littoral zones. Hydraulic pipeline dredges are proposed for similar usage and timing. Bucket and barge or scow dredges are not proposed for beach or littoral zone disposal, but are proposed for year-round disposal in diked disposal sites. All of this year-round dredge and disposal activity is also proposed to allow overflowing scows for economic loading.

For sediments that are not suitable for beach or littoral zone disposal, overflowing scows are proposed for hydraulic pipeline, hopper, and bucket and barge dredges, with disposal on disposal islands, the ODMDS, and diked disposal sites. Overflowing scows carrying rock materials are proposed for disposal by hydraulic pipeline as well as bucket and barge dredges at the WOFES or ODMDS.

Beach or littoral zone placement of dredge materials during the spring, summer and fall months may affect nesting sea turtles, foraging and nesting shorebirds including the piping plover, and the reproduction and recruitment of beach invertebrates. Sea turtle nests may be on North Carolina beaches from May 1 to November 15. Shorebirds have a similar nesting season, with additional foraging and loafing usage during spring and fall migrations. Beach invertebrate populations generally have a bimodal population distribution with both early spring and early fall spawning and recruitment periods, the former in April and May and the latter in August and September (Donoghue 1999).

Active beach fill placement during the spring, summer and early fall months would thus alter the habitat used by all of these organisms. Nests could be buried by dredge material. Alterations to the grain size, color and composition could create unsuitable habitat for sea turtle nesting and beach invertebrate colonization and recovery. The greater the deviation from the natural grain characteristics present on the disposal beaches, the greater the potential impacts to all organisms using or living on the beaches. Deposition of disposal material during recruitment or nesting seasons could increase recovery times for invertebrate populations and reduce the abundance of sea turtle and shorebird nests or success of existing nests.

Physical alterations to the beach plan and profile would also impact sea turtles, shorebirds and beach invertebrates. If a tall berm is created at the existing high tide line, that berm will create an obstacle for emerging nesting sea turtles. Beach cusps that may be present initially would be eliminated by the fill, and these swash features seem to be preferable to beach invertebrates (Donoghue 1999). Any increase in topographical elevation in the intertidal zone, especially by a berm or mound of sand extending up to +8.0 feet, would have a high probability of forming a scarp as waves and tides reworked the fill sediment. Such scarps would be barriers to sea turtles trying to reach dry beach for nesting and could also impede the foraging patterns of shorebirds

who feed on swash zone invertebrates. Over time the sediments would be reworked and the likelihood of persistent scarps decreases.

The mechanics of pumping out the dredge materials onto the beach would generate other direct and indirect impacts to coastal fish and wildlife. Pipelines, either from a hopper pumpout or a hydraulic dredge, would be laid on the beach and in the nearshore waters. Such pipelines would create a physical barrier for not only wildlife resources but people utilizing the beach as well. Pipelines running parallel to the shoreline would impede sea turtle access to nesting habitat. Macrofauna such as ghost crabs would also have difficulty reaching foraging areas in or near the intertidal zone. The slurry being pumped out of the pipeline would require dewatering and heavy equipment to adjust the fill dimensions. As the slurry that is 80% or more fluid dewaters, sediment plumes will extend off of the beach. Juvenile surf fishes could be impacted with respiratory stress or trauma that is either lethal or sublethal. Filter-feeding molluscs in the immediate nearshore area could also be suffocated or traumatized. The heavy equipment on the beach used to move the fill could compact the sediments, destroy existing invertebrate burrows and run over nests of sea turtles or shorebirds. Compaction of the sediments could render them unsuitable for sea turtle nesting, burrow excavation and invertebrate recolonization.

Thus if beach disposal was to occur during the winter months when the beaches are less utilized by sea turtles, shorebirds and invertebrates, the impacts would be less. Sediments would have a longer period of time to be reworked across the beach profile. Impacts to fish and wildlife resources would be minimized by limiting beach disposal activities to winter only.

Similarly, hopper dredges have been known to incidentally take sea turtles present in the water column near the dredging activities. The number of sea turtles and other aquatic species killed or fatally wounded by such activities would logically increase with the increased abundance of these species in the water. The Service is concerned that use of hopper dredges year-round would have the additional impact of increased takes of federally listed resources as populations increase during spring and fall migration periods as well as the summer foraging and nesting season. Limiting hopper dredging activity to the winter season would minimize the potential number of takes of these species.

Colonial waterbird nesting season extends from May 1 to October 31. Disturbances to disposal islands utilized by these birds during their nesting season could increase abandonment of nests and lead to decreased reproduction success rates. Active pumpout of these islands to Kure or Carolina Beach, as well as additional disposal on them, would destroy any nests present during the nesting season. Noise and any potential fumes accompanying dredging activities adjacent to disposal islands may discourage usage of the islands for nesting. Night-time dredging activities with lights could further disrupt colonial waterbirds not only nesting on disposal islands, but those resting or foraging on the islands.

Overflowing scows throughout the project area would increase the areas impacted by sediment plumes and elevated turbidity levels. Areas that would otherwise be undisturbed by the project

could become affected. Primary nursery areas and submerged aquatic vegetation (SAV) could be sensitive to reduced light penetration, increased siltation and changes in dissolved oxygen or nutrient levels. Repeated overflowing of scows in localized areas could generate cumulative impacts and alterations to the benthic environment.

The Wilmington District conducted a field study of clamshell dredging and barge overflow at the MOTSU in 1987. The sediment dredged was maintenance material which predominantly consisted of silts and clays with fine sand. Dredging produced visible plumes of turbid water. Clamshell bucket dredging operations are cyclic, and turbidity plumes result from bottom impact, loss from the bucket during ascent from the bottom, and bucket spillage and overflow. The plumes formed a series of patches which tended to spread and merge as they were advected downstream. Suspended particles may block the gills and/or food filters of larval fish and invertebrates, including shrimp and anadromous fish. High levels of suspended solids may result in physiological stress to both benthic and nektonic species.

The estimated 26 month project period would extend increased impacts from expanded dredging methods through two seasons of nesting, spawning and recruitment for all fish and wildlife resources in the project area. As a result, this lengthy time period could hinder the recovery of any affected flora and fauna in the second season by perpetuating the impacts through another biological cycle. The cumulative impacts of depressed biological productivity for two years are unknown but could be significant. Preventing disturbing activities during periods of high biological productivity would minimize this risk of significant cumulative impacts to fish and wildlife resources.

Elimination of Bubble Curtain

Underwater blasting may result in the mortality of invertebrates, fish, sea turtles, and marine mammals. The lethal range of the shock waves produced by underwater explosions will vary among different groups of organisms. Furthermore, the lethal range will depend on the type of explosives used and the methods of blasting. The greater the distance between an animal and the explosion, the lower any adverse impacts of the blast.

Linton et al. (1985) summarize past studies on the effects of blasting on marine organisms. These studies indicate that different species and different life stages of the same species react differently to shock pressures. Eggs, larvae, juveniles, and adult organisms with air bladders tend to be most susceptible to explosives. Damage is directly proportional to the pressure produced by the explosion and the time over which it is produced. For example, a high velocity explosive produces a high pressure shock wave (usually expressed in pounds per square inch) for a short duration while a low velocity explosive produces a lower pressure shock wave over a longer time period.

Water is a good transmitter of shock waves (Du Pont Company 1980). The damaging effects on aquatic organisms increase in relation, but not in direct proportion, to increasing the weight of

the explosive charge. The shock wave from an underwater explosion diminishes over distance at a rate proportional to the cube root of the weight of the explosive charge. Therefore, the peak pressure generated by an 8-pound charge at a given distance is only about twice the peak pressure of a one pound charge at the same distance ($\sqrt[3]{8} = 2$). Thus, doubling the weight of an explosive charge does not double the impact to aquatic life (Young 1991).

Testing indicates that the highest mortality rates appear to occur within 140 feet of the blasts planned for this project (Appendix C). Delayed mortality of impacted fish that survive within this zone or present outside of the zone is not known. Cumulative impacts to fish exposed to several blasts (at varying distances) over the course of the project is also not known.

SECTION 11. COMPARISON OF IMPACTS

Current planning for the Wilmington Ship Channel involves two broad options. The Corps could retain the plans of the mid-1990s or adopt the design and construction changes which have been developed since the earlier project description. Environmental impacts would differ among these two options and this section considers those differences.

New Alignment for Ocean Entrance Channel

The construction of the entrance channel on a new alignment would impact previously undisturbed ocean bottoms. In general, the Service supports the use of previously disturbed areas rather than the use of new alignments. However, the environmental impacts associated with modifying the existing channel would be substantial if extensive blasting is required. Therefore, a comparison of impacts comes down to the dredging of the new alignment or the blasting required to enlarge the existing alignment.

Backfilling Abandoned Channel

The original plans would enlarge the existing alignment and the refilling of this channel would not be an issue. The key issue is that the undisturbed habitat (generally areas outside the ODMDS) along the new alignment would be replaced by the habitat that eventually occurs along the existing channel. If the existing channel is allowed to naturally fill with what is likely to be finer grained material than what occurs locally, the proposed change would produce an overall adverse impact of the marine benthic community. The abandoned channel would have significantly finer grained material than natural benthic bottoms and could be unsuitable habitat for some organisms. Also, the time to fill in the channel with naturally deposited sediment may take many years, postponing the return of the abandoned channel to more natural conditions. If the abandoned channel is artificially refilled with sediment matching the native grain sizes in adjacent areas, the physical characteristics of the abandoned channel are more likely to resemble current conditions in the undisturbed path of the proposed, new alignment.

Disposal on Beaches of Brunswick and New Hanover Counties

While beach disposal was under consideration during the mid-1990s, the present proposal includes specific plans to place large quantities of material on project area beaches. Earlier plans suggested that the most cost effective disposal option would be placement in the ODMDS. The use of the ODMDS would have impacted both benthic and pelagic organisms at and near the site, but this area was subject to periodic disposal activities from other projects. The proposed change would produce impacts similar to any beach nourishment project using offshore borrow areas. Such impacts include harm to beach invertebrates, nearshore fishes, organisms on area hardbottoms, shorebirds including the federally threatened piping plover, and sea turtle reproduction. The long-term impacts on beaches such as Bald Head Island could be significant with only a few years between disposals. Such short disposal intervals would leave little time for

the recovery of beach invertebrates and may seriously diminish the value of this important sea turtle nesting area by continuous escarpment formation and persistent beach compaction.

The two options for beach disposal, whether it is limited to Bald Head Island and the east end of Oak Island or includes the west end of Oak Island and Holden Beach as well, have slightly different impacts. If all of the 4.8 mcy of material is placed on Bald Head and the east end of Oak Island, the magnitude of the beach disposal will be greater. But placement of the material equally over all four placement reaches would extend the impacts of beach fill over a much larger spatial area; the magnitude of the fill would be reduced, though.

Disposal at ODMDS

There are relatively minor differences between the two alternatives in regard to this project feature. The original design called for the placement of most of the soft sediment from the seaward portion of the project in the ODMDS. The proposed changes would reduce the amount of material by disposing of beach quality sand on project area beaches.

Expansion of Dredging Methods

Proposed modifications to dredging methods include the elimination of areas where certain techniques are forbidden, the use of overflowing for hopper dredges and scows, and the expanded use of dredged material disposal sites. The Corps' proposals are generally accompanied by vague statements that the changes must be consistent with appropriate environmental protection measures. This may mean that the changes would adhere to the strict letter of environmental regulations, but extend beyond measures that previous agreements have indicated were beneficial for fish and wildlife resources. The driving force for the proposals appears to be efforts to reduce project costs.

The Service believes that dredging restrictions that the Corps seeks to eliminate for this project were developed on the basis of sound biology. The elimination of these restrictions would produce some increase in adverse environmental impacts. Such increases may be small. The use of overflow loading of dredges and scows is likely to increase turbidity and siltation. The use of all dredging techniques in areas that previously allowed only certain methods is likely to adverse impact sensitive natural areas, such as fisheries nursery areas. The areas subject to the adverse impacts of overflow loading would be enlarged. However, without comprehensive monitoring such impacts would not be determined.

Overall, the Corps indicates that these changes are being proposed in order to save money and not on the basis of any new biological data. While the environmental impacts of these changes could be relatively small, the magnitude of such impacts are likely to remain unknown. The Service concludes that fish and wildlife resources would be better served by the retention of these dredging restrictions.

Elimination of Bubble Curtain

Based on data acquired by the Corps during test blasts with the bubble curtain, the elimination of the bubble curtain is not likely to produce any significant increase in mortality of aquatic organisms near the blast site. However, the failure of the curtain to reduce mortality does not negate the fact that some mortality will occur near the blast. The bubble curtain was proposed as a mitigation measure and it has now been shown to be ineffective. To some extent the elimination of this mitigation would be offset by a reduction in the number of total blasts and a decrease in the area requiring blasting. However, the Service believes that blasting will adversely affect aquatic organisms, especially fish, in the Cape Fear River, and that some form of compensatory mitigation should be provided.

SECTION 12. CONSERVATION MEASURES

Fish and wildlife conservation measures include: 1) mitigation; and 2) enhancement. Mitigation, as defined by the Council of Environmental Quality and adopted by the Service in its Mitigation Policy (Federal Register 46[15] 1656-1662, January 23, 1981) includes: 1) avoiding the impact altogether by not taking a certain action or parts of an action; 2) minimizing impacts by limiting the degree or magnitude of the action and its implementation; 3) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; 4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the project; and 5) compensating for the impact by replacing or providing substitute resources or environments. This five-action sequence should be viewed as the proper order for formulating mitigation measures.

An issue that is not limited to one of the listed six project modifications, but is relevant to the entire project, is the potential for adverse impacts from contaminants within the dredged sediments. All fish and wildlife resources would benefit by avoiding the introduction of toxic substances into the aquatic and upland habitats of the project area. Certain harmful substances may be contained in the bottom sediments along the new channel alignment and material in existing dredge spoil disposal sites. It is important that toxic substances in toxic amounts are not introduced into the beaches and nearshore ecosystems of the project area.

Wilmington Channel is a major point of entry along the East Coast of the U.S., and as such has seen a great deal of vessel traffic from all over the world. Ballast exchange by freighters that have traveled all over the world could introduce unknown biological and chemical contaminants to the Cape Fear River in the project area. Transfer of petrochemicals, tar, turpentine, and other industrial materials exposes the project area to potential contamination. Various industries along the banks of the Cape Fear River are known to use and discharge toxicants; the Cape Fear basin includes many known or suspected hazardous waste sites. Hog waste lagoon and municipal sewage spills in the Cape Fear watershed in recent years have largely unknown long-term contamination impacts downstream. The Service is concerned that the number and diversity of known point-source and non-point source pollution inputs to this system may result in contaminants-related issues with any dredge spoil in this project excavated from the Cape Fear River or disposal islands.

In 1998 the EPA and the Corps adopted a new Inland Testing Manual (ITM) as a guideline for contaminants testing and evaluation for dredging inland waters, including disposal on dredge spoil islands. The ITM provides a four-tier assessment process for contaminants testing, and the Tier One Assessment is basically a documentation procedure that searches known literature, studies and tests for the project area. Based upon the results of this review, new analysis of sediments may be conducted or determined unnecessary. Either way, the Tier One Assessment documents the decision-making process.

The Service recommends that the Corps conduct a Tier One Assessment for all of the sediments in this project, including those in the spoil islands scheduled for pumpout. This conservation measure would minimize the risk of contamination to fish and wildlife resources in all disposal areas. All of the sediment data provided thus far for this project indicate a significant proportion of fine grain sizes that have a high probability for contaminant adhesion. A Tier One Assessment, performed in accordance with ITM guidelines, should be included in the environmental documents for the project. That assessment should include documentation of the significance of contaminant-related risks, and it should identify the need for any additional assessment. Should any sediments contain toxicants that exceed reasonable screening values for contaminant effects (e.g., EPA Region 4 screening guidelines; NOAA and USGS-BRD derived screening guidelines), appropriate measures should be taken to manage the contaminants.

New Alignment for Ocean Entrance Channel

The annual work schedule for creating the new channel will have a profound effect on the environmental impacts of the project. This is due to the fact that a significant proportion of the material taken from the new channel would be carried directly to the beaches for disposal. The timing of beach disposal is critical to the severity of several environmental impacts. These impacts are: (1) mortality of beach invertebrates; (2) reduced sea turtle nesting success; (3) disturbance of shorebirds foraging and nesting; and, (4) disturbance of offshore marine mammals.

Overall biological activity for these resources is less during the colder months. From a strictly biological point of view, the least harmful period for beach disposal would be the four months from December through March. This period would avoid the time when sea turtle nests (both the nesting and incubation periods) may be on area beaches, May 1 to November 15. The months April and November include the period when beach invertebrates such as *Donax* spp., *Emerita* spp. and digger amphipods may be on the beaches in high numbers. Piping plovers may begin nesting activities in March and April. However, the Service believes that it is very important to avoid dredging and subsequent beach disposal when sea turtle nests may be on area beaches.

No studies concerning the effects of dredging sand for borrow material or channel creation off the North Carolina coast have been conducted. Therefore, impacts associated with offshore sand mining are unknown, and mitigation requirements are difficult to predict. Hurme and Pullen (1988) recommend pre-project, baseline surveys in all potential borrow sites. This requirement is also appropriate for the creation of a new channel. Offshore monitoring is needed in order to determine the effects channel creation has on marine communities in and adjacent to the new alignment. Special attention should be given to identifying hardbottoms and to monitoring the effects on hardbottom habitats which may be near proposed borrow areas. Stender et al. (1991) and Maier et al. (1991) used side scan sonar and underwater television cameras to identify live bottom sites near potential offshore sand borrow sites in South Carolina. The purpose of these surveys would be to avoid important benthic resources such as Essential Fish Habitats, clam beds or active spawning areas.

Based on pre-project survey data, in-kind mitigation should be provided for the loss of benthic habitat along the new alignment. Such mitigation may be possible along the existing channel that would be abandoned if it is backfilled appropriately by the Corps. Natural processes would fill in much of the abandoned channel, but that process would take years and may never fully approximate the natural benthic environment. Backfilling by the Corps with fill sediment that matches native benthic substrate conditions would minimize recovery and recolonization periods of benthic flora and fauna. Sediment size, composition and organic content should be matched to maximize mitigation success.

Areas of the new alignment that pass through the ODMDS or offshore shoals may be subject to large movements of sediment that could increase shoaling along the new alignment. Fine grained material deposited in the ODMDS is more likely to be pushed by prevailing currents into the new alignment. An increase in shoaling would lead to increased maintenance dredging and create the turbidity and sedimentation associated with such dredging. Regular surveys of the buffer surrounding the new alignment through the ODMDS would detect bathymetric changes that contribute to shoaling in the new channel. The survey area should be extended to incorporate the entire new alignment seaward of station 50+00 where it passes through or closely to shoals. Such surveys would identify areas of shifting sediment and could suggest areas where future dumping should be avoided in order to minimize maintenance dredging of the new alignment.

Backfilling Abandoned Channel

Offshore shoals and underwater ridges are desirable habitats for many species of fish. Hurme and Pullen (1988) write that " . . . little is known about the potential effects of modifying the general offshore bathymetry on fisheries." Just as the physical characteristics of the material placed in the abandoned channel are important in reestablished natural habitat values, the contours of both the channel and surrounding areas will be important. The Corps should seek to recreate the natural bathymetric contours and geomorphology of undisturbed ocean bottoms.

Certain construction techniques can minimize long-term harm to offshore organisms. The ability of a benthic community to repopulate a borrow area is influenced by the similarity of sediment surrounding the area, the new sediment-water interface, and possible changes in water quality (Hurme and Pullen 1988). If the abandoned channel is refilled with only finer-grained material, the area will not replace existing benthic habitat lost by the construction of the new channel. In order to minimize the permanent loss of benthic habitat, the Corps should attempt to refill the abandoned channel with material of similar grain size, mineral composition, and organic content.

In order to fully assess the impacts to benthic habitat, the Corps should sponsor a long-term monitoring program to evaluate the recolonization of the abandoned channel. Such a program is the only method for determining the actual development of benthic habitat as the channel refills with sediment. If benthic organisms fail to become established in the area, it may be necessary to develop new mitigation measures.

Disposal on Beaches of Brunswick and New Hanover Counties

The placement of sediment on area beaches should be done in a manner to match the shape and slope of the natural beach. Often beach nourishment results in a steep escarpment between the beach fill area and the natural offshore slope. Such a change in beach profile may cause access problems for nesting sea turtles or obstruct hatchling sea turtles on their way to the ocean. Shorebirds and macrofauna feeding in the swash zone would be impaired by scarps that form at the mean high water line. Human recreational use of the beach's intertidal zone may also be hampered.

Efforts should be made to ensure that the beach profile after nourishment is a natural, gently sloping beach rather than a layered beach with sharp escarpments. If the nourished beach profile develops high escarpments, they should be leveled to grade into the natural profile. Immediately after completion of sand bypassing on beaches and prior to the sea turtle nesting seasons, monitoring shall be conducted to determine if escarpments are present and escarpments shall be leveled as required to reduce the likelihood of impacting sea turtle nesting and hatching activities. Escarpments may be created during the nesting and incubation season that require the use of heavy equipment to grade. However, the use of bulldozers or other heavy equipment on the beach are harmful to existing nests. The use of heavy machinery can cause sand compaction on nourished beaches (Nelson et al. 1987, Nelson and Dickerson 1988a). Heavy equipment may crush nests over which it passes. Such heavy equipment should be kept off the beaches during the nesting and incubation season, May 1 through November 15.

Just as heavy equipment to level escarpments should not be used during the sea turtle nesting and incubation period, such equipment should not be used to move sediment placed on the beach during this period. Limiting the number of heavy vehicles on the beach, perhaps to one regular sized bulldozer, would minimize the potential for crushing invertebrate burrows and the spatial extent and degree of compaction of sediments. Dredge pipelines should not be stockpiled on the beach, either, as they impede human and wildlife utilization of the entire beach habitat.

Beach nourishment should not result in changes in sand density (compaction), beach shear resistance (hardness), beach moisture content, beach slope, sand color, sand grain size, sand grain shape, and sand grain mineral content. These parameters should be similar to the original beach sand. Any changes could result in adverse impacts on sea turtle nest site selection, digging behavior, clutch viability, and emergence by hatchlings (Nelson and Dickerson 1987, Nelson 1988). The beach invertebrate populations that live in burrows also would be impacted adversely by such changes.

These impacts can be minimized by using sand similar to the native beach material and by tilling the beach after nourishment if the sand becomes compacted. The level of beach compaction can be assessed by measuring sand compaction using a cone penetrometer. Tilling of a nourished beach may reduce sand compaction to levels comparable to unnourished beaches. A pilot study by Nelson and Dickerson (1988b) showed that a tilled nourished beach will remain uncompacted

for up to 1 year. Therefore, the Service advocates multi-year beach compaction monitoring and, if necessary, tilling to ensure that project impacts on sea turtles are minimized. Service policy calls for beaches to be tilled if compaction levels exceed 500 pounds per square inch (psi), and we recommend pulling a root rake with tines at least 42 inches long and less than 36 inches apart pulled through the sand of compacted beaches.

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

Fish and wildlife resources will benefit from the longest interval possible between placements of sediment on beaches. If the project leads to increased erosion in the deposition areas, the interval between sediment placement will gradually decrease over time. Extended time periods allow beach invertebrates to recover and minimize the turbidity and siltation associated with the movement and disposal of sediment. Species which annually move offshore and then return to the beaches in the spring, e.g., mole crabs and coquina clams, are much more likely to recolonize a nourished beach at the first recruitment period after sand placement. Hackney et al. (1996, p. 109) conclude that accomplishing renourishment before larval recruitment will ensure rapid recovery of these species. However, more sedentary species, such as digger amphipods of the genus *Haustorius*, have much slower rates of recolonization. In the North Carolina beach nourishment study of Reilly and Bellis (1978, p. 67), the authors concluded that the life history and behavior of *H. canadensis* did ". . . not favor its return to the nourished area quickly." The point of these concerns is that shorter intervals between new sediment placements may reach the point where a given species never returns to the placement area.

The ability for invertebrates to return to the sediment placement area is also influenced by the length of the project. Since surviving populations on the edges of the placement area may supply the colonists for the placement area and dispersal may be limited, the shorter the placement area, the greater the opportunity for adjacent populations to reach the entire length of new beach. In this regard, a series of small projects spaced over several years may be more beneficial to beach invertebrates than a single large project which covers many miles of beach. Such a procedure would allow beach invertebrates to colonize the impacted zone from nearby, unaffected beaches.

Several aspects of beach disposal can lead to greater erosion in the area. These aspects include an altered offshore and nearshore bathymetry that can produce increased wave energy striking the beach, altered wave patterns, and a steeper beach profile that also allowed greater wave energy to strike the beach. These factors, either together or especially in combination, can increase the removal of the new sediment. The Service's concern about increased sediment removal stems from the fact that such removal would decrease the time between sediment

additions. More frequent sediment additions increase all the direct impacts of dredging and sediment placement.

Another reason for concerns about increased erosion rates is the shoreline development that is likely to follow early sediment placements. Early placements are likely to create an atmosphere of protection from coastal storms, and greater development of more expensive structures occurs over the years. If such development does occur and the erosion rate of the beaches increases, demands for more damaging shoreline protection measures, e.g, rock sea walls and groin fields such as the one on Bald Head Island, are likely.

Therefore, a major conservation measure would be a thorough assessment of the erosion rates on beaches that would receive sediment. This assessment would be essentially a measure of the longevity of the artificial beach and the program must be a long-term commitment. If the erosion rate increases, a condition that leads to a decrease in beach longevity, the Corps will need to consider a broader array of measures to protect loss of fish and wildlife habitat.

Artificial beaches may have both dramatic, short-term abnormalities as well as subtle and long-term changes that adversely affect fish and wildlife resources. In the former category, erosional "hot spots" and the formation of escarpments are detrimental to successful sea turtle nesting. Escarpments may form rapidly during storms. A project conservation measure would be a monitoring program to detect the more apparent abnormalities of the artificial beaches. Such programs could also include measures of biological productivity along the beaches.

The project should provide procedures for detecting and removing escarpments along project area beaches. Immediately after completion of sand bypassing on beaches and prior to the sea turtle nesting seasons, monitoring should be conducted to determine if escarpments are present and escarpments should be leveled as required to reduce the likelihood of impacting sea turtle nesting and hatching activities. As noted, the use of heavy equipment on the nesting beaches during the nesting and incubation period may be counterproductive since nests could be harmed or destroyed. Therefore, the Service prefers that work to control escarpments be completed immediately prior to May 1, the start of the nesting season, and that only minor, non-mechanical work be conducted on the beaches during the actual nesting and incubation period. Some leveling and contouring is also appropriate at the time the beach is created.

Project plans should also include a monitoring program for the federally threatened seabeach amaranth plants. Survey data would serve three functions. These functions are: (1) provide data to the Service for assessing the current status of the species and developing recovery procedures; (2) provide baseline population data for use in assessing species recovery in the project area after nourishment; and, (3) provide information to the Plant Conservation Program of the North Carolina Department of Agriculture which would assess the feasibility of relocating plants.

Disposal at ODMDS

The proposed project modifications would result in less dumping at the ODMDS. Some material that would have been directed to this site would be placed on area beaches. Therefore, the Service has no specific conservation measures regarding this project modification.

Expansion of Dredging Methods

Conservation measures to benefit reproduction by colonial waterbirds are primarily related to avoiding disturbances of the birds during the sensitive breeding season. While sand removal from a nesting site is an extreme example, measures must also consider more subtle disturbances such as the noise, fumes, lights, and movements associated with dredging. The activities associated with dredging cause stress and excessive flight responses among breeding birds. Dredging activities near nest sites can ultimately cause the birds to abandon nests. Therefore, dredging activities and sand removal from breeding areas should not occur at or near nesting sites of colonial waterbirds during the breeding season of April 1 through October 31.

Impacts to sea turtles would be minimized by restricting the operation of hopper dredges during periods when sea turtles are most abundant in waters of the project area. As noted in this report, the highest concentration of sea turtles in the water of the project area occur during the warmer months of April through September. This period is similar to the actual nesting period of sea turtles. Therefore, harm to both turtles in the water and on the beach would be minimized by restricting hopper dredging to the colder months of October through March.

Accurate data is needed to assess the impacts of hopper dredging on sea turtles. A significant conservation measure for these protected species would be trained observers on all hopper dredges to count the number of turtles killed during dredging. Data on dredging impacts to sea turtles would be useful in refining seasonal restrictions on dredging and in implementing equipment modifications to protect sea turtles.

The Service would like to support the conservation recommendations of the National Marine Fisheries Service concerning hopper dredging and beach nourishment activities in the southeastern United States (NMFS 1995). The following conservation measures and recommendations are especially relevant to this project:

1. "...precautions that reduce the likelihood of dredge collisions with endangered whales include: aerial surveys conducted in right whale critical habitat during the breeding season, the adoption by dredge operators of necessary precautions when whales are sighted, and reduction in dredge speed during evening hours or days of limited visibility when whales have been spotted within the previous 24 hours." (NMFS 1995, p. 17);

2. "NMFS, based on the recommendations of Griffen (1974), has recommended water column sediment load deposition rates of no more than 200 mg/cm^2/day, averaged over a seven

day period to protect coral reefs and hard bottom communities, rather than use of only state standards." (NMFS 1995, p. 19);

3. "...the COE should reinitiate consultation for any project in which more than one turtle is taken in any day, or once five or more turtles are taken. The Southeast Region, NMFS, will cooperate with the COE in the review of such incidents to determine the need for developing further mitigation measures or to terminate the remaining activity." (NMFS 1995, p. 20);

4. "One hundred percent inflow screening is required, and 100 percent overflow screening is recommended when sea turtle observers are required on hopper dredges in areas and seasons in which sea turtles may be present... . If conditions disallow 100 percent inflow screening, inflow screening can be reduced but 100 percent overflow screening is required, and an explanation must be included in the preliminary dredging report..." (NMFS 1995, p. 21). 100% of the screened material must be observed by on-board observers (NMFS 1995, p. 23);

5. "The sea turtle deflecting draghead is required for all hopper dredging during the months that turtles may be present, unless a waiver is granted by the COE SAD in consultation with NMFS." (NMFS 1995, p. 21);

6. "Beach observers cannot be used in place of shipboard observers for hopper dredging of borrow areas unless the COE can demonstrate that the volume of sand deposited on beaches will not preclude observation and identification of turtles or turtle parts." (NMFS 1995, p. 22);

7. "To prevent the impingement of sea turtles within the water column, every effort should be made to keep the dredge pumps disengaged when the dragheads are not firmly on the bottom." (NMFS 1995, p. 22)

8. "An annual report (based on either calendar or fiscal year) must be submitted to NMFS summarizing hopper dredging projects, document sea turtle and sturgeon incidental takes, and whale sightings." (NMFS 1995, p. 22);

9. "NMFS requires monitoring by endangered species observers with at-sea large whale identification experience to conduct daytime observations for whales between December 1 and March 31, when humpback and right whales occur in the vicinity of channels and borrow areas, north of Cape Canaveral. ... During daylight hours, the dredge operator must take necessary precautions to avoid whales. During evening hours or when there is limited visibility due to fog or sea states of greater than Beaufort 3, the dredge must slow down to 5 knots or less when transiting between areas if whales have been spotted within 15 nm of the vessel's path within the previous 24 hours." (NMFS 1995, p. 22);

10. "North of the St. Johns River, in Florida, endangered species observers on hopper dredges within nearshore and riverine areas must also monitor for shortnose sturgeon impingements." (NMFS 1995, p. 22); and,

11. 100% observer monitoring by endangered species observers with at-sea sea turtle identification experience is required to conduct daytime observations for sea turtles between April 1 and November 30 (NMFS 1995, p. 23).

Elimination of Bubble Curtain

The Service provided conservation measures related to blasting in the Cape Fear River in the FWCA Report for the original project (USFWS 1996a). Those measures were based on the planned use of the bubble curtain to mitigate the underwater shock waves from each explosion. The elimination of the protective curtain requires a reconsideration of conservation measures for blasting.

First, the annual timing of blasting is an important conservation measure. The Service recommends that blasting should be restricted to the time of year of lowest biological activity. However, finding a suitable time period for blasting will be difficult because the critical time periods for whales, manatees, sea turtles, larval fish, and adult fish do not coincide.

The current "window" for blasting in the lower Cape Fear River is the six-month period from August 1 through January 31. This schedule is based primarily on concerns for fisheries resources, including the federally endangered shortnose sturgeon. The Service supports the use of this schedule. However, the Service has determined that the federally endangered manatee is most likely to occur in the project area during the period between June 1 and September 30. While sea turtles may occur in the estuary during all months of the year, they are most abundant from April through September.

The Service believes that blasting during August and September could harm and/or kill manatees and sea turtles. Therefore, we believe that blasting should be limited to the four-month period from October 1 through January 31. Even within the four-month blast period recommended above, important fisheries resources and sea turtles may be present in the project area.

Some fish are likely to be killed by blasts within the Cape Fear River. The exact extent of fish mortality may never be known, but the lack of hard data should not eliminate the need to compensate for these losses in some manner.

The Corps should provide contractual opportunities to local universities to conduct aquatic resource surveys before, during and after the project construction period in order to document and gather important data on valuable fish and wildlife resources such as the shortnose sturgeon and impacts to their populations and distributions. This data should be made available to the

Service, NMFS and all interested parties in order to better define dredging windows, types of dredges allowed, and impacts of dredging on aquatic resources.

Dams along the Cape Fear River are a significant impediment to certain fish reaching historical spawning areas. Reproduction would be enhanced if areas upstream from these dams were accessible to the fish. In the Cape Fear River 99 miles of mainstem and a very large mileage of tributary streams (likely over 1,500 miles) exist between Lock and Dam #2 and Buck Horn Dam (next dam upstream). The Service would like to work with the Corps to provide some form of structural fish passage at Lock and Dam #2 and Lock and Dam #3 additional to the fish locking that is currently being accomplished. This fish passage could be in the form of a larger version of the prefab ladder that is on Lock and Dam # 1 or perhaps just the strategic placement of boulders on or near the downstream toe of the dams. To mitigate for fish losses due to blasting the Service proposes the Corps provide structural fish passage at Lock and Dams 2 and 3 in addition to the fish locking sequence that is currently employed for anadromous fish and fund a graduate student (Master of Science) to examine the effectiveness of the structures. The Coastal Program of the Service will work with the Corps to provide technical assistance and potentially serve as a funding partner.

SECTION 13. RECOMMENDATIONS

In accordance with the FWCA, the Service offers the recommendations in this section in order to avoid, minimize, and mitigate adverse impacts on fish and wildlife resources. These brief recommendations are the culmination of all the information presented and analyzed in the preceding sections of this report. These recommendations should not be considered without a thorough understanding of the entire report, specifically the conservation measures presented in Section 12.

All of the previous conservation measures and recommendations made by the Service relating to project features that have remained unchanged, such as those related to saltwater intrusion, post-blasting monitoring for killed and injured organisms, and potential increased erosion of riparian shorelines from increased ship wakes, are still valid and should be supplemented by the following recommendations on these project modifications.

1) A Tier One Assessment according to the Inland Testing Manual (ITM) adopted by the Corps and the EPA in 1998 be conducted on all sediments in the project, and such documentation be included in the environmental documents. Sediments to be assessed include those from any disposal islands proposed for pumpout for either beach or offshore disposal. Should any sediments contain contaminants or toxins that exceed EPA standards, appropriate measures should be taken to manage the contaminants.

New Alignment for Ocean Entrance Channel

2) The Corps should address the issue of existing and proposed Essential Fish Habitats (EFH) in the new channel alignment and immediate surrounding areas. If any existing or proposed EFH are located in the new alignment construction area or offshore disposal areas, the Corps should coordinate with the NMFS to take the appropriate conservation measures.

3) Loss of benthic habitat with the creation of a new channel should be mitigated in-kind with backfilling the abandoned channel with identical or very similar substrate grain size, composition and geomorphology as adjacent benthic substrates.

4) The 2500' designated buffer surrounding the channel where it passes through the existing ODMDS should be regularly surveyed for bathymetric changes in order to monitor increased shoaling rates of the channel, which would lead to increased maintenance needs. Additional surveys should be conducted along a similar 2500' corridor for the entire new channel alignment, seaward of station 50+00, in order to monitor for shoaling from other adjacent sediment bodies. Multi-beam or the Corps SHOALS surveys would yield more accurate bathymetry data than a few scattered soundings and increase spatial resolution and coverage.

Backfilling Abandoned Channel

5) Sediments used to backfill the abandoned navigational channel should match the native grain size, mineral composition and organic content in order to better mimic the native habitat.

6) Backfilling of the abandoned channel should approximate the natural bathymetric contours and geomorphology of the surrounding areas. Deviation from the natural conditions could prevent or delay re-colonization of the newly filled area by benthic organisms.

7) The backfilled channel should be monitored regularly with both bathymetric surveys (preferably multi-beam or SHOALS) and benthic organism surveys to establish recolonization rates and success or failure. Bathymetric surveys would generate data on changes to the former channel due to altered current or wave patterns, which could suspend portions of the fill and remove it from the channel. Any measured impacts over the life of the project should be mitigated through coordination with the Service, NMFS and other relevant agencies.

Disposal on Beaches of Brunswick and New Hanover Counties

8) No disposal of dredge materials should take place on beaches or the littoral zone during the sea turtle nesting and incubation season of May 1 to November 15, which roughly coincides with shorebird nesting and beach invertebrate spawning and recruitment seasons.

9) Fill placement should not create a pronounced hill or mound of sand that could create an obstacle or scarp to wildlife and human resources utilizing the beach.

10) Heavy equipment used to manipulate fill sediments placed on the beach should be kept to a minimum, perhaps only one regular size bulldozer on any given beach at any given time. Night work should use the minimum amount of light necessary (which may require shielding) or low pressure sodium lighting during project construction.

11) Sediments disposed on the beaches or adjacent littoral zones should be *at least* 90% sand, match native grain size ranges and mineral composition, contain as little organic matter as possible and be free of contaminants exceeding safe levels.

12) Beach fill should be monitored for compaction, escarpment formation, and subaerial and subaqueous profiles on a regular basis (perhaps quarterly and after every storm) in order to determine the longevity of the material's placement. Immediately after completion of sand disposal on beaches and prior to sea turtle nesting seasons, monitoring shall be conducted to determine if escarpments are present and escarpments shall be leveled as required to reduce the likelihood of impacting sea turtle nesting and hatching activities.

13) Beaches scheduled to receive maintenance materials (i.e., Bald Head Island and Caswell Beach) should be monitored long-term for increased erosion rates, decreased biological productivity and cumulative impacts to fish and wildlife resources, especially Federally-listed

species such as sea turtles, piping plovers, and seabeach amaranth. Any measured impacts over the lifespan of the project and its maintenance should be mitigated through coordination with the Service, NMFS and other relevant agencies.

Expansion of Dredging Methods

14) Hopper dredges should not be used during the summer sea turtle nesting season or spring and fall migration periods when species numbers in inland waters are high.

15) Observers should be present on all hopper dredges to monitor for incidental takes of sea turtles year-round. All takes should be documented and reported to the Service and NMFS, and appropriate conservation measures coordinated in the event of excess takes.

16) Dredging activities should not occur adjacent to disposal islands during the colonial waterbird nesting season of April 1 to October 31 in order to minimize disturbance to such nests. Activities should be minimized from disturbing colonial waterbirds with potential noise, lights and fumes at all times of the year. Potential screening/blocking or other appropriate conservation measures should be coordinated with the North Carolina Colonial Waterbird Management Committee and other relevant agencies.

17) Spoil islands should not be pumped out or re-filled during the colonial waterbird nesting season to minimize disturbances to nesting habitat and existing nests.

18) All dredging activities should comply with existing agreements with the National Marine Fisheries Service and the U.S. Fish and Wildlife Service as to timing and types of allowable dredges. The 1995 Biological Opinion and Incidental Take Statement issued by NMFS to the Corps should be fully complied with in particular.

Elimination of Bubble Curtain

19) The Service recommends mitigation for the loss of fish associated with the blasting of rock during the project. The Service proposes the Corps provide structural fish passage at Lock and Dams 2 and 3 in addition to the fish locking sequence that is currently employed for anadromous fish and fund a graduate student (Master of Science) to examine the effectiveness of the structures.

20) All blasting should avoid times of spawning or known important juvenile stages of fish in the project area.

21) The Corps should provide contractual opportunities to local universities to conduct aquatic resource surveys before, during and after the project construction period in order to document and gather important data on valuable fish and wildlife resources such as the shortnose sturgeon

and impacts to their populations and distributions. This data should be made available to the Service, NMFS and all interested parties.

SECTION 14. SUMMARY AND POSITION OF SERVICE

The Wilmington Harbor, North Carolina, 96 Act Project Modifications may result in significant alterations in the diverse ecosystems of the lower Cape Fear River watershed. The planning process to date has adequately documented the economic justification for the proposed modifications, the range of alternatives considered, and the selection of a preferred alternative.

In the past the Service has expressed concern about the environmental impacts of other projects to modify the Wilmington Harbor Ship Channel. The large construction effort needed to accomplish the preferred alternative for the present project modifications has the potential to create significant direct, indirect, and cumulative adverse environmental impacts. However, the Service believes that a thorough consideration of the environment during planning can avoid many of the most severe impacts and minimize others.

With the exception of impacts associated with blasting, the Service believes that the most direct impacts associated with construction will be short-term and rectified in time. However, blasting in the ship channel has the potential to produce significant harm to important fisheries resources and Federally protected species. These impacts may be avoided or minimized by a comprehensive program to restrict the use of blasting, the use of seasonal restrictions on blasting, the proper selection of equipment and blasting procedures, monitoring programs, and programs to contain blast impacts and halt blasting if important resources are detected within scientifically-based, predetermined danger/safety zones. The elimination of the bubble curtain in the proposed modifications fails to meet the Service's concerns regarding containing blast impacts. Mitigation for the loss of fish and other aquatic resources should be provided. The Service recommends improved fish passage at Lock and Dams 2 and 3, and our Coastal Program is willing to coordinate such mitigation activities. Monitoring of the effectiveness of this mitigation could be provided through funding of a Master's student at a local university.

The Service is more concerned about the long-term, secondary impacts of the proposed project modifications. This report has detailed concerns about potential indirect impacts from each of the six modifications. The Service realizes that these impacts may be difficult to predict with a high degree of accuracy. However, the Service is concerned that several of the Corps' efforts to evaluate these impacts have not been completed. There are currently only minimal or no evaluations of the potential impacts to the longshore transport system that influences area beaches, turbidity and siltation effects on nearshore hardbottoms or estuarine nursery areas, contaminants contained within the dredged sediments, grain size compatibility with native beach sediments, cumulative impacts to beach invertebrate populations, and alterations to local water circulation and wave patterns resulting from the new channel alignment, backfilling of the old channel, and filling the existing ODMDS to full capacity. The Service strongly recommends that the Corps fully evaluate all potential, indirect impacts which may be produced by the project, develop long-term monitoring programs where major uncertainties exist, and plan remedial measures for a "worse-case" scenario of each potential impact.

The proposed expansion of dredging methods generates a set of direct and indirect impacts that would adversely affect fish and wildlife resources throughout the project area. Increased turbidity and siltation with overflowing scows could smother important estuarine benthic habitat and nursery areas, suffocate fish and alter the nutrient and oxygen levels of local waters. The year-round use of dredges, some of which have been documented to take Federally-listed species such as sea turtles, would breach previously arranged agreements the Corps has with resource agencies. The Service cannot support the expansion of dredging methods proposed in this set of project modifications.

The Service believes that some of the proposed project modifications offer opportunities for the enhancement of fish and wildlife resources within the project area. Such measures include: (1) the use of soft sediment which is free of contaminants and properly placed and graded on existing disposal islands to benefit nesting by colonial waterbirds; (2) the use of soft sediment which is free of contaminants, of the appropriate grain size, and properly placed in the littoral zone near the mouth of the Cape Fear River to support area beaches; and (3) the use of sediment which is contaminant-free and properly placed to fill the abandoned navigational channel to restore a more natural benthic habitat. The Service strongly recommends that the Corps fully consider each of these measures.

In summary, the Service has provided recommendations which, in our opinion, will: (1) eliminate, or minimize, most short-term, direct impacts; (2) generate information on potential indirect impacts which are now poorly understood; (3) define those elements of the environment which are susceptible to long-term degradation and which require monitoring and contingency planning for possible remedial actions; and (4) designate actions which could benefit the natural resources of the project area. If the Corps implements each of these recommendations, the Service believes that the proposed project modifications are compatible with the long-term viability of marine, estuarine, and freshwater ecosystems in the project area and the many fish and wildlife resources which they support.

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APPENDICES

APPENDIX A

Acronyms Used

ODMDS	Offshore Dredged Material Disposal Site
WOFES	Wilmington Offshore Fisheries Enhancement Structure

SUPPLEMENT
to the FINAL FISH & WILDLIFE COORDINATION ACT REPORT

APPENDICES B, C, and D

These appendices from the Coordination Act Report have been omitted because they contain earlier versions of material presented in updated form elsewhere in the text and appendices of the USACE Environmental Assessment.