

Appendix D

WILMINGTON HARBOR SAND MANAGEMENT PLAN OCEAN ENTRANCE CHANNELS AND INNER HARBOR BETWEEN LOWER SWASH AND REAVES POINT

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: Bald Head Shoal; Smith Island; Bald Head – Caswell; Southport; and Battery Island. These ranges are shown on Figure 1. Beach quality sands will also be removed from portions of the Inner Harbor channel extending from the Lower Swash Range to the Reaves Point Range. These Inner Harbor channel ranges are also shown on Figure 1. An estimated 4.8 million cubic yards of beach quality material will be removed from the Lower Swash Range seaward to the Bald Head Shoal Range and approximately 1.3 million cubic yards of beach quality material removed from the Snows Marsh Range to the Reaves Point 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 Bald Head Shoal, Smith Island, Bald Head – Caswell, Southport, Battery Island and Lower Swash channels. Construction of the ocean entrance channels into Wilmington Harbor will entail the removal of approximately 14.8 million cubic yards of material, 4.8 million cubic yards of which is beach quality sand. Beach quality sand exists throughout all of the entrance channel except the new Bald Head Shoal Channel. Within the Bald Head 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 NGVD. Material below these depths consists mainly 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 Jay Bird Shoal, which lies west of the channel, and Bald Head Shoal. Bald Head Shoal forms the east boundary of the existing channel, however, the new 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 Offshore 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 with at least one-half of the added cost justified by the dollar value of the storm damages prevented. Before the additional cost of beach disposal can be determine, an acceptable disposal plan for the new work material must be established and the cost for this disposal plan determined. The formulation of the disposal plan for the new work material is discussed below. 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 project feasibility report had all of the material from the Lower Big Island Range through the Bald Head Shoal Channel going to the offshore disposal area. It should be mentioned that the disposal plan in the feasibility report did not include consideration of the realigned Bald Head Shoal Channel. The alignment of the new Bald Head 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 Bald Head 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 Bald Head 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 through 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). In addition, no material would be place in a 2,500-foot wide corridor parallel to and west of the new entrance channel to assure that the deposited material does not move into and shoal the new channel (see Figure -1). The size of the corridor through the ODMDS needed to prevent the return of deposited material into the channel 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 April 2000 with the award of a contract to construct the offshore portion of the Bald Head Shoal Channel

seaward of station 120+00. The material to be removed from this segment of the new channel, which totals about 5.7 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 Bald Head Shoal Channel and the other ocean entrance channels, which will include 4.8 million cubic yards of beach quality sand and 4.3 million cubic yards of unsuitable beach material, will be awarded near the end of calendar year 2000. Work on the inner portions of the project between the Snows Marsh Range and Reaves Point Range will also be performed in early 2001. Approximately 1.0 million cubic yards will be removed from this portion of the project with disposal of the dredged material currently scheduled to go to the ODMDS. The economic and engineering viability of other options for the disposal of the beach quality material to be removed from Snows Marsh to Reaves Point 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 2001 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 1 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 16.8 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 21 million cubic yards, exceeding the remaining capacity of the existing ODMDS by more than 4.2 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 the 4.8 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 4.8 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 16.2 million cubic yards, effectively depleting the remaining capacity of the existing ODMDS. Once the new ODMDS becomes operational, all future dredged material requiring ocean disposal will be placed in the new area.

9. The disposal of the 4.8 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. On Bald Head Island, the rate of disposal on the 2,000-foot segment on West Beach would be 120 cubic yards per foot of beach, or a total of 240,000 cubic yards of channel material. Based on the characteristics of the sediment to be removed, about 83 percent of the dredged material is expected to remain in place resulting in a net fill of 200,000 cubic yards. Following initial adjustments of the fill, this quantity of material should widen West Beach by 90 to 100 feet. The disposal rate for the channel material along the first 2,000 feet of South Beach would also be 120 cubic yards per foot of beach. 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. Disposal along the remaining 12,000 feet of South Beach would be increased to 175 cubic yards per lineal foot of beach. The total dredged material volume placed on South Beach would be 2,100,000 cubic yards. With a retention rate of 83 percent, the western 2,000 feet of South Beach would be widened 90 to 100 feet, the same as West Beach, while the eastern 12,000 feet of South Beach would be widened by 130 to 140 feet. 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 (2,220,000 cubic yards) would be equally distributed along the 25,000-foot disposal area on Oak Island-Caswell Beach. This would result in a gross placement rate of about 90 cubic yards per foot of beach or an in place rate of roughly 70 cubic yards per foot of beach.

10. The dredged material disposal rates proposed in the base plan would result in initial or constructed beach widths on Bald Head Island of approximately 180 feet on West Beach and the west end of South Beach and 270 feet along the eastern 12,000 feet of South Beach. Over a period of several months, the material will undergo sorting and slope adjustments that will reduce the beach widths to around 90 to 100 feet on West Beach and the west end of South Beach and approximately 130 to 140 feet over the remaining portions of South Beach. Following these 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. On Oak Island-Caswell Beach, constructed beach widths should increase by 140 to 150 feet, again decreasing to around 70 feet within a few months following placement. Erosion of the adjusted material on Oak Island-Caswell Beach is also expected to occur at rates slightly greater than that of the existing beach.

11. **Cost Estimate-Base Disposal Plan.** Cost estimates for constructing the ocean entrance channel in accordance with the Base Disposal Plan described above are

presented in Table 1. The dredge equipment that would be used for the initial construction includes an ocean certified cutter-suction pipeline dredge for deposition of the sand on the beach and a hopper dredge for removal of the material not suited for beach disposal. The unsuitable material will be placed in the existing ODMDS. Placement of material on Bald Head Island would require the use of one booster pump. Placement of material on East Oak Island-Caswell Beach would require 2 booster pumps. The costs presented in Table 1 will be used to determine the incremental cost for placing beach quality material on the remaining western segment of Oak Island and along the east end of Holden Beach under authority of Section 933.

Table 1
Cost Estimate for Wilmington Harbor Entrance Channel
Base Disposal Plan

Item	quantity	Unit	Unit Cost	Cost
Beach Disposal-Pipeline				
Mobilization & Demobilization	1	Job	\$1,770,000	\$1,770,000
Placement on Bald Head Island	2,580,000	Cu. Yds.	\$2.40	\$6,192,000
Placement on Oak Island-Caswell Beach	2,220,000	Cu. Yds.	\$4.90	\$10,878,000
Subtotal-Beach Disposal	4,800,000			\$18,840,000
Ocean Disposal				
Pipeline Mobilization & Demobilization	1	Job	\$1,393,000	\$1,393,000
Disposal in ODMDS	10,041,000	Cu. Yds.	\$2.40	\$24,098,000
Subtotal Ocean Disposal	10,041,000			\$25,491,000
Total Cost Base Disposal Plan				\$44,331,000

12. **Section 933 Cost Estimates.** The Brunswick County beach towns of Bald Head Island, Caswell Beach, Oak Island, Holden Beach, and Ocean Isle 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. 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.

13. In keeping with the desires of the Brunswick County Consortium, and for purposes of evaluating the cost and benefits associated with beach disposal of the new work material, the 4.8 million cubic yards of beach quality material will be equally distributed along all of the beach areas on Bald Head Island, Oak Island-Caswell Beach and the Holden Beach. The 4.8 million cubic yards of beach quality material to be removed from the channel equates to 4.0 million cubic yards of in place sand on the beach based on a retention rate of 83 percent discussed previously. The shoreline segments that would receive material from Wilmington Harbor 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 equal distribution of the Wilmington Harbor beach quality material in these segments would result in an in place fill volume of approximately 50 cubic yards per lineal foot of beach. The width of the fill immediately following placement will be around 100 feet. The construction width is expected to adjust to around 50 feet within a few months following placement. Following the initial adjustments, erosion of the fill material will occur at rates equal to or slightly higher than the historic erosion rates. Table 2 provides a summary of the dredged volume and in place volume for each beach segment.

Table 2
Distribution of Wilmington Harbor Entrance Channel Dredged Material

BEACH SEGMENT	LENGTH (FEET)	DREDGED VOLUME (CY)	IN PLACE VOL. (CY)
Bald Head Island	16,000	1,000,000	833,000
East Oak Island-Caswell Beach	25,000	1,550,000	1,292,000
West Oak Island	25,600	1,590,000	1,325,000
Holden Beach	10,600	660,000	550,000
Totals	77,200	4,800,000	4,000,000

14. Bald Head Island and the East Oak Island-Caswell Beach segments are the designated disposal areas for the beach quality new work material and do not require economic justification. Therefore, economic justification is only needed for the West Oak Island and Holden Beach segments. Cost estimates for placing the new work channel material along all of the beach segments listed in Table 2 were prepared in order

to determine the total cost of this operation. Due to the distance between the Wilmington Harbor entrance channels and the west end of Oak Island and the east end of Holden Beach, the least costly dredging-beach disposal operation for these remote segments would involve a hopper dredge with direct pumpout capability. The cost estimate for determining the overall cost of dredging the Wilmington Harbor entrance channels with disposal of the beach quality material in all of the four beach segments is given in Table 3. The total cost of this combined operation will be compared to the total cost of the Base Disposal Plan to determine the incremental cost for placing material on the West Oak Island and Holden Beach.

Table 3
Cost Estimate for Wilmington Harbor Entrance Channel
Section 933 Plan

Item	quantity	Unit	Unit Cost	Cost
Beach Disposal-Pipeline				
Mobilization & Demobilization	1	Job	\$1,770,000	\$1,770,000
Placement on Bald Head Island	1,000,000	Cu. Yds.	\$2.40	\$2,400,000
Placement on Oak Island-Caswell Beach	1,550,000	Cu. Yds.	\$3.30	\$5,115,000
Beach Disposal -Hopper				
Mob & Demob Pumpout Equipment	1	Job	\$1,294,000	\$1,294,000
Placement on West Oak Island	1,590,000	Cu. Yds.	\$7.50	\$11,925,000
Placement on Holden Beach	660,000	Cu. Yds.	\$8.80	\$5,808,000
Subtotal-Beach Disposal	4,800,000			\$28,312,000
Ocean Disposal				
Hopper Dredge Mob & Demob	1	Job	\$1,393,000	\$1,393,000
Disposal in ODMDS	10,041,000	Cu. Yds.	\$2.40	\$24,098,000
Subtotal Ocean Disposal	10,041,000			\$25,491,000
Total Cost Section 933 Disposal Plan				\$53,803,000

15. Allocation of Cost Difference. The difference in cost between the Base New Work Disposal Plan and that associated with equally distributing the beach quality material to the four beach communities in the Brunswick County Consortium is \$9,472,000. This added cost is due to the disposal of material on West Oak Island and Holden Beach as the base plan includes disposal on East Oak Island-Caswell

Beach and Bald Head Island. Therefore, the added cost under the Section 933 disposal plan will be allocated to West Oak Island and Holden Beach. The added cost for placing sand in these two areas is due to the higher unit cost for placing sand in these more remote areas and the volume of material to be placed. Accordingly, the allocation of the added cost to West Oak Island and Holden Beach was based on the percentage of the added cost attributable to these two beach segments. Based on the cost shown in Table 3, the total cost for placing beach quality material on West Oak Island and Holden Beach (excluding the mobilization and demobilization cost) is \$17,733,000. Of this total, West Oak Island's share is about 67 percent and Holden Beach 33 percent. These percentages were used to allocate the \$9,472,000 in added cost between the two beach segments resulting \$6,346,000 being allocated to West Oak Island and \$3,126,000 allocated to Holden Beach. These distributed added costs are the added costs that must be justified on the basis of the storm damage reduction in order for the added costs to be eligible for Federal cost sharing.

Inner Harbor – Snows Marsh Range to Reaves Point Range Sand Management Plan

16. **Introduction.** The sand management plan for the inner harbor addresses dredging and disposal issues associated with the Snows Marsh, Horseshoe Shoal, and Reaves Point channels. An estimated 1.3 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 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 conjunction 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 nourishment adjacent beaches.

17. **Plan Formulation.** The disposal plan for new work material presented in the 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 1.3 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 2.6 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 Reaves Point reach will assure that the dredge material disposal occurs in the

least costly, environmentally acceptable manner, consistent with engineering requirements established for the project.

Maintenance Material Disposal Plan

18. **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 primary 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 Bald Head 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.

19. 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 states (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.”

20. 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.

21. 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.

22. **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.

23. The Wilmington Harbor project, historically, has not included the disposal of littoral sands on the adjacent beaches on 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 50 feet or more.

24. 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.

25. 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.

26. 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.

27. 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 also includes a 100-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 Bald Head 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 will be continued 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.

28. **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.

29. 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 out weigh the negative impacts.

30. **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.

31. **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.

32. 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. A comparison of the cost for ocean disposal versus beach disposal of the littoral material is provided in Table 4. 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.

Table 4
 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

33. **Summary.** The sand management plan developed for the new work beach quality material and maintenance material to be removed from the new entrance channel 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, 2,580,000 cubic yards of the new work material would be placed on Bald Head Island and 2,220,000 on Oak Island-Caswell Beach.
- (c) Under Section 933, the material would be equally distributed along Bald Head Island, Caswell Beach, Oak Island, and Holden Beach in accordance with the volumes shown in Table 2.
- (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.

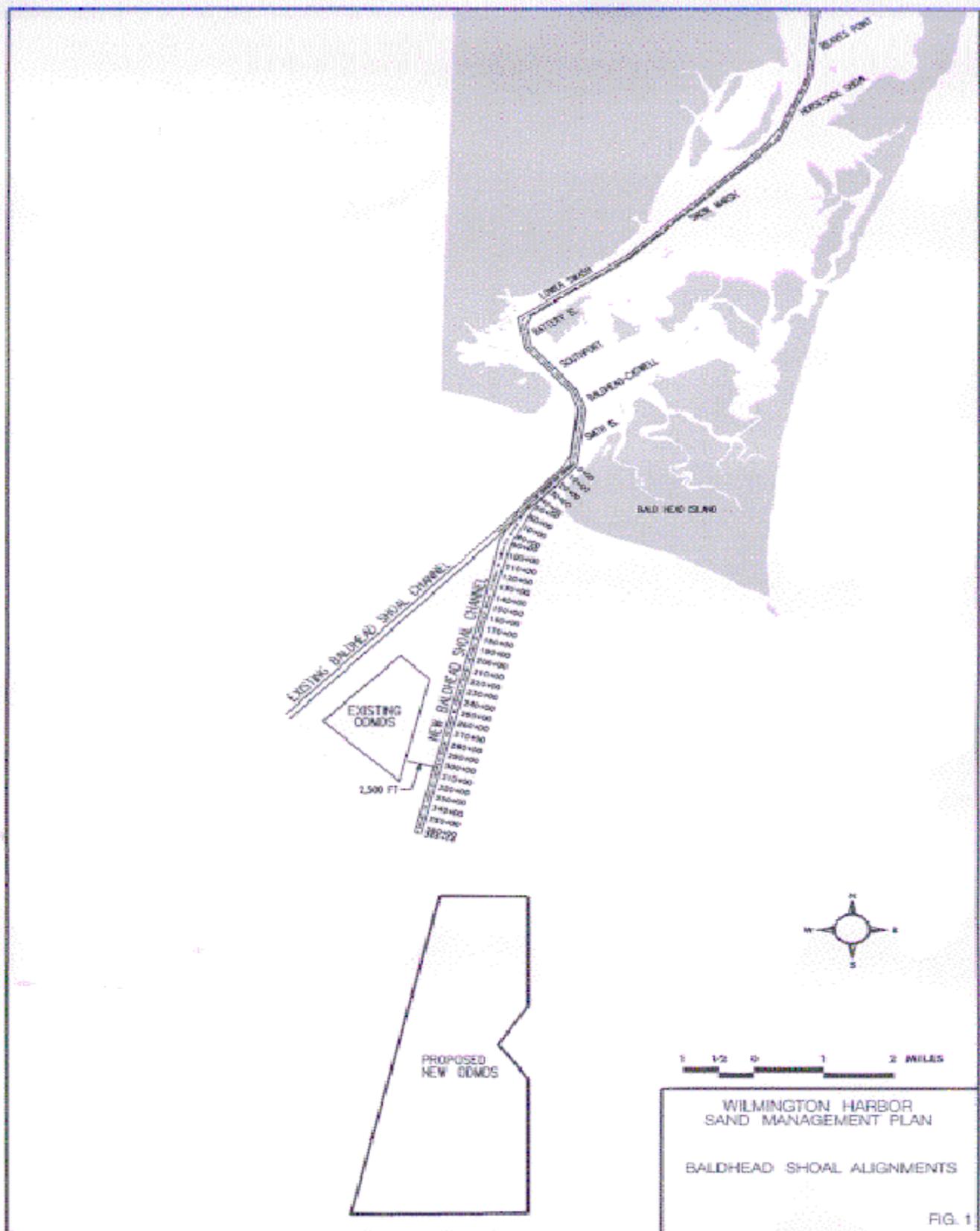
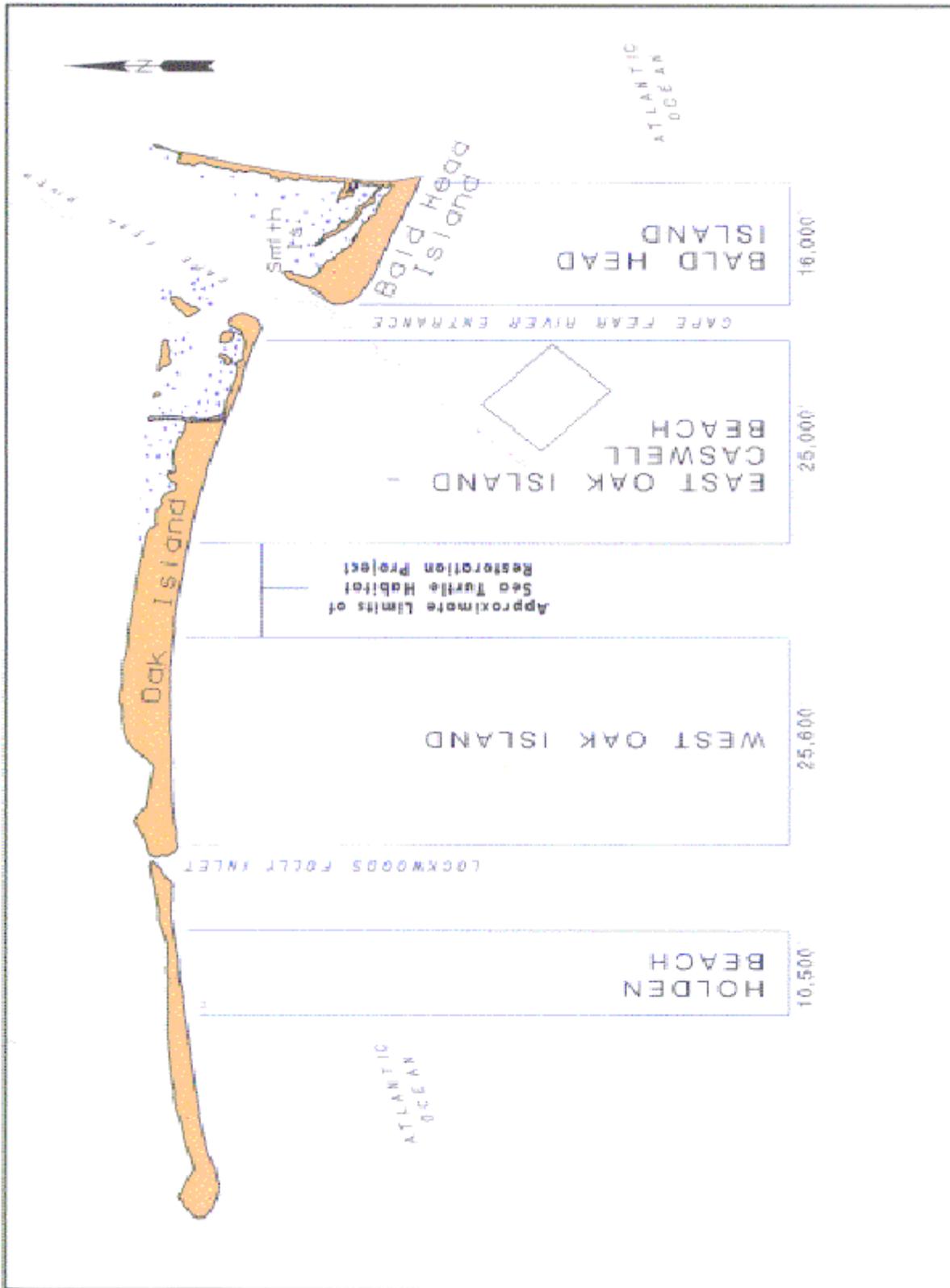


FIGURE 1.



POTENTIAL BEACH DISPOSAL AREAS
BRUNSWICK COUNTY, N.C. Figure 2

FIGURE 2.