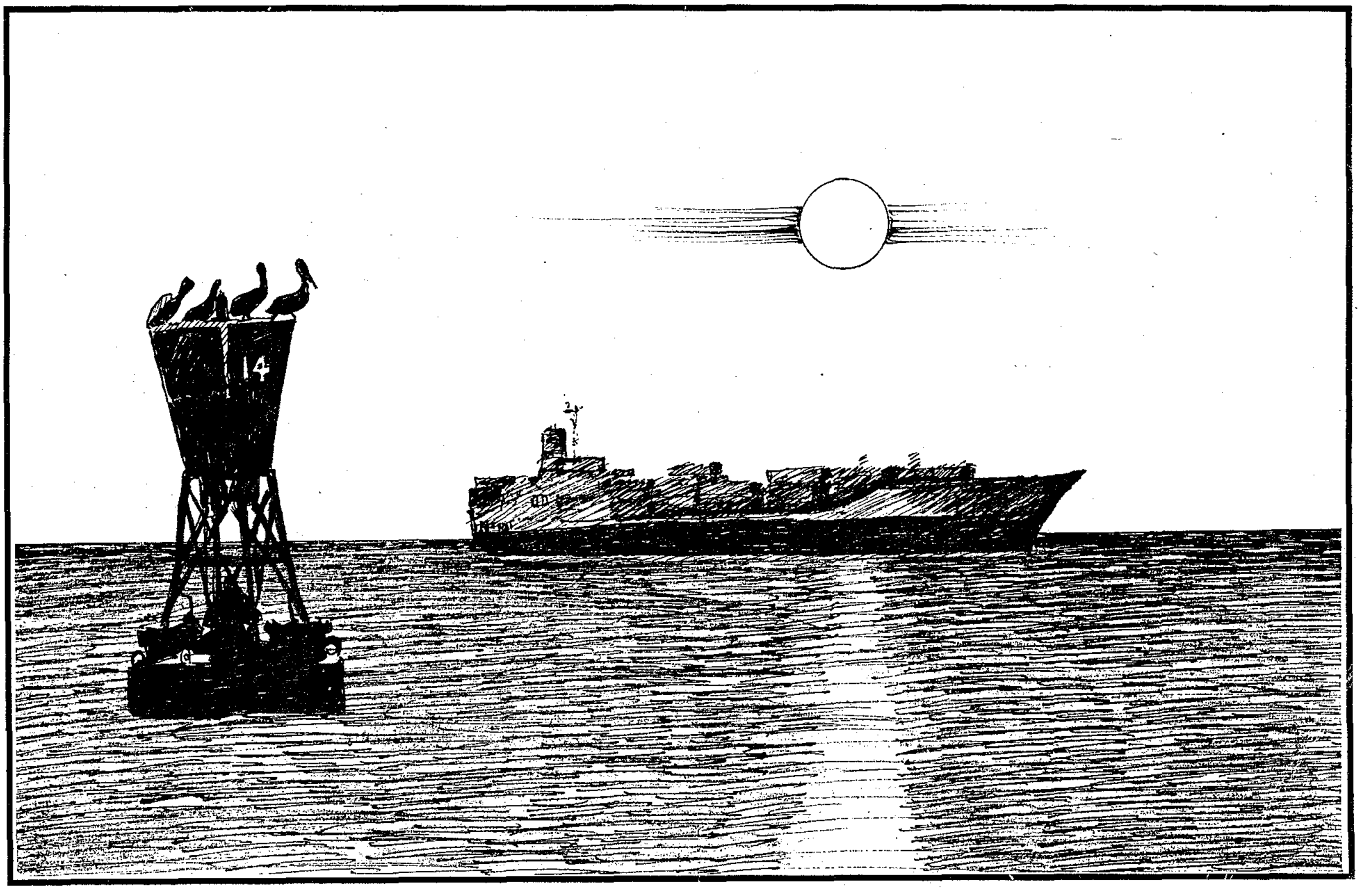
US Army Corps of Engineers
Charleston District

February 1996

Charleston Harbor
Charleston, South Carolina

Final Feasibility Report
with Environmental Assessment



Addendum

Paragraph 3(a) of the Project Guidance Memorandum for this study calls for CECW-AR coordination with CECW-PD and IWR regarding the vessel operating costs that were used to compute project benefits. This coordination was accomplished in January and February of 1996 and in response to the discussions that took place, CECW-P directed the District to recompute project benefits using the vessel operating costs presented in the FY95 Economics Guidance Memorandum [EGM].

The District recomputed project benefits using the methods described in Appendix E (Economics); all inputs except vessel operating costs were held constant at their original values. The results of this analysis are presented in this addendum to the Main Report and reconfirm that the recommended plan is the NED plan. The District has coordinated with CECW-P regarding the preparation of this addendum.

The use of the vessel operating costs from the FY95 EGM resulted in declines of various magnitudes in transportation costs and project benefits. Container traffic was less affected by this change than were dry and liquid bulk cargo. Baseline transportation costs associated with container traffic declined by about 4 percent with the use of the vessel operating costs from the FY95 EGM and benefits declined by about 6 percent. The impact on dry and liquid bulk traffic was more pronounced, with baseline transportation costs declining by about 10 percent and benefits declining 15 to 20 percent.

The three major components of the recommended plan are the channel deepening project, a turning basin for the Daniel Island Terminal, and a channel realignment project in the Shutes and Folly reaches of the harbor. Table 1 summarizes the benefits associated with the total deepening project and Table 2 shows the benefit-cost comparisons for the various channel depths. Net benefits are maximized with the 45-foot project depth, with a benefit-cost ratio of 1.75.

The revised benefits and benefit-cost ratios for the Daniel Island Turning Basin and the Shutes/Folly Realignment are shown in Tables 3 and 4, respectively. Net benefits for the turning basin are maximized at a depth (of the turning basin) of 45-feet, with a benefit-cost ratio of 1.15. The Shutes/Folly Realignment is also shown to be feasible, with a benefit-cost ratio of 1.67.

As noted above, the use of the vessel operating costs shown in the FY95 EGM did not result in any changes to the original recommendations. Revised average annual net benefits of the total recommended project are $7.5 million, with a benefit-cost ratio of 1.70. A summary of the re-evaluated costs and benefits of the total recommended project is shown in Table 5.

Table 1
Charleston Harbor Study
Re-Evaluation of Channel Deepening Benefits
Using FY95 EGM Vessel Operating Costs

	Channel Depth					
Item	41	42	43	44	45	46
<u>Present Value of Benefits</u>						
European Containers	19,800.3	33,787.6	57,021.1	76,872.7	88,380.8	93,211.8
Pacific Containers	39,638.9	45,468.8	50,998.6	59,524.4	59,524.4	59,524.4
Coal	17,886.5	20,111.5	22,903.0	24,176.0	25,295.4	25,295.4
Grains	1,864.6	3,056.4	3,794.2	4,905.3	6,320.2	7,735.0
Iron	480.0	556.1	619.1	629.0	668.4	707.4
Petro	13,680.3	20,139.9	24,470.4	24,908.2	27,365.0	29,821.8
Subtotal	93,350.7	123,120.3	159,806.4	191,015.7	207,554.2	216,295.9
BDC	511.2	1,970.3	2,717.5	4,165.6	5,019.0	7,026.5
Total	93,861.9	125,090.6	162,523.9	195,181.3	212,573.2	223,322.4
<u>Average Annual Benefits</u>						
European Containers	1,549.1	2,643.4	4,461.0	6,014.1	6,914.5	7,292.4
Pacific Containers	3,101.1	3,557.3	3,989.9	4,656.9	4,656.9	4,656.9
Coal	1,399.4	1,573.4	1,791.8	1,891.4	1,979.0	1,979.0
Grains	145.9	239.1	296.8	383.8	494.5	605.1
Iron	37.6	43.5	48.4	49.2	52.3	55.3
Petro	1,070.3	1,575.6	1,914.4	1,948.7	2,140.9	2,333.1
Subtotal	7,303.3	9,632.3	12,502.4	14,944.1	16,238.0	16,921.9
BDC	40.0	154.1	212.6	325.9	392.7	549.7
Total	7,343.3	9,786.4	12,715.0	15,270.0	16,630.6	17,471.6

Source: Computations by the Charleston District.

Table 2
Charleston Harbor Study
Re-Evaluation of Net Benefits for
Complete Harbor Deepening Project
Using FY95 EGM Vessel Operating Costs
(Thousands of 1995 Dollars)

	Project Draft in Feet					
Item	41	42	43	44	45	46
General Navigation Features						
Channel Deepening	34,093	44,918	51,798	59,596	65,407	73,916
Contraction Dikes	3,569	3,569	3,569	3,569	3,569	3,569
Mitigation	20	20	20	20	20	20
Subtotal	37,682	48,507	55,387	63,185	68,997	77,505
Contingencies, 15 Percent	5,652	7,276	8,308	9,478	10,349	11,626
Subtotal	43,335	55,783	63,695	72,663	79,346	89,130
Monitoring of ODMDS	500	500	500	500	500	500
PED	2,620	2,620	2,620	2,620	2,620	2,620
Construction Management	1,600	1,600	2,000	2,000	2,000	2,400
Total	48,055	60,503	68,815	77,783	84,466	94,650
Aids to Navigation	78	78	78	78	78	78
Non-Federal Costs						
Berthing Areas	4,290	4,505	4,679	4,698	5,229	5,405
Disposal Diking	583	939	1,322	1,720	2,130	2,549
Real Estate	15	15	15	15	15	15
Subtotal	4,888	5,459	6,016	6,433	7,373	7,968
Contingencies, 15 Percent	733	819	902	965	1,106	1,195
Total	5,621	6,278	6,919	7,397	8,479	9,164
Total First Costs	53,754	66,859	75,812	85,258	93,023	103,892
IDC	9,844	12,601	13,578	15,402	16,704	18,060
Total Investment Cost	63,598	79,459	89,390	100,661	109,727	121,952
Average Annual Cost						
Interest	4,849	6,059	6,816	7,675	8,367	9,299
Amortization	126	158	177	200	218	242
Annual O&M	145	341	538	734	930	1,227
Total AAC	5,121	6,557	7,531	8,609	9,515	10,768
Average Annual Benefits						
Channel Deepening	7,343	9,786	12,715	15,270	16,631	17,472
B/C Ratio	1.43	1.49	1.69	1.77	1.75	1.62
Net Benefits	2,222	3,229	5,184	6,661	7,116	6,704

Source: Computations by the Charleston District; reflects January 1995 dollars and the current federal discount rate of 7.625 percent.

Table 3
Charleston Harbor Study
Re-Evaluation of Net Benefits of
Daniel Island Turning Basin
Using FY95 EGM Vessel Operating Costs
(Thousands of 1995 Dollars)

	Project Draft in Feet				
Item	41	42	43	44	45
Summary of Costs					
General Navigation Features					
Construction Cost	$6,388	$6,656	$6,950	$7,244	$7,482
Contingencies	958	998	1,043	1,087	1,122
Total First Costs	7,347	7,655	7,993	8,330	8,604
IDC*	(362)	(377)	(393)	(410)	(423)
Total Investment Cost	6,985	7,287	7,599	7,920	8,181
Average Annual Costs					
Interest	532	555	579	604	624
Amortization	14	14	15	16	16
Annual O&M	55	59	62	66	70
Total AAC	601	628	657	686	710
Average Annual Benefits					
Total AAB	674	677	742	775	813
B/C Ratio	1.12	1.08	1.13	1.13	1.15
Net Benefits	73	49	85	89	103

Source: Computations by Charleston District; reflects January 1995 dollars and the current federal discount rate of 7.625 percent.

* Reflects discounting of costs incurred after base year of 2002.

Table 4
Charleston Harbor Study
Re-Evaluation of Net Benefits of Shutes/Folly Channel Realignment Using FY95 EGM Vessel Operating Costs
(Thousands of 1995 Dollars)

Item	Costs/Benefits for 45′ Channel
<u>Summary of Costs</u>	
<u>Existing Alignment</u>	
Construction Cost	
Rebellion/Folly Reach	$4,094
Horse/Shutes Reach	1,732
Contingencies	<u>873</u>
Subtotal	6,700
<u>New Alignment</u>	
Construction Cost	
Rebellion/Folly Reach	3,670
Horse/Shutes Reach	6,246
Contingencies	<u>1,487</u>
Subtotal	11,402
Total Incremental First Cost	4,702
IDC	<u>1,263</u>
Total Investment Cost	5,965
<u>Average Annual Cost</u>	
Interest	455
Amortization	12
O&M	<u>10</u>
Total AAC	477
<u>Average Annual Benefits</u>	
Delay Reduction	378
Reduced Transit Time	<u>417</u>
Total AAB	795
<u>B/C Ratio</u>	1.67
<u>Net Benefits</u>	318

Source: Computations by Charleston District; reflects January 1995 dollars and the current federal discount rate of 7.625 percent.

Table 5
Charleston Harbor Study
Re-Evaluation of Net Benefits of Total Harbor Project Using FY95 EGM Vessel Operating Costs
(Thousands of 1995 Dollars)

Item	Main Channel	Daniel Island Turning Basin	Shutes/Folly Realignment	Total Project
Total First Costs	$93,023	$8,604	$4,702	$106,330
IDC	16,704	(423)	1,263	17,544
Total Investment Cost	109,727	8,181	5,965	123,873
Average Annual Costs				
Interest	8,367	624	455	9,445
Amortization	218	16	12	246
Annual O&M	930	70	10	1,010
Total AAC	9,515	710	477	10,701
Average Annual Benefits				
Total AAB	16,631	813	795	18,239
B/C Ratio	1.75	1.15	1.67	1.70
Net Benefits	7,116	103	318	7,538

Source: Computations by Charleston District; reflects January 1995 dollars and the current federal discount rate of 7.625 percent.

EXECUTIVE SUMMARY

This report has been prepared under authority of resolutions adopted by the Senate Committee on Environment and Public Works and the House Committee on Public Works and Transportation on 27 March 1990 and 1 August 1990, respectively. These resolutions authorized the Corps of Engineers to conduct a review of the reports on Charleston Harbor, South Carolina with a view of determining whether any modifications to the existing project are advisable at this time with particular emphasis on deepening and widening. Planning, Engineering and Design (PED) studies will be continued under this authority.

Charleston Harbor is the largest and most important seaport in South Carolina and is ranked as the second largest container port on the East Coast and Gulf Coast of the United States. The harbor is a natural tidal estuary formed by the confluence of the Cooper, Ashley and Wando Rivers and located about midway of the South Carolina coastline, being approximately 140 statute miles southwest of the entrance to Cape Fear River, North Carolina, and 75 statute miles northeast of the Savannah River, Georgia.

The authorized Charleston Harbor Project was essentially completed in August 1991 with the exception of the Wando River Extension (August 1994) and Shipyard River Entrance (June 1996). The authorized project provides for a 42 foot deep by 1,000 foot wide entrance channel extending for approximately 11 miles from the 42 foot contour to the mouth of the harbor; thence, 40 foot deep by 600 foot wide (generally) to Goose Creek on the Cooper River a distance of 16 miles; a 2.1 mile long 40 foot deep channel in the Wando River extending from the Cooper River to the Wando Terminal; 0.7 miles of improvements in Shipyard River consisting of a 38 foot deep by 300-foot wide entrance channel, and a 700 foot diameter Turning Basin A, a 30 foot deep by 200 foot upper channel and a 500 foot diameter Turning Basin B; 2.8 miles of improvements in Town Creek 40 foot deep by various widths; an anchorage basin at the junction of Ashley and Cooper Rivers 35 foot deep approximately 2,200 feet by 5,200 feet; three turning basins 1,400 feet in diameter in Town Creek, Wando River and at the head of the project. Features that are authorized but not constructed include: a 1,000 foot Turning Basin A in Shipyard River and deepening and widening the upper channel to 38 feet deep by 250 feet wide; widening Turning Basin B to 1,000 feet, this feature was determined not to be economically justified; and deepening and enlarging the anchorage basin to 40 feet.

Existing channel depths, widths, and alignments constrain the ability of vessels to utilize the port to their design capacity, increase transit time due to limited ability to pass except at designated locations, and/or present hazardous conditions. Vessels with deeper draft will be able to take advantage of a deeper channel and reduce transportation costs from tidal delays. Additional transportation savings will result from improved passing areas and alignments. Benefits from improved depths of 41 to 46 feet were considered in this study.

The 45-foot channel depth was identified as the National Economic Development (NED) plan and is the recommended plan. The recommended plan provides a 16.3 mile 47 foot by 800 foot wide entrance channel with continued maintenance of the authorized 42 foot by 1,000 foot channel, 45 foot interior channels, and turning basins, with no improvement in width unless otherwise noted, and a realigned channel in the Shutes/Folly Reach of the lower harbor, and reduction of the Town Creek Channel from the Cooper River bridges to Myers Bend to a 16 foot by 250 foot channel. The Daniel Island Reach channel will be widened to 875 feet beginning at the conjunction of Myers Bend tapering to a width of 600 feet at Daniel Island Bend. Features for construction to coincide with the completion of the proposed Daniel Island Terminal are: construction of an additional contraction dike located just north of Shipyard River and the Navy degaussing pier, restoration of the existing training dikes to their original condition when the third is constructed, removal of existing contraction dike on Daniel Island, and construction of a turning basin 1,400 feet by 1,400 ft.

Based on the construction schedule, the total initial project cost is estimated to be $116,639,000. Of this amount $27,020,000 would be the initial sponsor cost share of the general navigation features for 25 percent of the first cost. The sponsor is responsible for 100 percent of the dredging cost associated with deepening all berthing areas to the project depth in the amount of $6,012,000. The initial Federal share of the general navigation features of first cost is $81,062,000. The sponsor shall pay an additional 10 percent of the cost of the general navigation features of the project in cash over a period not to exceed 30 years, at an interest rate determined pursuant to section 106 of WRDA 86. The value of lands, easements, rights-of-way, relocations, and dredged material disposal areas shall be credited toward the additional 10 percent. This credited amount is estimated to be $2,466,000 bringing the total initial sponsor share of first cost to $43,841,000 with total Federal share being $72,798,000.

The South Carolina State Ports Authority (SPA) is the project sponsor. They support the plan recommended in this report.

CHARLESTON HARBOR, SOUTH CAROLINA
DEEPENING/WIDENING
DRAFT FEASIBILITY REPORT

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CHARLESTON HARBOR, SOUTH CAROLINA
DRAFT FEASIBILITY REPORT

1. The Study and the Report

1.1 Study Authority

The study for the Charleston Harbor Deepening/Widening was authorized by resolutions adopted on 27 March 1990 and 1 August 1990, respectively, by the Senate Committee on Environment and Public Works and the House Committee on Public Works and Transportation.

> "Resolved by the Committee on Environment and Public Works of the United States Senate, that the Board of Engineers for Rivers and Harbors is hereby requested to review the reports of the Chief of Engineers on Charleston Harbor, South Carolina dated August 27, 1981 and May 1, 1985 (the latter published as House Document Number 100-27, 100th Congress, 1st Session) and other pertinent reports, with a view to determining whether any modifications of the recommendations contained therein are advisable at this time in the interest of navigation, with particular view toward deepening and/or widening."
>
> "Resolved by the Committee on Public Works and Transportation of the United States House of Representatives, that the Board of Engineers for Rivers and Harbors is requested to review the reports on Charleston Harbor, South Carolina, published as House Document 100-27, One Hundredth Congress, First Session, and other pertinent reports, to determine whether any modifications of the recommendations contained therein are advisable at this time in the interest of navigation, with particular emphasis on deepening and widening."

The feasibility phase of this project was initiated in April 1993 when the reconnaissance report was approved and the Feasibility Cost Sharing Agreement (FCSA) was signed.

1.2 Study Purpose and Scope

The purpose of this study was to evaluate problems and opportunities for improved navigation in Charleston Harbor and to recommend the plan that best satisfies the environmental, economic, and engineering criteria. The scope of this feasibility study involves analysis of existing conditions and requirements, identifying opportunities for enhancement, determining alternative plans for improvement, preparing economic analyses of alternatives, identification of environmental impacts, and identification of the National Economic Development (NED) plan.

1.3 Non-Federal Partner

The South Carolina State Ports Authority (SCSPA) was created to develop and improve the harbors and seaports of South Carolina for the handling of waterborne commerce from and to any part of the state and other states or foreign countries. They are the non-Federal partner for the Charleston Harbor project and have full authority and capability to provide all non-Federal requirements.

1.4 Evaluation Criteria

1.4.1 **Regulations and Guidance.** Authority for the Corps of Engineers to investigate the need for navigation improvements and to construct those improvements is derived from Federal legislation and Executive Orders. These laws and orders are implemented by regulations that establish the engineering, economic, and environmental criteria used to determine whether the Federal Government can participate in a potential project. The principal regulations that determine the scope of the present study are as follows: *Economic Principles and Guidelines for Water Resources and Related Land Resources Implementation Guidelines* (Water Resources Council, March 10, 1983); Engineering Regulation (ER) 1105-2-100, *Guidance for Conducting Civil Works Planning Studies;* ER 200-2-2, *Policy and Procedures for Implementing NEPA* (NEPA is the National Environmental Policy Act of 1969), and ER 1110-2-1150, Engineering and Design for Civil Works Projects, 31 March 1994. The following paragraphs describe conditions placed by regulation for the feasibility phase in planning for navigation improvements.

1.4.2 **Engineering Criteria.** Projects should be adequately sized to meet user needs and provide sufficient depth and entrance dimensions for safe access. Engineering during the feasibility phase must be in sufficient detail to provide the basis for the complete project schedule, acquisition of real estate, assessing risk to achieve functional objectives and safety.

1.4.3 **Economic Benefits and Costs.** National Economic Development (NED) benefits, defined principally as effects of a plan that increase the national output of goods and services, must exceed the combined Federal and local costs of constructing, maintaining, and operating the project. Benefits and costs must be expressed in terms of constant time and value of money. Benefits generally include items such as fuel savings, reduced labor costs, and reduced maintenance costs. Federal interest in the project exists if the benefits exceed the costs, resulting in a benefit-to-cost ratio (B/C) greater than 1.0.

1.4.4 **Environmental Impacts.** Federal laws and environmental regulations require the evaluation of impacts of the project on the environment. Any proposed plan must be consistent with the State's Coastal Zone Management Program and State and local plans. Fish and wildlife impacts are assessed in coordination with the U. S. Fish and Wildlife Service and National Marine Fisheries Service. Their report is provided pursuant to the Fish and Wildlife Coordination Act, as amended. Other environmental requirements are given in the Clean Water Act, National Historic Preservation Act, Threatened and Endangered Species Act and others. Corps of Engineers policy requires that any study identify and pursue opportunities for environmental enhancement and/or environmental restoration. The effects of each alternative on the social and natural environment must be evaluated and the information provided to the public for review. This report contains the Environmental Assessment to satisfy the requirements of the National Environmental Policy Act of 1969.

1.4.5 **Non-Federal Partner Interests.** The alternative must be acceptable to the non-Federal partner. The level of the partner's interest in and support for the recommended alternative must be assessed as well as his financial capability to fund its share of the cost to implement the project.

1.5 Prior Studies and Reports

1.5.1 **Prior Studies and Reports.** Navigation improvements to Charleston Harbor were initially authorized by the River and Harbor Act of 1852. For a listing of prior studies and reports refer to Exhibit A at the end of this report.

1.5.2 **Reconnaissance Study.** The reconnaissance phase of this study was completed with the signing of the Federal Cost Sharing Agreement (FCSA) by the Corps and the SCSPA on April 13, 1993. The study determined that Federal interest existed for a 42 foot channel and that there was a willing partner for the feasibility phase. By signing the FCSA, the South Carolina State Ports Authority agreed to proceed with the feasibility phase of the study.

2. Study Area Description

2.1 Regional Characteristics

2.1.1 **Location.** The harbor is approximately 14 square miles in area and lies almost midway along South Carolina's Atlantic Coast. This tidal estuary is fed by the Ashley, Cooper, and Wando Rivers. The harbor is flanked by the City of Charleston on the western shore; James Island, a residential community, and Morris Island, a barrier island used as a dredged material disposal area, on the south; the community of Mount Pleasant and Sullivan's Island, a developed barrier island, on the north; and the Atlantic Ocean on the east. Figure 1 shows the study area. The entrance to the harbor is protected by two granite, rubble mound jetties, 2900 feet apart, which spring from Sullivans Island to the north and Morris Island to the south. Its location along the South Atlantic Seaboard permits ready access to European and South American ports. The harbor's size and location are incentives to recreational boating activities.

2.1.2 **Climate.** At Charleston, continental air masses from the west are moderated by mixing with marine air masses from the Atlantic Ocean. Summers are warm and winters are relatively mild with average temperature in January of 48°. Relative humidity is fairly high in the area because of the influence of the Atlantic Ocean. The area's severest weather comes in the form of violent thunderstorms, tornadoes, and hurricanes. Most tornadoes occur from March through June with April being the peak month. The hurricane season extends from June to November producing infrequent storms which affect the study area. The average annual precipitation is 51.6 inches. The highest precipitation occurs during the months of March through September. The maximum amount of rain in 24 hours was 9.4 inches in June 1973 (Department of Commerce [DOC 1992]).

2.1.3 **Topography and Geology.** The study area is located in the southern part of the Atlantic Coastal Plain, a physiographic area characterized by meandering rivers, wetlands, and low-lying peninsulas and islands. Most of the land in the Coastal Plain is between 0 and 40 feet above mean sea level (MSL), although some areas to the north may reach 100 feet above MSL.

The geology of the Charleston region is characterized by a series of Pleistocene and recent surficial beach ridge sediments. Recent and Pleistocene sands, silts, and clays are underlain by the Cooper Marl, a brownish green, calcareous, massive clay unit with good load-bearing capacity. The depth to the Cooper Marl varies across the region. Results of soil borings throughout the study area indicates that

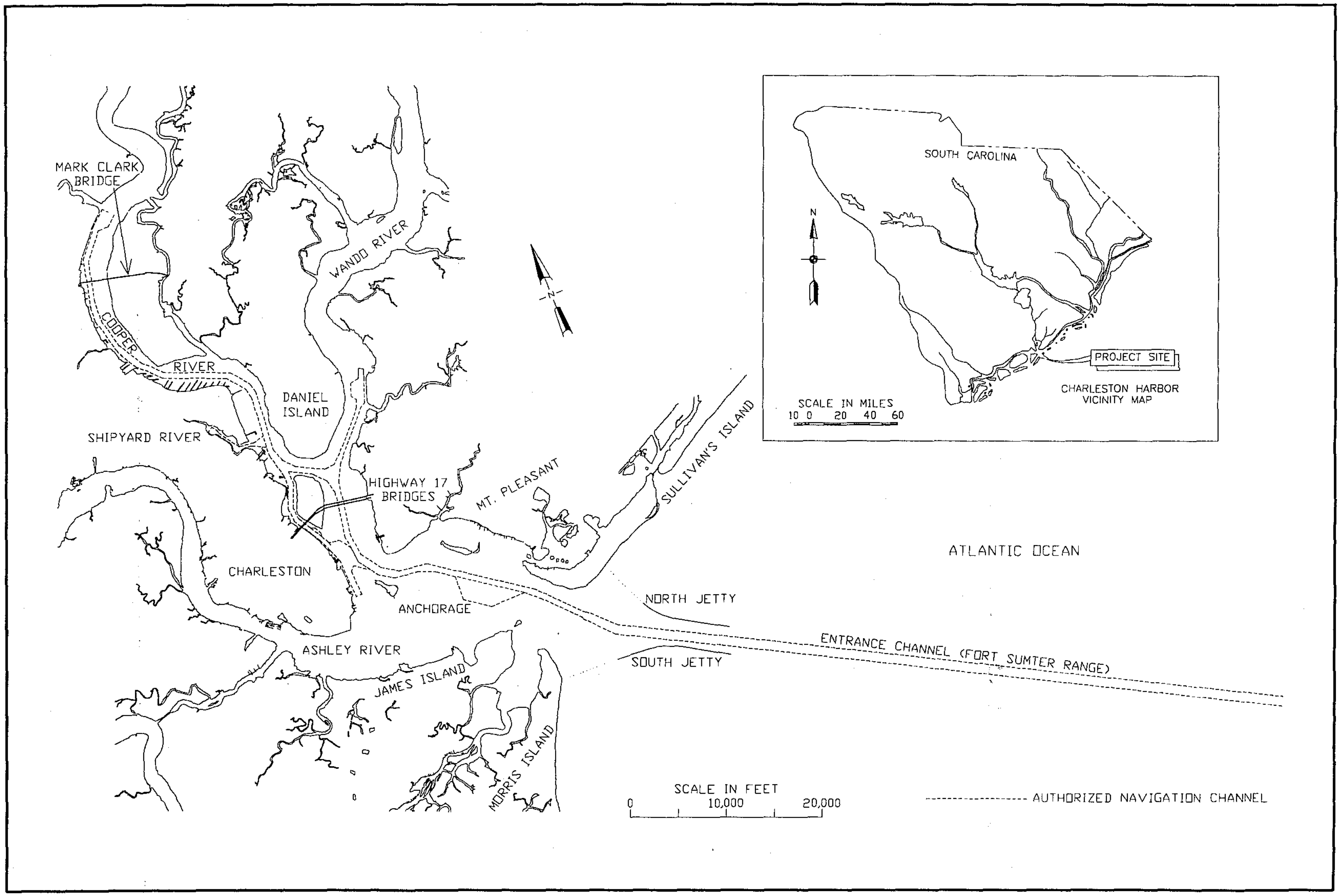


Figure 1. Location and vicinity map

the top of the marl occurs at 35 to 40 feet below land surface. The middle Eocene Santee Limestone underlies the Cooper Marl, extending downward approximately 250 feet below the marl. The material encountered above the marl is typically very soft organic clay.

2.2 **Economic Base**

The Charleston economy relies heavily on the tourism and recreation market. The Charleston Peninsula provides luxury hotels, fine dining, historic setting, and unique retail stores. With the temperate climate, water related sports are enjoyed year round. The nearby barrier islands have some of the finest beaches in South Carolina suited for surfing, sailing, kayaking, and other water sports. Both commercial and sport fishing are abundant along the entire state coast. In addition, shrimp, blue crabs, and oysters are among the local favorites.

Charleston also has a strong military tie. The Charleston Air Force Base, Charleston Navy Base and Shipyard, and Naval Weapons Station are all located within Charleston County. By the end of 1996 the Naval Base and Shipyard will be decommissioned as part of the recent military base closures. The recently opened Strategic Logistic Mobility Base (SLMB) and the 1340th Major Port Command are the main Military users of the Port. The SLMB will be home base for up to 18 large cargo ships loaded with everything required to put a mechanized infantry brigade in the field. The vessels will be cycled in and out of Charleston for servicing of the cargo on board.

Charleston is home of some of the finest medical facilities and institutions of higher learning in South Carolina. Among the medical facilities located on the Peninsula are the Veterans Administration Hospital, Bon Secours - St. Francis Xavier Hospital, Roper Hospital, Charleston Memorial Hospital and the Medical University of South Carolina. The College of Charleston, The Citadel, Johnson and Wales, Trident Technical College, Limestone College, Webster University, Nielson Electronics Institute, Central Wesleyan, and Charleston Southern University provide the community with the opportunity for college educations.

Industrial development in the study area includes the WestVaco paper plant, Bayer Corporation, Amoco, Robert Bosch Corporation and others. A NUCOR steel mill is scheduled for construction in Berkeley County and will add iron carbide to the imports coming into Charleston Harbor.

2.2.1 **Commerce.** Charleston Harbor is the largest and most important seaport in South Carolina and is ranked as the second largest container port on the East Coast and Gulf Coast of the United States. In 1994, more than 10 million short tons of waterborne commerce was moved through the harbor. The most important export products are coal, chemicals, paper, grain, wood pulp, cement, textiles, and lumber. Petroleum products, chemicals, bauxite and non-ferrous ores are the major import commodities for Charleston Harbor. Two-thirds of this traffic was containerized cargo.

Figure 2
Evergreen Container Vessel

In the past two decades, the size of the vessels that used the terminal facilities of Charleston has increased. Design drafts of containerships continue to increase beyond the presently authorized channel depth of 40 feet. At present these vessels must light load or make use of the tidal advantage due to restricted channel depths. The depth of the harbor also impedes the introduction of larger vessels into the fleet that calls on Charleston despite the efficiency gains that can be realized with larger vessels. The dimensions of the existing channel were based on a design vessel with a 810-foot length and a 36-foot draft. The largest container vessels presently coming to Charleston Harbor are 965 feet in length with a draft of 44 feet. The frequency of these vessels calling on Charleston Harbor continues to increase. Most of the largest vessels that call on Charleston are containerships; however, a large number of bulk carriers and tankers also call on the Port. Charleston's demand for container trade has grown dramatically since its introduction in the mid-1960's and is expected to grow in the future.

3. Plan Formulation

3.1 Overview

Plan formulation is a process for identifying problems, needs, and opportunities, formulating alternative plans and evaluating those plans to determine which best meets the planning objectives.

3.2 Existing Project and Environmental Conditions

3.2.1 **Existing Federal Navigation Improvements.** The Federal navigation project for Charleston Harbor includes channels, jetties, contraction dikes, and dredged material disposal areas. They were constructed in partnership with the South Carolina State Ports Authority and are described in detail in the following paragraphs.

Jetties. The entrance to Charleston Harbor is flanked by dual-jetty weir systems 2900 feet apart. Construction of these rubble mound jetties was completed in 1895. The south jetty, which springs from Morris Island, is 19,104 feet in length. The north jetty extends seaward from the southern end of Sullivans Island and is 15,443 feet in length. These jetties were constructed to enhance navigation in Charleston Harbor by reducing the shoaling within the channel. The elevation of the jetties is approximately 12 feet above mean low water (MLLW) with the ends extending from station 0+00 to station -112+00 of the Federal navigation channel. The weir portion of the jetties rests just below MLLW from the islands to approximately station 0+00 of the entrance channel.

Deep Draft Channel. The present channel depth of 40-feet below MLLW within the harbor and 42 feet in the entrance channel was authorized under PL99-662 (Water Resources Development Act of 1986). Construction began in 1988 and was for all practical purposes completed in September 1994 with construction of the 1550 foot extension of the Wando River channel. In addition to the main portion of the present project, the Tidewater, Upper and Lower Town Creek Reaches plus the Wando River are also included in the Federal navigation channel. The entrance channel is 1000 feet wide from station 0+00 to -700+00 near the 42-foot ocean contour. The width of the channel in the inner harbor varies throughout the remaining 16 miles of navigational channels. The length and width of each channel reach is shown in Table 1. All channels have a 4:1 side slope. The entire Federal navigation channel is comprised of 27 individual reaches. These reaches vary from less than one quarter of a mile in length to more than 11 miles. Sharp and frequent bends contribute to the difficulty of navigating the larger vessels currently porting at Charleston. Meeting and passing is routinely performed within the entrance channel

Table 1
Existing Project Dimensions

Section of Waterway	Depth (Feet)	Width (Feet)	Channel Length (Miles)
Fort Sumter Range	42	1000	11.36
Mount Pleasant Range	42	600-1000	1.89
Rebellion Reach	40	600	2.17
Folly Reach	40	600	0.62
Shutes Reach	40	800	0.34
Horse Reach	40	800	0.98
Hog Island Reach	40	600	1.17
Drum Island Reach	40	600	0.96
Myers Bend	40	800	0.47
Daniel Island Reach	40	600	1.20
Daniel Island Bend	40	700	0.65
Clouter Creek Reach	40	600	1.33
Navy Yard Reach	40	600-675	1.05
North Charleston Reach	40	500	1.02
Filbin Creek Reach	40	500	0.88
Port Terminal Reach	40	600	0.62
Ordnance Reach	40	1400	0.43
Custom House Reach	40	Varies	0.37
Town Creek -			
Upper	40	500	1.23
Lower	40	400	1.02
Turning Basin	40	1400	
Tidewater Reach	40	630	0.82
Shipyard River -			
Entrance Channel	38	300	0.53
Basin A	38	700	0.15
Connector Channel	30	200	0.55
Basin B	30	500	0.17
Wando Channel	40	400	2.37
Wando Turning Basin	40	1400	
Anchorage Basin	35	2250	1.40

and other reaches in the lower harbor where sufficient channel width and reach length provide for safe navigation. Three turning basins are located at various terminals in the harbor including: Columbus Street Terminal (Custom House Reach), Wando Terminal and the North Charleston Terminal as referenced in Figure 2. These turning basins are maintained to the project depth.

Shipyard River. Shipyard River navigational channel was originally authorized by the River and Harbor Act of 3 July 1930. The initial depth was 20 feet to Basin A and 10 feet deep from Basin A to Basin B. Shipyard River Entrance Channel and Basin A are currently authorized and constructed to 38 feet. The connector channel and Basin B are 30 feet deep. Location of the channels in Shipyard River relative to Charleston Harbor channels are shown in Figure 1 and Plate 1.

Anchorage. An anchorage basin is located adjacent to Rebellion Reach (see Figure 1). This area is 2250 feet wide and nearly 7400 feet long. The authorized depth of this anchorage is 35 feet MLLW. The anchorage basin was authorized by the River and Harbor Act of 2 March 1945.

3.2.2 **Project Maintenance.** The existing project is maintained to the authorized project depth of 40 feet MLLW (42 feet for the entrance channel) and 38-feet in Shipyard River. In addition, two-feet of advanced maintenance and two-feet of allowable overdepth are authorized. Shoaling frequently occurs in particular reaches. Plate 1 illustrates the location of the prominent shoals throughout the project limits. The shoal in the Drum Island Bend and Drum Island Reach requires dredging on almost a six-month cycle. In addition to the shoaling problem, this area is difficult for large, less maneuverable vessels to navigate because of the combination of the shoal, the bend - the first turn of a tight S-turn, and the currents. Other reaches with significant shoaling problems are the Wando Terminal Extension, Shipyard River, Lower Town Creek, Daniel Island Reach and Custom House Reach. Dredging records from 1988 to 1994 indicate the average annual maintenance dredging quantities to be approximately 1.8 million cubic yards throughout the inner harbor. This material is placed in upland disposal sites located throughout the study area (see Plate 2).

Maintenance dredging is also performed in the berthing areas of the private terminals and Navy piers. Dredging in the inner harbor is typically done by pipeline dredges. Hopper dredges are used to maintain the entrance channel. Clamshell dredges have been used to load barges to transport inner harbor material to the Ocean Dredged Material Disposal Site (ODMDS).

3.2.3 **Disposal Sites.** The current dredged material disposal sites for Charleston Harbor are: Drum Island, Morris Island, Clouter Creek, Yellowhouse

Creek, Naval Weapons Station, and the Ocean Dredged Material Disposal Site (see Plate 2). The size of the upland sites are listed in Table 2.

Table 2
Size of Upland Disposal Sites

Disposal Site	Acres
Morris Island	527
Drum Island	138
Clouter Creek	1,488
Yellowhouse Creek	600
Naval Weapons Station	290

Site Descriptions -

ODMDS - The Charleston Ocean Dredged Material Disposal Site is located South-West of the entrance to Charleston Harbor and was designated for use of disposal of dredged material on August 3, 1987. In addition, a second site was also designated specifically for disposal of harbor deepening material. The Charleston ODMDS was three square miles in size and averaged 11 meters in depth. The Charleston Deepening site had an interim designation for a seven-year period, was 11.8 square nautical miles in size and averaged 11 meters in depth. The Charleston ODMDS was located totally within the boundaries of the larger deepening site. On October 23, 1995, the Environmental Protection Agency modified the language for the designated use of the larger deepening site from "seven years" to "continued use". Additionally, the smaller Charleston ODMDS was dedesignated in order to protect the natural resources found within its boundaries. For this project, the larger (originally the deepening site) disposal area will be used for disposal of both new work and maintenance material from the entrance channel and inner harbor reaches.

Morris Island - Morris Island is a barrier island south of the Charleston Harbor entrance channel. This disposal area was created by using hydraulic dredges to place insitu material along perimeter dikes from within the disposal area. These initial dikes were constructed in 1969/70. The site is divided into two cells. The northern cell is approximately 168 acres with an average interior elevation of approximately 15.8 MLLW, and the surrounding containment dikes have an approximate top elevation of 24.1 MLLW. The southern cell is 359 acres in size and has an interior average elevation of approximately 13.1 MLLW with a surrounding containment dike top elevation being approximately 22.0 MLLW. The use of this disposal site has historically been primarily designated for maintenance material from Rebellion Reach and the Anchorage Basin. New work material from Shutes, Folly, Rebellion, and Wando River Reaches have also been placed on Morris Island.

Drum Island - This site is located within the inner harbor area, opposite the confluence of the Wando and Cooper Rivers. This site is bordered by Town Creek and the Cooper River. This area was enclosed by dikes having a top elevation of 9.5 feet MLLW in 1954. Material from Town Creek, lower harbor berthing areas, and parts of the Cooper River shoals were placed in this site from 1958 to the present. The life of this site has been well extended due to successful management of dredged material placement. Portions of this site have been released for use as bird rookeries. The present interior elevation of the main area averages about 19.0 feet MLLW and the dike elevation is about 33.0 feet MLLW.

Clouter Creek - This area is located along the east bank of the Cooper River East of North Charleston and the Charleston Naval Shipyard. Two-thirds of this site was formerly owned by the U.S. Navy. With the closing of the Charleston Naval Shipyard this site is being transferred to the Corps for continued use of dredged material disposal. The northern third is owned by the SCSPA. This site houses four cells ranging in size from 190 - 460 acres. The Navy managed the South and Middle Cell for placement of material from Navy Base piers and slips. Material from the Federal channel and turning basin has been placed in the remaining cells. The height of the dikes vary in elevation from 23.0 feet MLLW in the North Cell and 16.0 feet MLLW in Highway Cell to 30.0 feet MLLW in the South Cell. Interior elevations vary from about 20.0 feet MLLW in the South Cell to about 12.0 feet MLLW in the Highway Cell.

Yellowhouse Creek - This site is located on the east bank of the Cooper River to the east of the Naval Weapons Station. Maintenance material from the Naval Weapons Station piers and channels has been placed in this disposal site since 1964. The diked area is approximately 600 acres with dike average elevation of 19.0 feet MLLW and interior elevation average elevation of 12.9 feet MLLW.

Naval Weapons Station - This disposal area is located at the south end of the Naval Weapons Station on the west bank of the Cooper River. This site has been used for disposal of material from the Naval Weapons Station channel since 1960. This site is owned by the U.S. Navy and currently under license to the Corps until the year 2010. The dikes enclose an area of approximately 290 acres with average interior elevation of 10.0 feet MLLW and dike elevation of 22.0 feet MLLW.

3.2.4 **Environmental Conditions.** The environmental conditions of the Charleston Harbor estuary system are briefly described below with detailed discussion provided in the environmental documents located at the end of this report.

Physical Features. The harbor is a tidal estuary fed by the Cooper, Ashley, and Wando Rivers. The areas surrounding the harbor have topographic relief which lend to the existence of marsh areas. Sullivan's Island and Morris Island have marsh areas of up to one mile in width between the islands and the adjoining mainland. The harbor contains approximately 5,200 acres of regularly flooded marsh, the Wando 6,400 acres, the Ashley 4,300 acres, and the Cooper 9,200 acres. Intertidal, emergent wetlands are the most conspicuous class of wetlands in the study area. These include salt and brackish water marshes. The low salt marsh is monospecific, being vegetated with smooth cordgrass. The high marsh, which occurs above mean high water (MHW), is flooded irregularly by spring and storm tides, and has a varied plant composition. Plants which grow in salty soil include halophytes which occur in abundance include black needlerush, saltwort, sea lavender, and marsh aster.

Brackish water marshes represent a transition zone between salt marshes and tidal freshwater marshes. Plant species found in the more seaward brackish marshes are quite similar to those of the upper high marsh zone of the salt marsh. Pure stands of black needlerush may occur in these marshes. Saltwater bulrush, aster, marsh elder, sea-myrtle, panic grass, saltmeadow cordgrass, sea ox-eye, broomsedge, and seaside goldenrod also may be present. Giant cordgrass occasionally appears along upland borders of the more seaward brackish marshes. As salinity decreases, giant cordgrass generally replaces needlerush as the dominant plant.

These emergent wetlands are highly productive natural systems that provide spawning, nursery, and feeding habitat for important commercial finfish and shellfish, and most marine sport fishes inhabit estuarine areas during all or part of their life cycles. Estuarine emergent marshes also provide valuable habitat for various waterfowl and other wildlife species, including wading birds, shorebirds, and mammals such as the marsh rabbit, marsh rice rat, river otter and mink.

Estuarine intertidal shorelines, sand bars, and mud flats are classified as intertidal, unconsolidated shore; these are typically grouped together as intertidal flats. Intertidal flats are composed of sandy and muddy sediments in a wide range of relative proportions. Intertidal flats also provide valuable habitat for benthic invertebrates which are heavily preyed on by fish, wading birds, and shorebirds. Estuarine, intertidal, reef habitat is represented primarily by oyster reefs occurring in estuarine intertidal zones. The American oyster can tolerate a wide range of salinity, temperature, turbidity, and oxygen tension and is, therefore, adapted to the periodic changes in water quality that characterize estuaries. Oysters often build massive, discrete reefs in the intertidal zone. Oyster reefs occur throughout the project area but are closed for recreational and commercial harvest due to unacceptable water quality. Water quality in the Wando River upstream of the Wando terminal is suitable for shellfish harvest.

Fish and Shellfish. Fishery resources within Charleston Harbor and the project area consist of numerous estuarine and marine species. Demersal fish species which are typically associated with the lower water column and substrate of Charleston Harbor include Atlantic croaker, bay anchovy, Atlantic menhaden, spotted hake, weakfish, spot, blackcheek tonguefish, white catfish, and silver perch. Other fish which are of commercial or recreational value and are commonly found within Charleston Harbor include flounder, red drum, spotted seatrout, bluefish, spot and black drum.

Six anadromous fish species, Atlantic sturgeon, shortnose sturgeon, American shad, blueback herring, hickory shad, and striped bass, and one catadromous species, American eel, utilize Charleston Harbor and its tributaries as migration routes and spawning areas. Fishes which commonly reside within the intertidal marshes of the project area include mummichog, sheepshead minnow, Atlantic silverside, and bay anchovy. Other species which frequent intertidal marshes include both species of mullet, croaker, and numerous species of food fish. Tidal pools in the high marsh area are inhabited by species such as sailfin molly and mosquitofish. Charleston Harbor estuary supports large populations of penaeid shrimp and blue crab which are harvested both commercially and recreationally. The shrimp fishery is South Carolina's largest commercial fishery, averaging 3.24 million pounds ($11.8 million) annually during recent years. The Charleston Harbor estuary contributed approximately 20% of the state's total 1978-1987 shrimp landings. Annual commercial landings of blue crab averaged 6.17 million pounds ($1.8 million) during recent years, with Charleston Harbor accounting for about 8% of the statewide total.

The majority of the upland areas around Charleston Harbor contain either residential or commercial development. Daniel Island, which extends northward from the confluence of the Cooper River and Wando River, supports agricultural activities and a diversity of wildlife habitats. The majority of remaining undeveloped upland areas adjacent to the harbor are presently serving as dredged material disposal sites.

Water Quality. Water quality in Charleston Harbor is classified as SB by the South Carolina Department of Health and Environmental Control (SCDHEC). The SB rating applies to tidal salt water suitable for primary and secondary contact recreation, crabbing, and fishing, except for the harvesting of clams, mussels, or oysters for market purposes or consumption. These waters are also suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora. Waters rated as SB should not have dissolved oxygen concentrations less than 4 mg/l and fecal coliform concentrations should not exceed a geometric mean of 200 colonies/100 ml based on five consecutive samples taken within a 30 day period.

Although these concentrations have been exceeded occasionally, recent review of data collected by SCDHEC indicates that water quality within the harbor basin often meets SB standards for dissolved oxygen and fecal coliform levels.

Water quality in the Wando River is classified SFH (Shellfish Harvesting Waters) for the portion of the river from its headwaters to a point 2.5 miles upstream of its confluence with the Cooper River. This classification applies to tidal saltwaters protected for shellfish harvesting. SFH water must maintain a daily average dissolved oxygen concentration of 5 mg/l or higher with a low of 4 mg/l and have median coliform concentrations of 14 colonies/100 ml with no more than 10% of the samples exceeding 43 colonies/100 ml. For the portion of the Wando River from its confluence with the Cooper River to a point 2.5 miles upstream, the river is classified as SA waters. SA waters have the same designated uses as SB waters, although the water quality standards are stricter for dissolved oxygen. SA waters require a daily average of dissolved oxygen of not less that 5.0mg/l with a low of 4.0 mg/l.

Sediment Analysis. Materials in the entrance channel include overburden deposits which consist of: High plasticity (fat) clay (CH); low plasticity (lean) clay (CL); high plasticity silt (MH); low plasticity silt (ML); clayey sand (SC); silty sand (SM); poorly graded sand (SP); poorly graded silty sand (SP-SM); silty clayey sand (SM-SC); other silt, sand and clay mixtures; and silty gravel (GM). The soils often contain varying amounts of small to large shell fragments and shells, fossil fragments, gravel, rock fragments, and cemented sand or silt nodules. The consistency of relative density of materials to be dredged varies. Although some soft or loose sediments including clays, silts, sands, and shell may exist, primarily in the superficial or upper deposits, most of the subsurface materials range from stiff or medium dense to hard or very dense sediments with some layered very soft to hard limestone and/or limestone gravel. In many areas, these dense to very dense sands and stiff to hard clays are several feet thick, often calcareous and partially indurated or cemented, have high blow counts, and are expected to be difficult to remove. Previous experience has shown that rock cutting equipment may be required for efficient removal of the limestone rock encountered and, possibly, some of the dense or very dense partially cemented sands and very stiff to hard silts and clays in the entrance channel.

The soils encountered for the deepening of the inner harbor can be divided into three separate groups: overburden soils, the Cooper Marl formation, and Coquina.

a. Overburden Soils. Overburden soils consist of sands, silts, clays, and loose shell formations overlying the predominate Cooper Marl or coquina. Predominate overburden soils are recent organic clayey silts (MH/OH) and fine sands (SP) and silty fine sands (SM) with varying shell content. The overburden soils are typically loose in the case of granular deposits and soft to very soft for cohesive deposits. These soils are encountered for the full length of a 20-foot vibracore at scattered locations from station 36+00 to station 829+00.

b. Cooper Marl. The Cooper Marl formation is found extensively throughout the harbor. The marl is an overconsolidated, fine grained, hard to very hard calcareous deposit containing glauconite and characterized by phosphatic nodules in the lower portion. Generally, the marl is less than 200 feet thick, although greater thicknesses are found. The marl at the project site is composed primarily of an olive-brown to olive sandy clayey silt (ML/MH) with occasional layers of very silty clayey fine sand (SM/SC).

c. Coquina. Overlying the Cooper Marl at some locations is a light gray calcareous cemented sandy shell that has been geologically referred to as Coquina. This formation is found primarily in the entrance channel. The degree of cementation can vary from weakly cemented to strongly cemented.

Threatened and Endangered Species. A complete listing of threatened and endangered species in the subject project area was provided by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. This listing is located on page 4 of the Environmental Assessment.

Cultural Resources. The city of Charleston, South Carolina, is situated on a narrow peninsula at the confluence of the Ashley and Cooper Rivers. Historic and cartographic research has confirmed that the Charleston Harbor area has been one of the most important ports in the south since its founding in the late seventeenth century. The city is one of the oldest permanent settlements in the United States and has many areas and structures of great significance in the history of the country from the Revolutionary War and Civil War to the reconstruction period. Prominent historical structures in Charleston Harbor include Fort Sumter, a former coastal fortification known for its role in the Civil War and Shute's Folly Island (Castle Pinckney), a military fortification dating back to 1799. Figure 3 shows the castle as seen today. The high level of maritime commerce and transportation associated with Charleston history confirms the important role of Charleston Harbor and its rivers to the development of the city, and as a result, those waterways should be considered high probability areas for submerged cultural resources associated with Charleston's maritime heritage. In anticipation of the proposed improvements to Charleston Harbor, the Charleston District has conducted for an archaeological remote sensing survey and documentation of effected portions of the harbor channel.

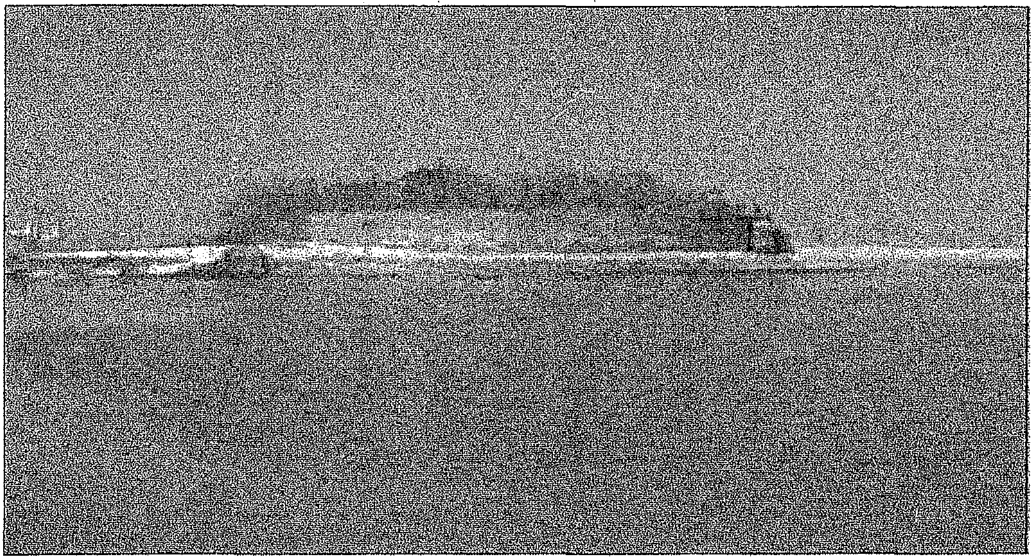
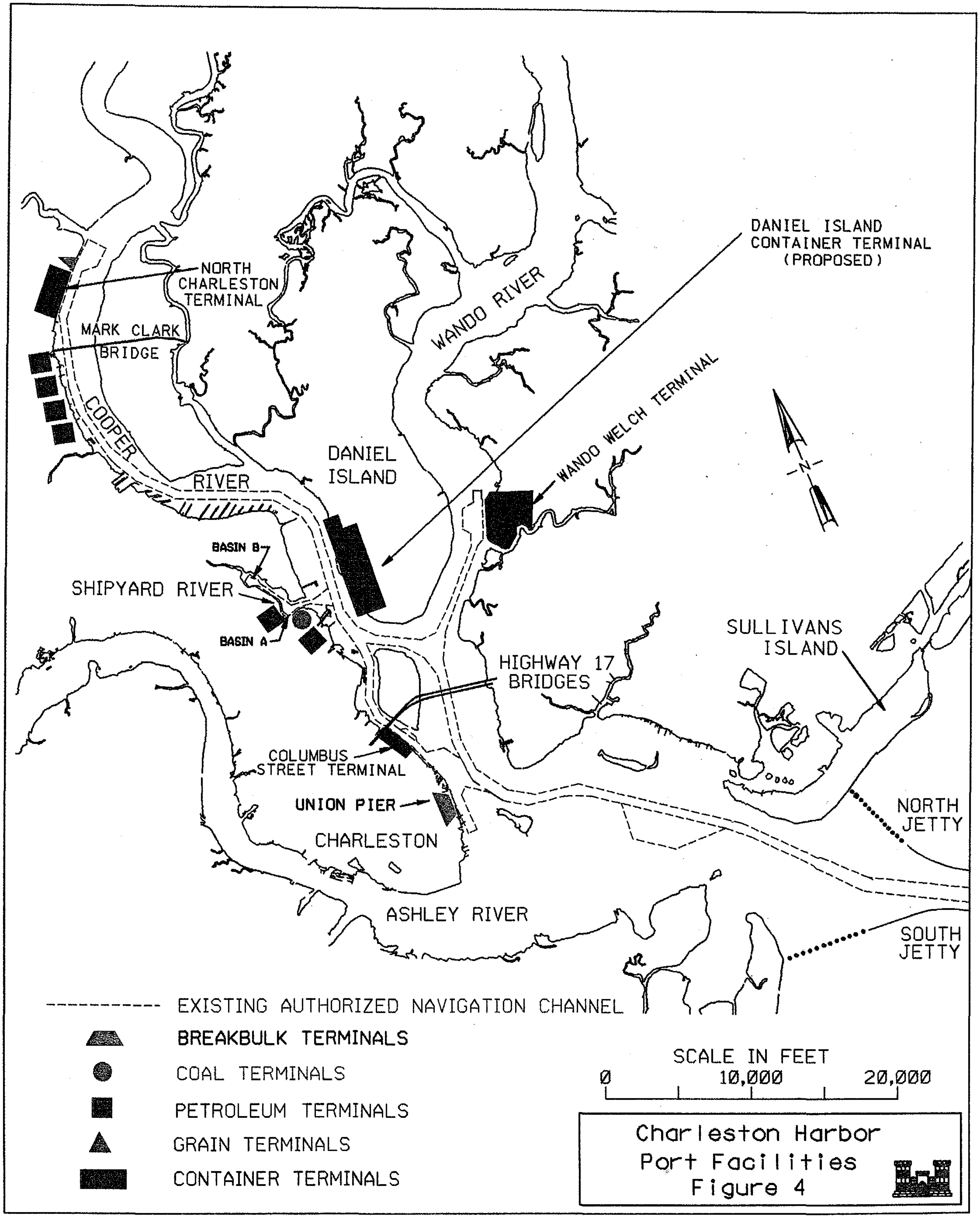


Figure 3: Castle Pinckney on Shutes Folly Island

3.2.5 **Port Facilities.** Charleston Harbor is a modern intermodal transportation hub, shipping and receiving bulk, breakbulk, containerized and other cargo from around the world. Major terminal facilities, shown in Figure 4, are described below. Table 3 lists the Oceanic lines and destinations for October 1995 at the port of Charleston.

Containerized cargo is handled at three terminals: North Charleston Terminal, Columbus Street Terminal and Wando Terminal. Figure 5 pictures an Evergreen container vessel at the North Charleston Terminal while Figures 6 and 7 show the Columbus and Wando Welch Terminals. These terminals have about 1.5 miles of combined berthing space, with 18 container cranes, 7 traveling bridge cranes, and



Charleston Harbor
Port Facilities
Figure 4

Figure 5: North Charleston Terminal

36 top-lift cranes typical of those shown in Figure 8. The North Charleston and Columbus Street terminals have rail and truck access; the Wando Terminal has truck access only. The North Charleston and Wando terminals handle only containerized cargo; Columbus Street handles some breakbulk and roll-on/roll-off (ro/ro) cargo. The State Ports Authority has purchased land on Daniel Island to develop a fourth container terminal, designed to have seven 1000-foot berths. Two berths are expected to be operational by 2003; the remaining berths will be completed in several phases as they are needed. When complete, the terminal will have a total annual capacity of 25 million tons.

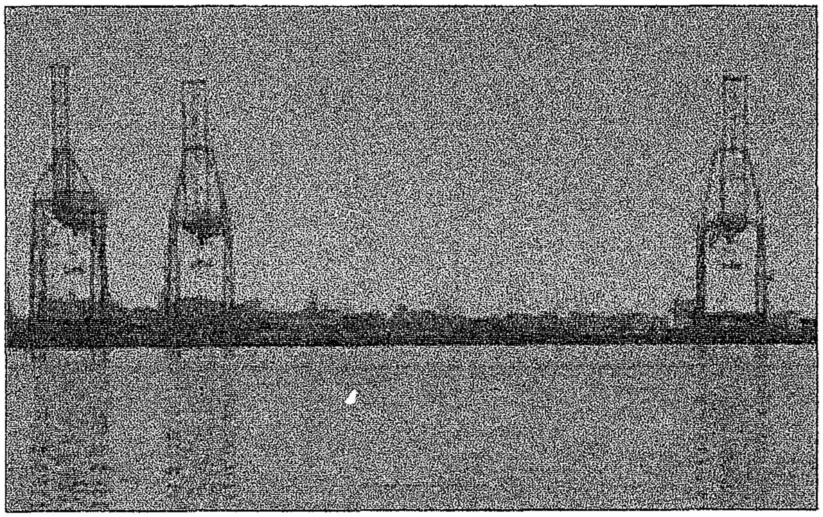


Figure 6: Columbus Street Terminal

The Union Pier Terminal is Charleston's primary handler of ro/ro cargo. This terminal also handles breakbulk cargo, and is equipped with one 30-ton gantry crane. Rail service at the pier provides drive-on/drive-off access to ro/ro vessels.

Figure 7: Wando Welch Terminal

Petroleum products are received at six berths located along the Cooper River between Myers Bend and the North Charleston Terminal. Since there are no petroleum product pipelines serving the coastal regions of South Carolina, nearly all gasoline and other petroleum products consumed in the region arrives by ship in Charleston Harbor. Petroleum product terminals are equipped with numerous land side holding tanks for storage and distribution.

Table 3

STEAMSHIP SERVICE PROFILE

Oceanic Shipping Services Offered at the Port of Charleston

Africa (East-South-West)

LINE	AGENT	FREQ.	PIER	CARGO
Farrell Lines	FA	11 Days	WA	B-C-RE
HUAL	P	10 Days	UP	R
Italia Line	I	Weekly	WA	C-R
Lykes Bros.	L	Weekly	NC	B
Maersk Line	M	4 Calls/Week	WA	C-RE
Mediterranean Shipping	MSC	Weekly	NC	B-C
Nedlloyd Lines	N	Weekly	WA	C-RE
P&O Containers Ltd.	PO	Bi-Weekly	WA	B-C
SafBank	GA	Weekly	NC	C-RE

Australia-New Zealand

LINE	AGENT	FREQ.	PIER	CARGO
ABC Containerline	AR	16 Days	NC	C-RE
COSCO	NL	Weekly	NC	C-RE
Maersk Line	M	4 Calls/Week	WA	C-RE
Mediterranean Shipping	MSC	Weekly	NC	B-C
Neptune Orient Line	TR	Weekly	WA	C-RE
NYK Line	NYK	Weekly	WA	C
SafBank	GA	Weekly	NC	C-RE

Far East-Indonesia-Southeast Asia

LINE	AGENT	FREQ.	PIER	CARGO
ABC Containerline	AR	16 Days	NC	C-RE
Am. President Line	APL	Weekly	CS	C-RE
COSCO	NL	Weekly	NC	C-RE
Evergreen	EM	Weekly	NC	C-RE
Hapag Lloyd	C	Weekly	WA	B-C-RE
HUAL	P	10 Days	UP	R
Hyundai Marine	P	Bi-Monthly	UP	B
Maersk Line	M	4 Calls/Week	WA	C-RE
Mitsui O.S.K. Line	MOL	Weekly	CS	C-RE
Nedlloyd Line	N	Weekly	CS	C-RE
Neptune Orient Line	TR	Weekly	WA	C-RE
NYK Line	NYK	Weekly	WA	C
OOCL	O	10 Days	CS	C-RE
P&O Containers Ltd.	PO	Bi-Weekly	WA	C-B
Pan Ocean	I	Monthly	UP	B
Wallenius Line	WA	8 Days	UP	R

India-Pakistan-Persian Gulf-Red Sea

LINE	AGENT	FREQ.	PIER	CARGO
Evergreen	EM	Weekly	NC	C-RE
Farrell Lines	FA	11 Days	WA	B-C-RE
Hapag Lloyd	C	Weekly	CS	B-C-RE
HUAL	P	10 Days	UP	R
Italia Line	I	Weekly	WA	C-R
Lykes Bros.	L	Weekly	WA	B-C-RE
Maersk Line	M	4 Calls/Week	WA	C-RE
Mediterranean Shipping	MSC	Weekly	NC	B-C
Nedlloyd Line	N	Weekly	CS	C-RE
Neptune Orient Line	TR	Weekly	WA	C-RE
NYK Line	NYK	Weekly	WA	C
P&O Containers Ltd.	PO	Bi-Weekly	WA	B-C
Sea-Land	SL	4 Calls/Week	WA	C
Shipping Corp. of India	NL	Weekly	CS	C

Mediterranean-N. Africa-Black Sea-Atlantic Is.

LINE	AGENT	FREQ.	PIER	CARGO
ABC Containerline	AR	16 Days	NC	C-RE
AZSCO	TC	18 Days	CS	B-C-R
COSCO	NL	Weekly	NC	C-RE
Evergreen	EM	Weekly	NC	C-RE
Farrell Lines	FA	11 Days	WA	B-C-RE
HUAL	P	10 Days	UP	R
Italia Line	I	Weekly	WA	C-R
Lykes Bros.	L	Weekly	WA	B-C-RE
Maersk Line	M	4 Calls/Week	WA	C-RE
Mediterranean Shipping	MSC	Weekly	NC	B-C
Nedlloyd Lines	N	Weekly	WA	C-RE
Nordana Line	WE	17 Days	CS	B-C-R
OOCL	O	2 Calls/Week	WA	C-RE
P&O Containers Ltd.	PO	Bi-Weekly	WA	B-C
Sea-Land	SL	4 Calls/Week	WA	C
D.B. Turkish Cargo	I	12 Days	CS	B-C
Zim Line	BR	Monthly	CS	B-C

South America

LINE	AGENT	FREQ.	PIER	CARGO
CCNI	I	Weekly	WA	B-C-RE
CSAV-Chilean Line	OF	Weekly	WA	B-C-RE
Grancolombiana	NL	10 Days	NC	B-C-RE
Lykes Bros.	L	Weekly	WA	B-C-RE
Maersk Line	M	4 Calls/Week	WA	C-RE
Mediterranean Shipping	MSC	Weekly	NC	C-B
Nacional Line	GA	Bi-Weekly	NC	C-RE
Nedlloyd Lines	N	Weekly	NC	C-RE
Sea-Land	SL	4 Calls/Week	WA	C

U.K.-N. Europe-E. Europe-N. Russia

LINE	AGENT	FREQ.	PIER	CARGO
ABC Containerline	AR	16 Days	NC	C-RE
Atlantic Container Line	I	Weekly	NC	B-C-RE
AtlantiCargo	STR	8 Days	NC	B-C
Deppe Lines	C	Weekly	WA	C
Evergreen	EM	2 Calls/Week	NC	C-RE
Gorthon Line	P	Monthly	UP	B
Hapag Lloyd	C	Weekly	CS	B-C-RE
HUAL	P	10 Days	UP	R
Italia Line	I	Weekly	WA	C-R
Lykes Bros.	L	10 Days	WA	B-C-RE
Maersk Line	M	4 Calls/Week	WA	C-RE
Mediterranean Shipping	MSC	Weekly	NC	B-C
Nedlloyd Line	N	Weekly	WA	C-RE
OOCL	O	2 Calls/Week	WA	C-RE
POL	NL	Weekly	NC	C-RE
P&O Containers Ltd.	PO	Bi-Weekly	WA	B-C
Sea-Land	SL	4 Calls/Week	WA	C
Star Shipping	ST	8 Days	NC	B-C
Tecomar	C	Weekly	WA	C-RE
TMM	K	Weekly	WA	C-RE
Wallenius Line	WA	8 Days	UP	R

West Indies-Caribbean-Central America-Mexico-Bermuda

LINE	AGENT	FREQ.	PIER	CARGO
AtlantiCargo	STR	8 Days	NC	B-C
CSAV-Chilean Line	OF	Weekly	NC	B-C-RE
Evergreen	EM	Weekly	NC	C-RE
Farrell Lines	FA	11 Days	WA	B-C-RE
Grancolombiana	NL	10 Days	NC	B-C-RE
Hapag Lloyd	C	Weekly	CS	B-C-RE
Lykes Bros.	L	Weekly	WA	B-C-RE
Maersk Line	M	4 Calls/Week	WA	C-RE
Nedlloyd Line	N	Weekly	WA	C-RE
Sea-Land	SL	4 Calls/Week	WA	C
TMM	K	Weekly	WA	C-RE

Pier Keys

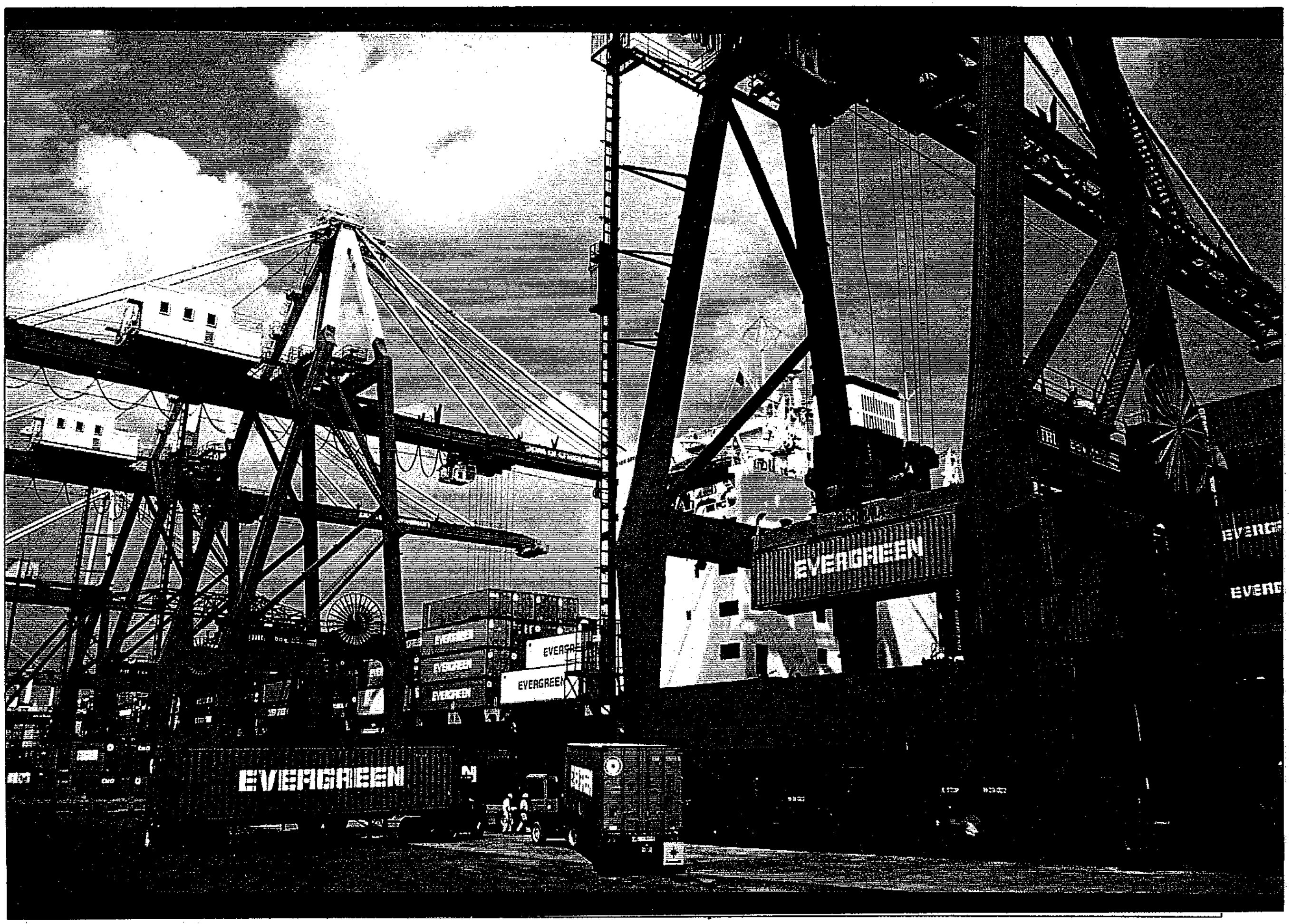
UP Union Pier **CS** Columbus Street
NC N. Charleston **WA** Wando Welch

Cargo Keys

B Breakbulk **C** Container
R Ro/Ro **RE** Reefer

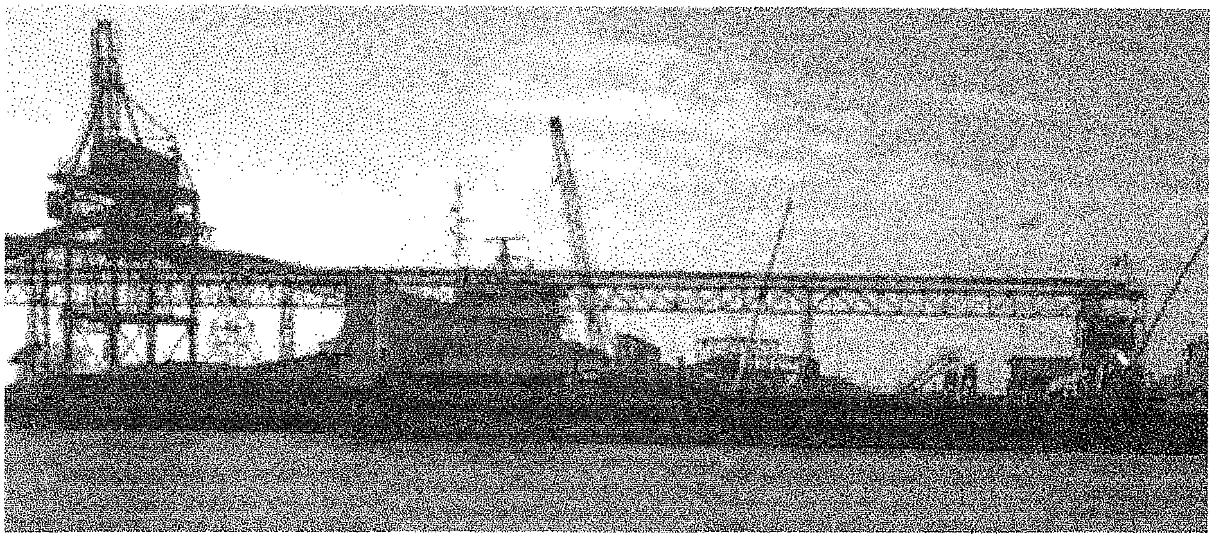
Figure 8

Container Terminal Cranes



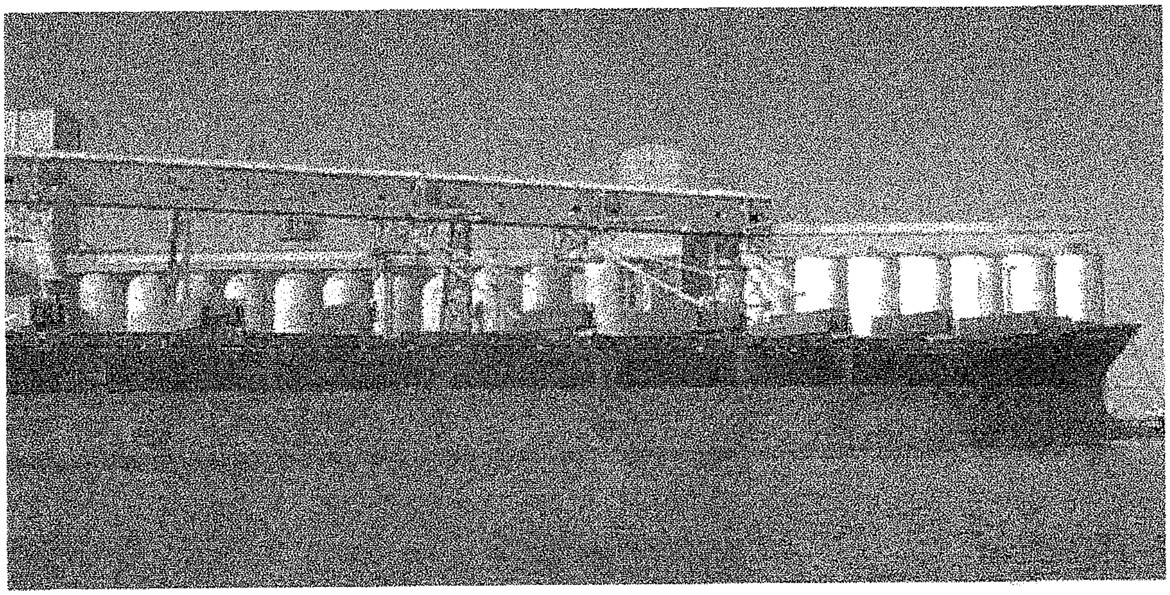
Coal has been exported from the Shipyard River Coal Terminal (SRCT) in Charleston since the coal terminal became operational in 1983. SRCT is served by CSX and Norfolk Southern railroads, and has on-site blending capabilities. The facility is equipped with ten conveyor belts, an underground reclaimer tunnel, a radial stacker, three car dumpers, and land-side storage areas that can accommodate about 300,000 tons of coal (See Figure 9). The maximum annual capacity of this terminal is 4 million tons.

Figure 9
Shipyard River Coal Terminal



The grain terminal is located near the upstream limits of the Federally maintained channel on the Cooper River. On-site facilities include a grain elevator with 50 concrete silos and other storage facilities with a combined capacity of 1.6 million bushels. Grains are moved by means of a 42-inch conveyor belt from the silos to the gallery, which extends the full length of the wharf and serves five vessel-loading spouts. This terminal is served by both rail and truck. (See Figure 10)

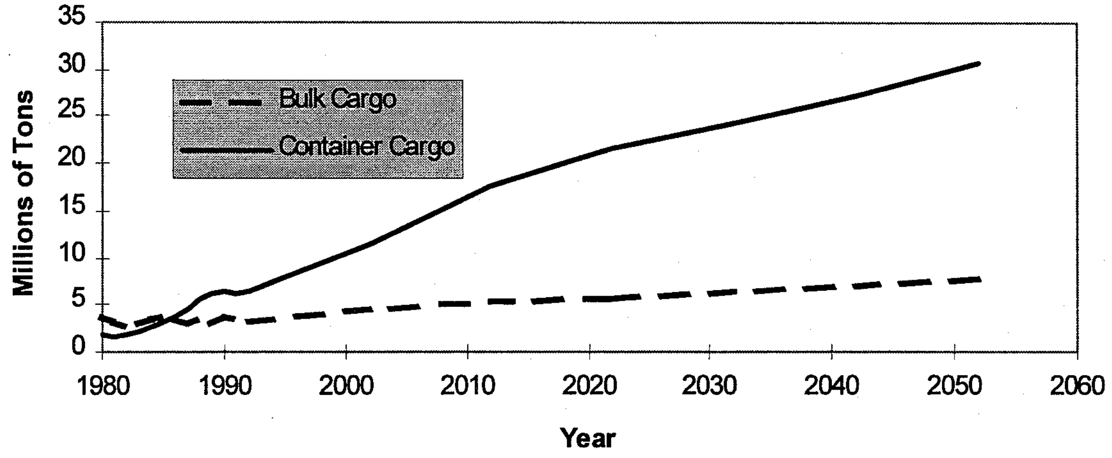
Figure 10
Grain Terminal



3.3 Deep Draft Commerce

3.3.1 **Existing Versus Future Without-Project Overview.** The volume of containerized cargo shipped and received in Charleston Harbor is projected to grow substantially over the period of analysis, while more modest growth is projected in bulk cargo. As reflected in Figure 11, containerized cargo is projected to grow at an average annual rate of 2.7 percent from 1992 to 2052; bulk traffic is projected to grow at an average annual rate of 1.4 percent over the same period.

Figure 11
Charleston Harbor Study
Projected Traffic Levels



Since 1993, rapid growth of container traffic has resumed after a period of low growth extending from 1989 to 1993. This rapid growth has been facilitated by institutional changes, such as the increased use of vessel-sharing agreements, and the addition of new berthing space and land side facilities at the Wando Terminal. When the addition to the Wando Terminal was completed in early 1995, one of Charleston's major carriers moved from the Columbus Street Terminal to the new facilities and a new shipping consortium moved into the facilities vacated at Columbus Street. Container traffic increased about 15 percent from 1993 to 1994, preliminary data indicate that container traffic continues to grow rapidly into 1995. The development of a the new terminal on Daniel Island will accommodate all projected future growth of containerized cargo.

3.3.2 **Existing Activity.** Container cargo accounts for about two-thirds of the total traffic and Charleston is the centerpiece of a modern intermodal transportation network, with immediate access to the interstate highway system and CSX and

Norfolk Southern railroads. Combined with a well-developed, modern infrastructure to accommodate cargo traffic, Charleston Harbor is a port capable of handling the existing cargo traffic as well as projected growth.

Institutional and structural changes have greatly improved the efficiency of operations in Charleston Harbor. Vessel-sharing agreements have allowed shippers to fully utilize the large vessels that are in use. More recently, groups of shippers have formed large, loosely-allied shipping consortiums to further improve shipping efficiency. The completion in 1995 of a new berth and additional landside facilities at the Wando Terminal allowed the addition of a major new shipping consortium to Charleston Harbor.

3.4 <u>Deep Draft Fleet</u>

3.4.1 **Historical Trends.** There are three primary vessel classifications which effect Charleston Harbor: Petroleum Tankers, Dry Bulk Carriers, and Container Vessels.

Petroleum Tankers - The design drafts of petroleum tankers calling on Charleston Harbor ranged from 31 feet to 44 feet. About 40 percent of the vessels had design drafts of 35 feet to 37 feet. Nearly half had design drafts in excess of 37 feet, with more than one-quarter of all vessels at 42 feet. Figure 12 shows the historical trend in the size of tankers porting at Charleston.

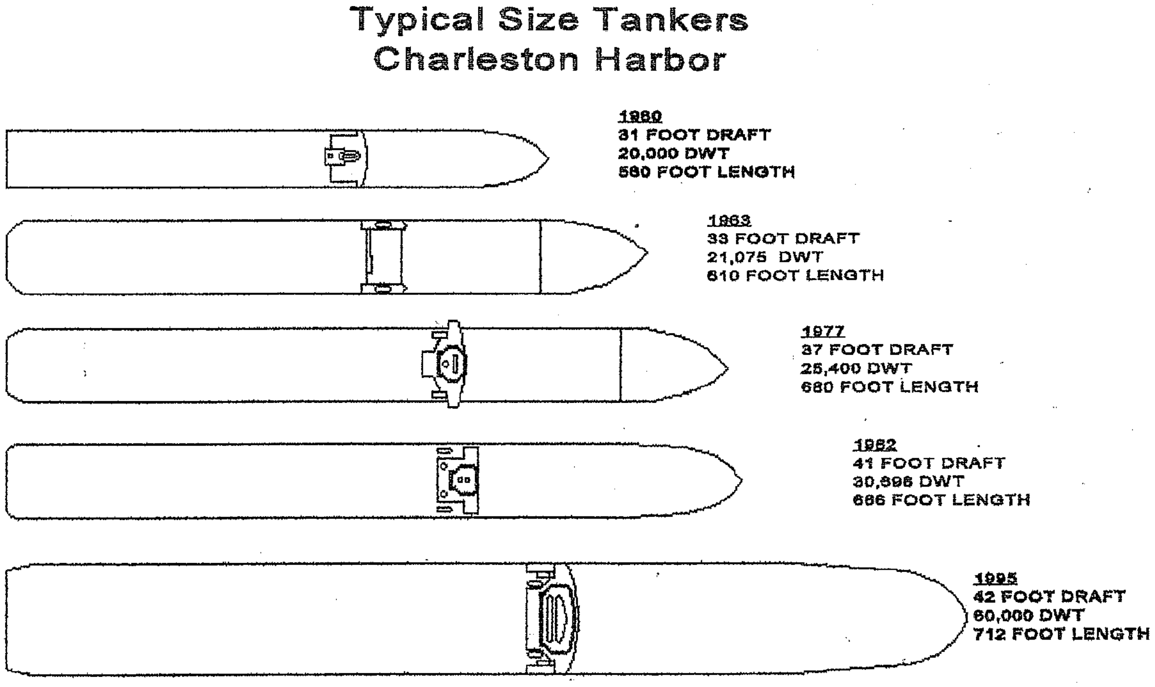


Figure 12: Tanker

Dry Bulk Carriers - These vessels carry grain and coal. For dry bulk carriers transporting grain, in 1993, design drafts ranged from 30 feet to 41 feet. About 25 percent of the vessels had design drafts of 34 feet to 36 feet with another 30 percent having design drafts of 40 feet to 41 feet. The existing coal fleet calling on the coal terminal at Shipyard River has a design draft of 36 feet (25 percent). These vessels require 2 feet of tidal advantage when fully loaded to provide the required four feet of underkeel clearance in the 38-foot channel at Shipyard River.

Container Vessels - Design drafts range from 34 feet to 44 feet for container vessels calling on Charleston Harbor from the Pacific Trade Routes (Pacific Ocean and thus, no post-Panamax vessels are found in this segment of the fleet. The vessels from the Atlantic Trade Routes have design drafts ranging from 31 feet to 44 feet with nearly half of the vessels at 37 to 38 feet. Another quarter of the Atlantic fleet had design drafts of 44 feet. Figure 8 shows the historical trend in the size of containerships porting at Charleston.

3.4.2 **Current Operating Practices.** Traffic levels are projected to increase without further investment in Charleston Harbor. As noted above, containerized

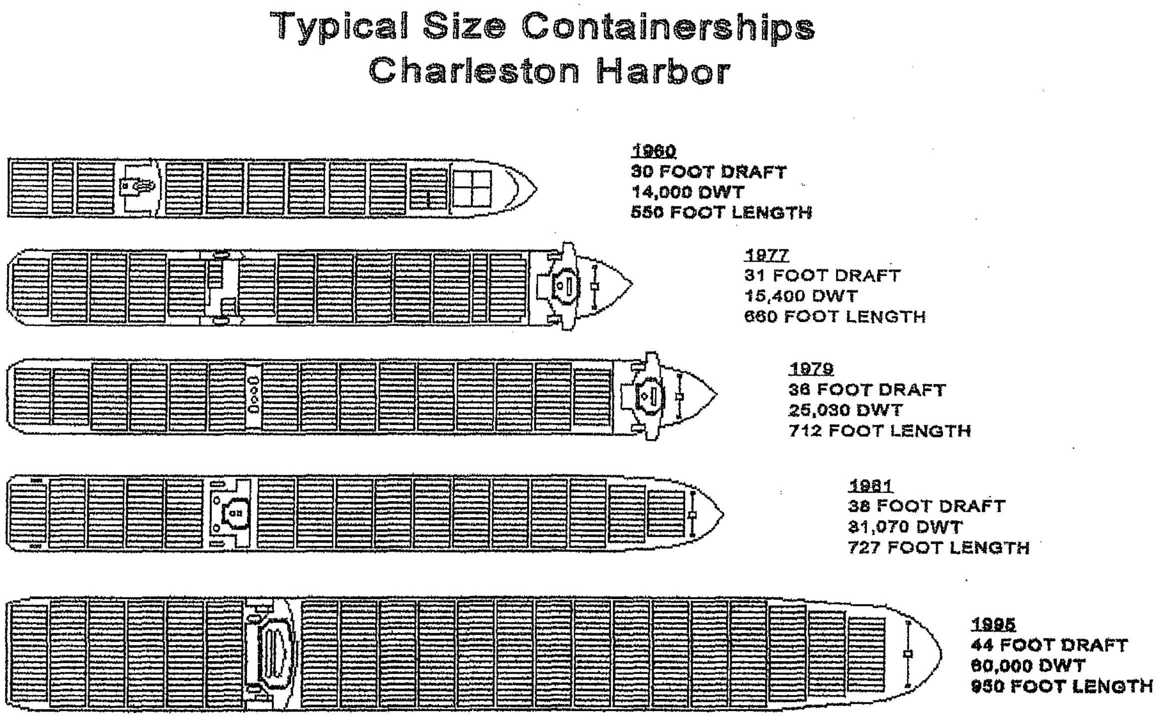


Figure 13: Containership

cargo is projected to grow at an average annual rate of 2.7 percent from 1992 to 2052; bulk traffic is projected to grow at an average annual rate of 1.4 percent over the same period.

In accordance with anticipated traffic growth, most infrastructure improvements are those associated with the shipment of container cargo. Construction of the first portion of the new container terminal on Daniel Island is scheduled to be completed by 2003. By that time, traffic levels will again be near existing capacity. Within a month of the completion of additional berth space and land side facilities at the Wando Terminal in 1995, Sea-Land moved to the new facilities and a new shipping consortium began using the space vacated by Sea-Land at the Columbus Street Terminal. Similar intra-harbor shifts are likely to occur with the availability of the new facilities at the Daniel Island Terminal.

Without additional depth, Charleston Harbor will continue to impose a constraint on the use of large vessels. Charleston presently attracts some of the largest container vessels in use, but these vessels incur tidal delays and light-loading costs when using Charleston. Most of the shipping companies that operate out of Charleston have additional large vessels on order. One company has ordered eight new container vessels that are scheduled to start calling on Charleston before the turn of the century. All eight of these vessels have design drafts of 41 feet and cannot enter or leave Charleston without incurring tidal delays.

The presence of 44-foot draft vessels in Charleston's container fleet indicates that the depth of Charleston Harbor is not always the determining factor in the design of new vessels. These large vessels are able to make better use of the draft elsewhere in their itinerary. However, vessels with design draft of 37 and 38 feet and involved in trade between North America and Europe, appear to be sized in accordance with the maximum depth available at container terminals on the east coast of the United States. Charleston is the last North American port of call for these vessels. When they reach the end of their economic life shortly after the turn of the century, their replacement with larger, more efficient vessels is likely with increased depth at Charleston Harbor.

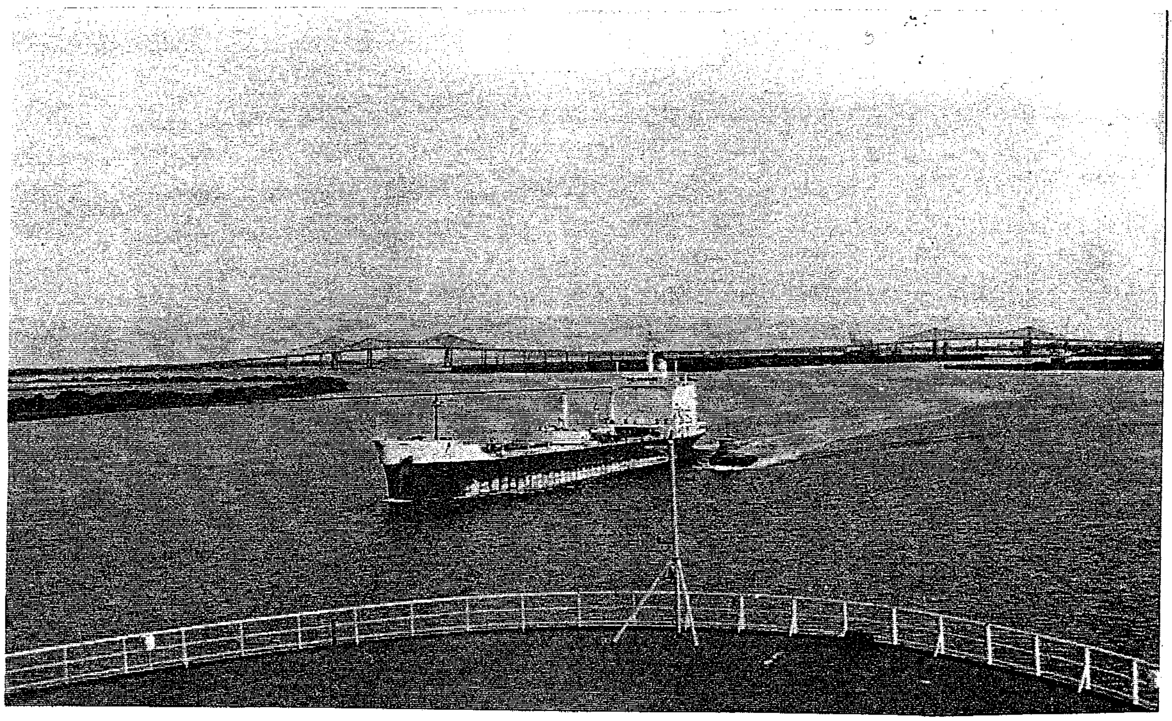
3.5 Problems and Opportunities

3.5.1 **Transportation Efficiencies and Delays.** The economic penalties imposed by inadequate channel depth can be severe. For the vessels that currently call on Charleston, operating costs commonly exceed $2,000 per hour. One foot of light-loading can increase transportation costs by roughly $1 per ton or more. With more than 1,000 vessel calls each year and more that 10 million tons of cargo, the cost of light-loading and tidal delays in Charleston Harbor can be excessive. The inability to attract larger vessels further penalizes the cargo in harbors with inadequate channel depth. Another problem in Charleston Harbor is the inability of the 860-foot commercial vessels to pass in various reaches.

The area between Hog Island Reach and Daniel Island Bend presents adverse conditions for safe navigation due to particular channel alignments, shoaling, and severe currents. Pilots experience significant problems in navigating even the 860-foot vessels through the sharp S-turn at the Drum Island Reach situated immediately up river of the Highway 17 bridges. Under ebb tide conditions, this area is plagued with strong currents from the Cooper and Wando Rivers. As inbound vessels make the turn from Hog Island Reach to Drum Island Reach the currents from the Wando River hit the starboard side of the vessel forcing it towards Drum Island. Drum Island Reach is also prone to serious shoaling thus restricting mariners to less than full channel dimensions. Successfully navigating this reach is critical in positioning the vessel to enter Daniel Island Reach. Additional navigational hazards are encountered at the southern end of Daniel Island Reach where three contraction dikes and two piers are located on either side of the channel compounded with the confluence of Shipyard River. Under optimum conditions the existing channel alignment forces vessels to pass very near tankers moored at the Allied petroleum pier creating a possible collision situation with catastrophic consequences (as seen in track plot for Test Reach H under existing conditions at flood tide located at the end of Appendix A). The existing project was designed for two-way traffic for 860-foot length vessels in Daniel Island Reach (See Figure 14). However, even with one-way traffic, the 950-foot length design vessels have difficulty navigating the approach to this reach.

The SPA plans to construct a new commercial container terminal on the Cooper River side of Daniel Island. This terminal will be 7000 feet long with seven 1000-foot berths. The construction of this terminal will further complicate the existing conditions in this reach. Construction of this terminal presented a challenge to provide safe navigation for vessels transiting the waterway as well as protection of docked vessels at the new and existing facilities. A design team consisting of personnel from SPA, WES, District, Division, and Harbor Pilots Association developed various channel design plans. The initial proposed terminal location placed the face of the wharf within 125 feet of the existing Federal channel. This proposal was discarded by the design team after initial simulation runs because of concerns that the plan would add to the existing navigation problems. The location of the southwest corner of the terminal inhibited the vessels turn from Myers Bend to Daniel Island Reach thus forcing the vessels too close to tankers at the petroleum pier. Several design plan alternatives were tested on the ship simulation model before consensus was reached by the design team resulting in the recommended plan described in this report. All tests revealed channel modification was required

Figure 14
Vessels Passing in Daniel Island Reach



Large vessels passing docked vessels too closely create a suction effect which causes an additional strain on the mooring lines of the docked vessels. Presently, this problem exists when large commercial vessels pass too closely to petroleum tankers are docked at the Allied pier. Large inbound vessels navigating the bends between the bridges and Daniel Island Reach must avoid the shoals in Drum Island Reach while preparing for the turn at Myers Bend allowing adequate distance between moored tankers at the Allied pier. The forces exerted on the moored ships can be reduced by having ship traffic travel at slower speeds. However, strong tidal currents in the Cooper River force that ship traveling with the currents to transit at a fairly high speed to maintain steerage. The new container terminal will contribute to this problem with the increased traffic and the potential of having seven container ships docked at the facility on the opposite side of the river. The location of the terminal is not dependant on traffic operation in the channel.

The design of this channel accounts for the existing and projected physical features associated with the Daniel Island Reach. The wider channel is needed even without the construction of other harbor improvements analyzed in this study to provide safe navigation for the size of the existing and projected commercial vessels utilizing Charleston Harbor. The new terminal is located in the most optimum location for safe navigation while allowing for efficient terminal operation as determined by ship simulations conducted at the Waterways Experiment Station. The terminal could not be moved any closer to the existing channel without compromising the safety of large commercial vessels traversing the bends around Daniel Island and that of ships docked at the Daniel Island Terminal. The west side of the Daniel Island channel remains in place to accommodate petroleum tankers calling on the Allied pier.

When the Daniel Island container terminal is constructed, there may be problems with channel alignment, stresses caused by passing ships on moored vessels, delays in getting vessels turned or other issues of navigation efficiency or safety that need to be addressed.

Town Creek has been maintained as an alternate route to the main Cooper River Channel since the main channel was relocated from the Town Creek Reach, Tidewater Reach, and South Channel located to the west of Shutes-Folly Island in the 1950's. The need for the alternate channel at the Upper Town Creek Reach, at its present dimensions, no longer exists, therefore this reach was reevaluated.

Opportunities for environmental enhancement and restoration are being explored throughout the study process.

3.5.2 **Planning Considerations.** The Panama Canal cannot accommodate vessels whose actual draft exceeds 40 feet or whose width exceeds 106 feet. This poses one of the most important planning considerations. Containerships trading with Asia are the only vessels calling on Charleston that transit the Panama Canal. The extent to which these vessels benefit from increased harbor depth is restricted by the limits imposed by the Panama Canal. The Post-Panamax vessels exceed these restrictions and are unable to use the Panama Canal. Furthermore, the extent to which the draft of Panamax and smaller vessels can be used in Charleston is constrained by the limits of the Panama Canal.

The depth available at harbors that trade with Charleston is another consideration. A portion of the petroleum product traffic originates at harbors along the Gulf Coast whose depth does not exceed 40 feet. This traffic will not benefit from increased channel depth at Charleston. The Panama Canal is the overriding circumscription for trade with Asia. Most of Charleston's European trading partners have harbor depths that exceed any depth that is being considered in this study and thus impose no restrictions.

The two Highway 17 bridges crossing the Cooper River and Town Creek connecting downtown Charleston with Mount Pleasant pose a concern for possible channel widening. The federal navigation channel was present prior to construction of either the Grace Memorial Bridge or the Silas M. Pearman Bridge. The two-lane Grace Memorial Bridge was built in the 1940's with a support piling span distance of 1000 feet over the navigation channel. The Pearman Bridge was built in the mid-1960's and only has a span distance of 700 feet over the channel.

Concern has been raised by the state highway department that the dredging activity in the immediate vicinity of the Highway 17 bridges has caused scouring around the foundation of the bridges. Hydrographic survey data indicates that scouring occurs at piers far removed from the navigation channel. The studies conducted for the harbor deepening do not support a linkage between deepening and pier scour. Nevertheless, coordination with the South Carolina Department of Transportation (SCDOT) will continue through PED regarding this issue.

3.5.3 **Dredged Material Disposal.** Another planning consideration is the availability of sites for the disposal of dredged material. In developing cost estimates for the construction of the improvements to the channel as well as future maintenance, the availability and capacity of disposal sites was evaluated to assure that the planned use of low-cost sites does not exceed their capacity. When the capacity of a site can be increased by diking, the additional costs of diking was quantified and added to the disposal cost. Upland disposal sites are limited in number and capacity. The cost of placing material in existing upland sites is less expensive than taking the material to the ODMDS for certain reaches located adjacent to upland disposal sites. In order for upland disposal of dredged material to be cost effective, the sites must have substantial capacity and be located adjacent to frequently dredged reaches of the Federal navigation project.

3.6 **Formulation of Alternatives**

Existing project depth is inadequate to accommodate all the vessels that are projected to call on the harbor without imposing large light-loading and/or tidal delay costs. A deeper harbor will allow the use of larger, more efficient vessels and more efficient use of the large vessels that already call on the harbor. Providing for increased length of two-way traffic reaches, channel configurations more suitable for safe navigation in problematic reaches, and a turning basin for the new Daniel Island Terminal will further improve the efficiency and safety of vessel operations. This study evaluates the economic costs and benefits of (1) channel depths ranging from 41 feet to 46 feet, (2) two-way traffic areas on the Wando River and in the Shutes and Folly Reaches of the main channel, and (3) a turning basin for the new Daniel Island Terminal. Separable increments of the channel deepening alternatives were evaluated incrementally. These increments are (1) the entrance channel and the main channel on the Cooper River to the North Charleston Terminal, (2) the reaches from the main channel to the Columbus Street Terminal, (3) Wando River, and (4) Shipyard River.

3.6.1 **Without-Project Condition.** The without-project condition assumes no change to the existing Federal navigation project, which would remain at 40 feet for the inner harbor channel, 42 feet for the entrance channel and 38 feet in Shipyard River. The channel in the Daniel Island Reach is considered to be widened at the existing project depth along the east bank to ensure navigational safety as shown in Figure 18. Operation of the new Daniel Island Terminal will not depend on channel deepening. The without-project condition is used to evaluate the benefits which would result from other alternatives. The existing or without-project condition was used as the base condition in the comprehensive modeling studies by the Corps' Waterways Experiment Station (WES).

3.6.2 **Channel Modifications.** Modification to channel width, alignment or structural alterations were considered in the evaluation of reaches where two-way traffic is necessary to accommodate the increase in traffic levels and vessel sizes. The current practice by harbor pilots is to meet and pass large vessels from the entrance channel to the upper end of Rebellion Reach in the lower harbor. Meeting and passing large vessels is avoided from Folly Reach thru Drum Island Reach due to short reach lengths and frequent bends in the channel. Two other obstacles inhibit safe navigation within this region: the Cooper River Bridges and the frequent shoaling of Drum Island Reach. Daniel Island Reach and Clouter Creek Reach are the only reaches in the 7.18 miles of the upper harbor which are suitable for meeting and passing large vessels. No passing is performed between two large vessels in the Wando River or Shipyard River. The channel modification alternatives are all considered in conjunction with the various channel depths (Section 3.6.3).

Shutes/Folly Realignment. The lower portion of the inner harbor provides the optimum location for meeting and passing of large vessels. The combined length of Shutes and Folly Reaches is 0.96 miles. The current alignment of these reaches prevents two-way traffic. The Cooper River above Horse Reach is a difficult passage for navigating large vessels and is not conducive to two-way traffic. Additional channel lengths suited for meeting and passing large vessels will reduce the delay time at terminals for vessels waiting on others to maneuver through the meandering channel. The elimination of bends in the Shutes, Folly, and Horse Reaches, will provide for two-way traffic on an additional 1.5 miles of the main channel. Figure 15 shows the existing and alternative alignment of these reaches.

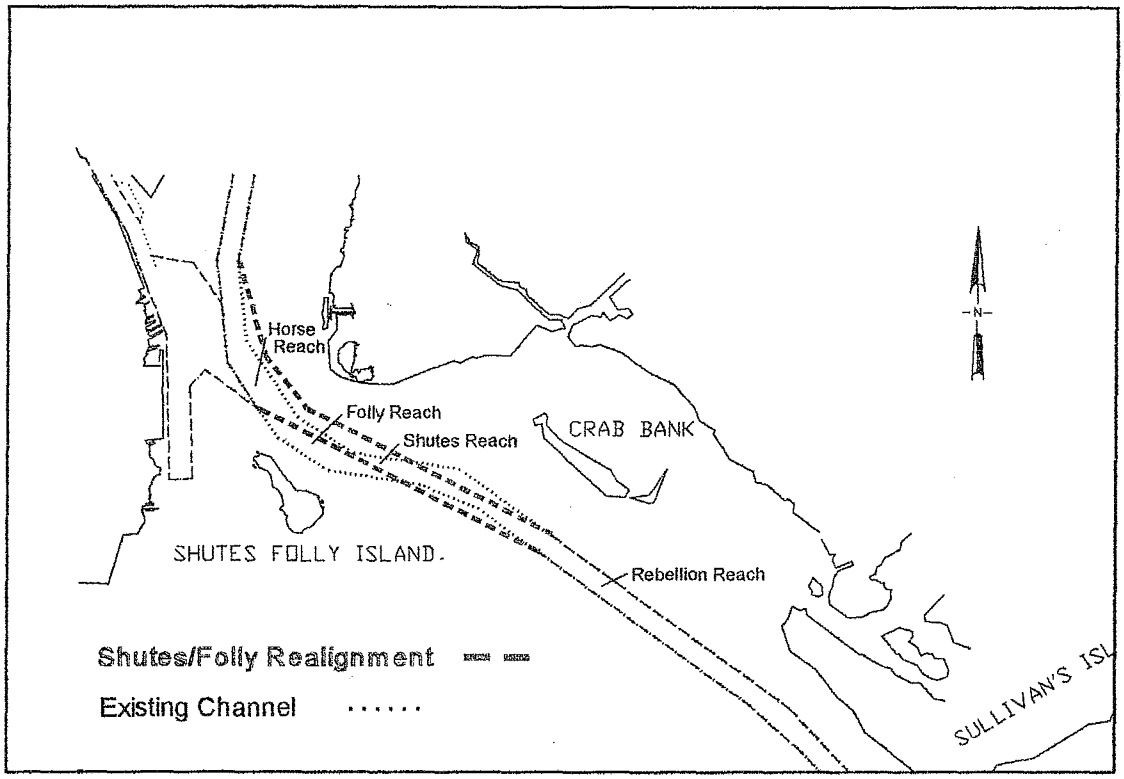


Figure 15: Alignment from Mt. Pleasant Range to Horse Reach

Wando River. The Wando River Reach is currently 400 feet wide and is unsuitable for two-way traffic. Delays are incurred at the Wando Terminal by vessels waiting

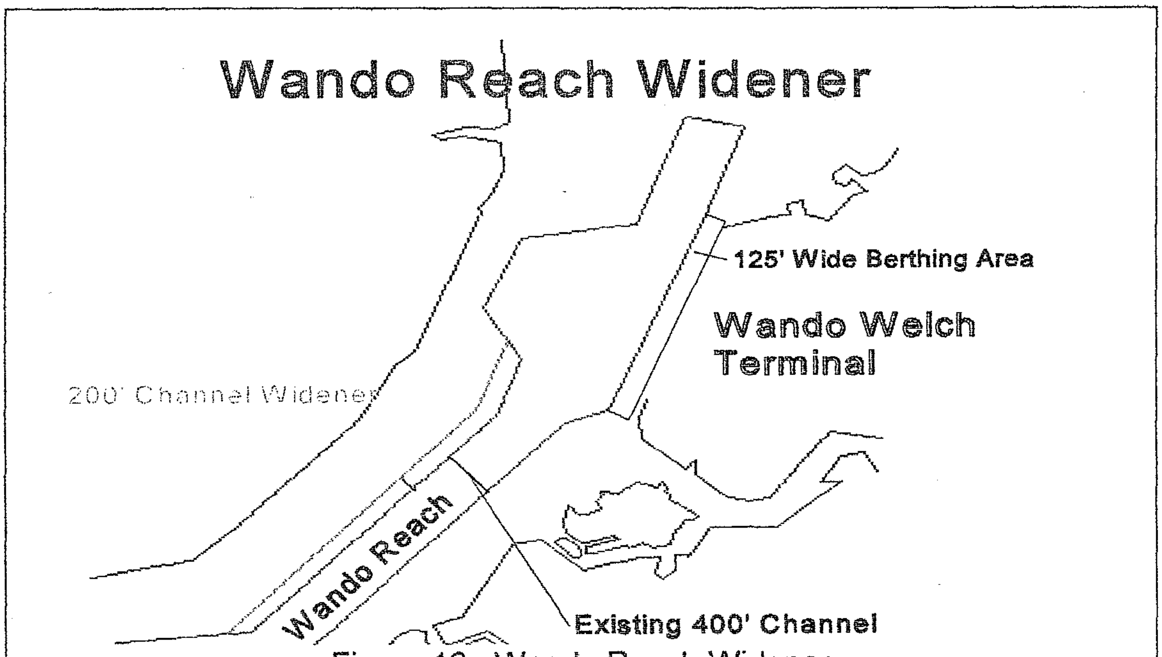


Figure 16: Wando Reach Widener

on inbound vessels navigating that reach. Widening this reach would provide 2.08 miles of additional two-way traffic. Figure 16 shows the existing Wando Channel along with the proposed 200-foot channel widener.

Entrance Channel. An initial investigation was conducted during the preliminary testing phase of the ship simulation study at the Waterways Experiment Station (WES). Tests were run to determine the suitability of the existing channel dimensions of the entrance channel. From these results, additional entrance channel widths (600 and 800-foot wide channels) were suggested for further investigation during the principal testing phase. Figure 17 shows the various channel widths which were evaluated during the ship simulation test runs.

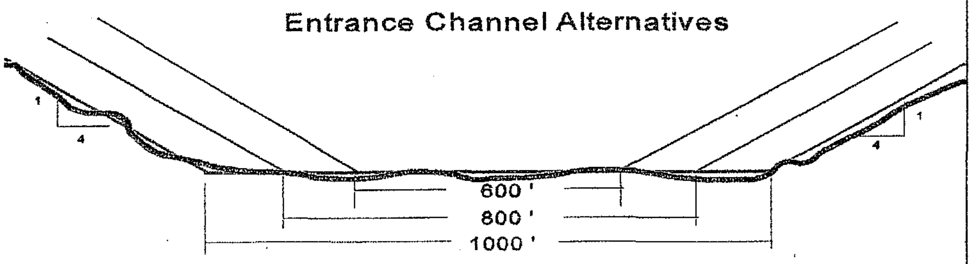


Figure 17

Daniel Island Reach. The proposed Daniel Island Container Terminal will require a 7000-foot long berthing area. A 1400X1400-foot turning basin located across the Cooper River from the terminal will be included in the alternative plan. Figure 18 shows the existing channel and proposed improvements.

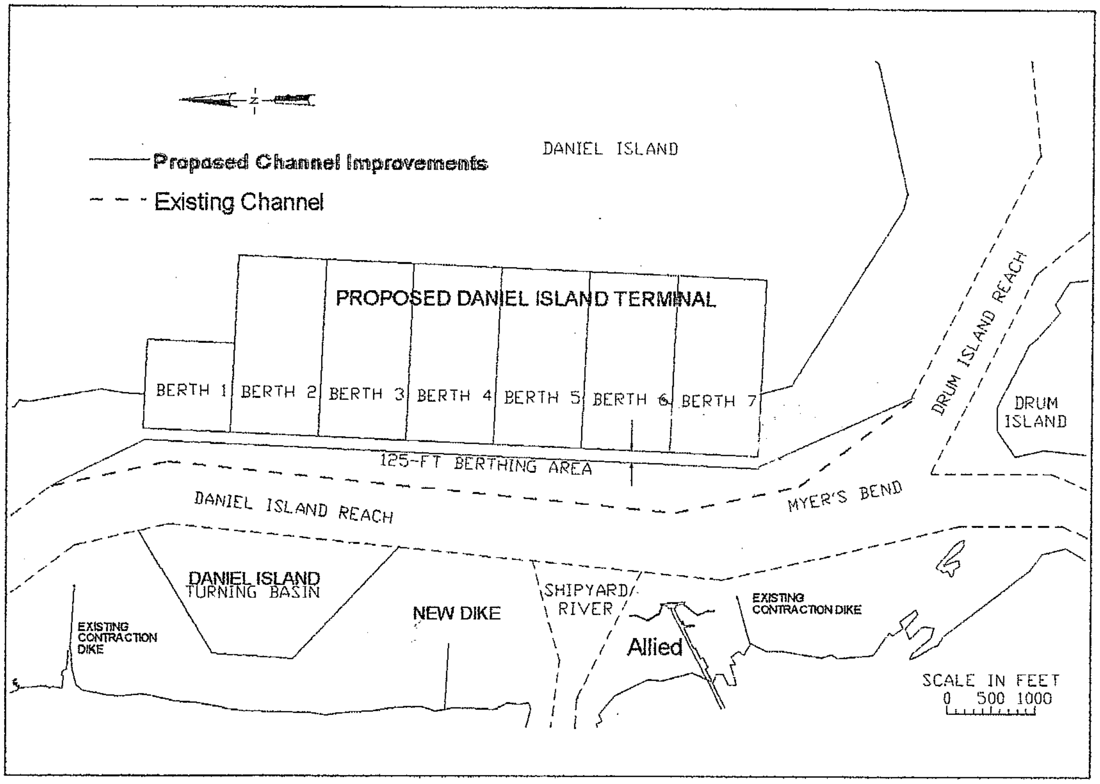


Figure 18: Daniel Island Terminal location and associated channel improvements

3.6.3 **Channel Deepening.** All deepening alternatives would require dredged material disposal site investigations pursuant to the plan selection. See Figure 19.

Alternative 1. This alternative would increase the authorized entrance channel depth to 43 feet approximately 14.7 miles from station 0+00 to the 43-foot ocean contour and increase the authorized project depth to 41 feet throughout the remaining project limits.

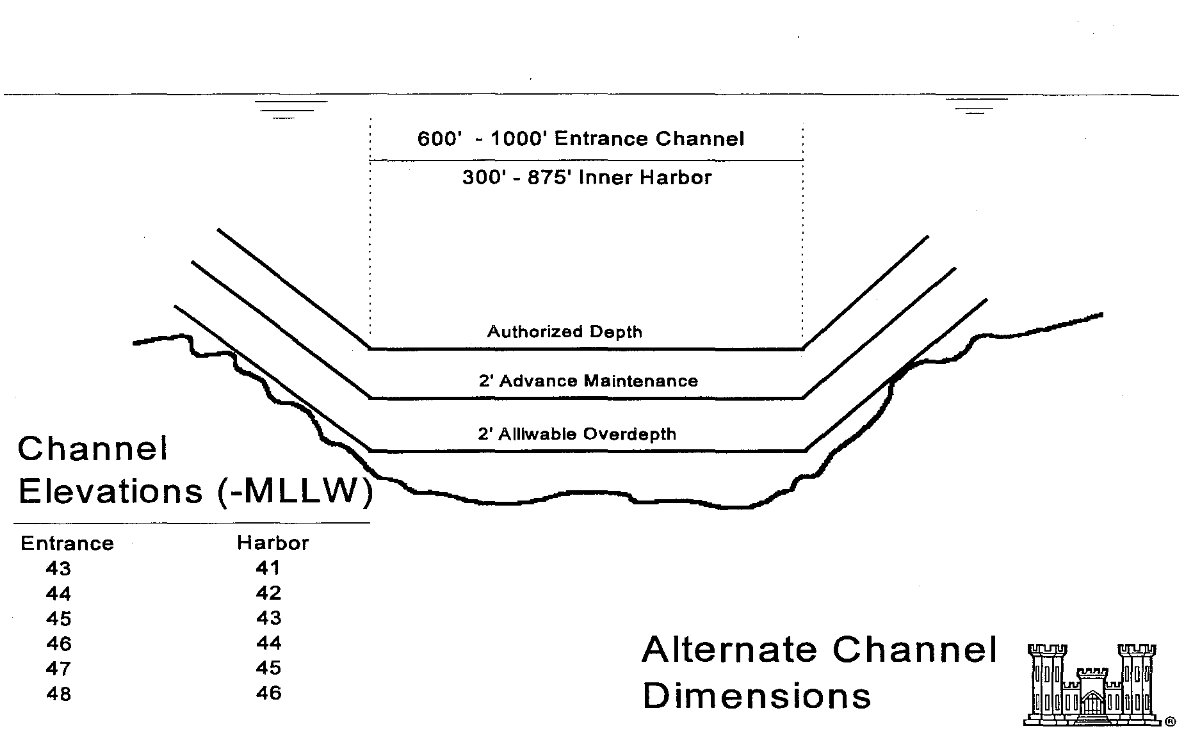
Alternative 2. This alternative would increase the authorized entrance channel depth to 44 feet approximately 14.8 miles from station 0+00 to the 44-foot ocean contour and increase the authorized project depth to 42 feet throughout the remaining project limits.

Alternative 3. This alternative would increase the authorized entrance channel depth to 45 feet approximately 15.2 miles from station 0+00 to the 45-foot ocean contour and increase the authorized project depth to 43 feet throughout the remaining project limits.

Alternative 4. This alternative would increase the authorized entrance channel depth to 46 feet approximately 16.1 miles from station 0+00 to the 46-foot ocean contour and increase the authorized project depth to 44 feet throughout the remaining project limits.

Alternative 5. This alternative would increase the authorized entrance channel depth to 47 feet approximately 16.3 miles from station 0+00 to the 47-foot ocean contour and increase the authorized project depth to 45 feet throughout the remaining project limits.

Figure 19: Alternate Channel Dimensions



Entrance	Harbor
43	41
44	42
45	43
46	44
47	45
48	46

Alternative 6. This alternative would increase the authorized entrance channel depth to 48 feet approximately 16.4 miles from station 0+00 to the 48-foot ocean contour and increase the authorized project depth to 46 feet throughout the remaining project limits.

3.6.4 **Non-Structural Alternatives.** Nonstructural alternatives to channel deepening include light-loading vessels, making optimal use of tidal delay, and optimizing the fleet used to transport cargo. The maximum practical implementation of these practices is assumed in the without project condition. For that reason, a separate nonstructural alternative was not evaluated.

3.7 Beneficial Use of Dredged Material

Opportunities for beneficial use of dredged material were examined. Several ideas were identified and they are discussed below.

3.7.1 **Shore/Erosion Protection.** Material removed from the entrance channel was considered for placement along the beaches of Morris Island or Folly Island or offshore of the islands as both are located to the south of the entrance channel and have eroded extensively since construction of the jetties in the late 1890's. This alternative was not pursued further because of increased cost associated with placing the material on the beach and unsuitability of the material for such disposal. Material placed on a beach for erosion protection is desired to be of coarser grain size than the natural material to prevent rapid erosion. The maintenance dredged material is fine grained sand and easily erodible by wave action. Material considered for offshore placement was to serve as a wave-breaker to the barrier islands. Placement of the dredged material near enough to shore to serve as a wave-breaker is not feasible due to the shallowness of the offshore waters and inability to get close enough to the shoreline to have any effect on the offshore wave action.

3.7.2 **Nesting Habitat at Crab Bank.** This plan provided for dredged material from the realigned area of Shutes/Folly Reaches to create a more suitable environment for nesting of a multitude of shorebirds on Crab Bank Shoal located between Shem Creek and Rebellion Reach. This plan received enthusiastic support from environmental agencies. The most desirable material for this plan is coarse clean sand or gravel which can be used for nesting habitat. However, the resource agencies also expressed an interest in having less desirable materials utilized as a base overlaid with a cap of the appropriate nesting material. The material to be removed from the channel reaches adjacent to Crab Bank would normally be taken to the ODMDS for disposal by means of an ocean-going scow after being removed by a clam shell dredge. This option appears to be feasible and may be further evaluated during Planning Engineering and Design.

3.7.3 **Castle Pinckney.** Castle Pinckney is located on Shutes Folly Island within the harbor. This small island has experienced erosion problems around the south-east side of the island that could threaten the culturally significant historical site. Placement of dredged material from the adjacent realigned Shutes/Folly Reaches was considered as both a protective action for the castle as well as creating a nesting area for shore birds. The potential disposal capacity of the island was considered insignificant as an alternate upland dredged material disposal site for this project. However, the State Ports Authority has requested the Corps of Engineers to investigate protection of Castle Pinckney shoreline under the Continuing Authorities Program.

3.7.4 **ODMDS.** Dredged material designated for disposal in the ODMDS consists of rock, marl and coquina. This material will serve as a reef in the immediate area of placement for a live bottom environment. The live bottom area to the west of the designated offshore site will be further protected by the additional material placed from this project.

4. Comparison of Alternative Plans

4.1 Design Considerations

Each alternative plan was evaluated for economic benefits, environmental concerns, aesthetics, and satisfaction of navigational requirements. The investigated plans combined variable channel width or realignment designs with channel deepening designs as coordinating plans. No channel realignments were considered for construction at a channel depth different from the selected project depth.

4.1.1 **Design Vessels.** The design vessels selected for this study were determined to be the most economically representative of the projected fleet calling on the port. Based on the commerce passing through Charleston Harbor, a containership and a bulk carrier were selected as design vessels. Dimensions of the selected design vessels as shown in Table 4. These design vessels are suited for the most optimum plan for simulating meeting and passing in the harbor.

Table 4
Ship Simulation Test Design Vessels

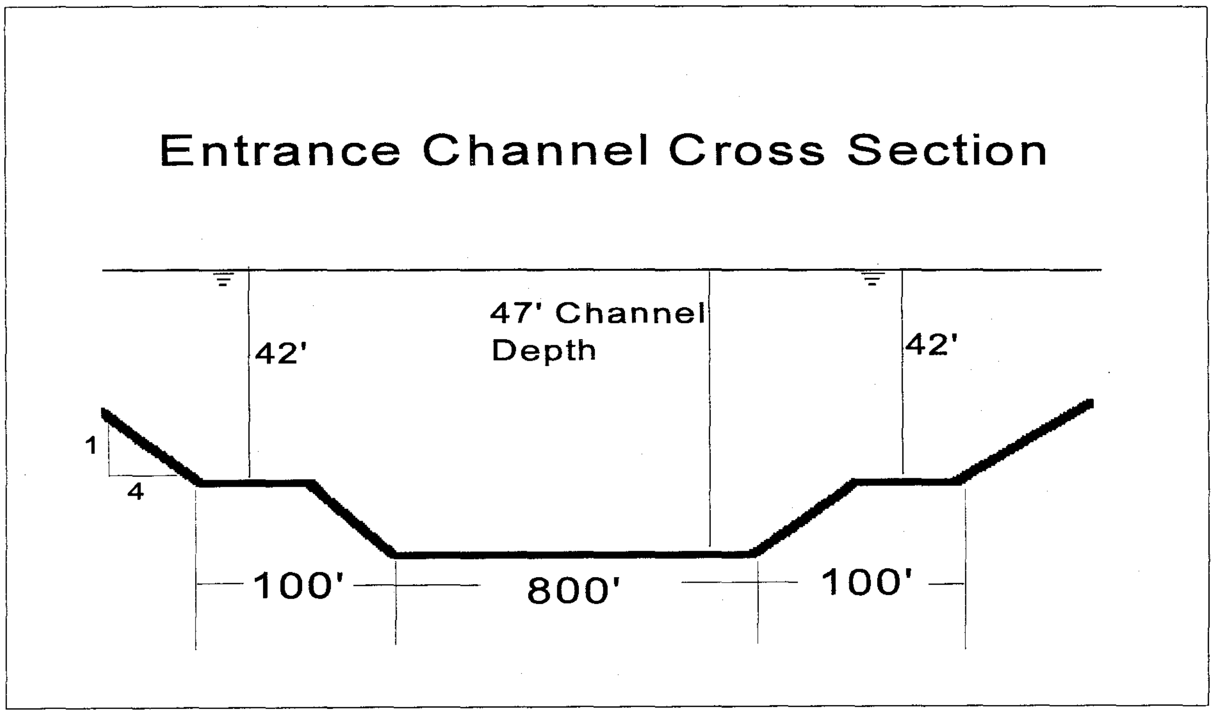
Test Design Vessels			
Ship Type	LOA ft	Beam ft	Draft ft
Container Ship	950	130	45
Bulk Carrier	875	144	45

4.1.2 **Channel Design.** Increases in vessel length, beam and draft combined with more vessel traffic creates the need for channel improvements in Charleston Harbor. The present port facilities have experienced a substantial increase in business in the past 15 years. The vessels calling on the harbor are much larger than in the past; container vessels exceeding 950 feet in length and with design drafts of 41 to 44 feet make up a significant share of Charleston's fleet. With the exception of the Wando Reach widener, all the alternative channel designs listed in Sections 3.6.2 and 3.6.3 were tested in the ship simulation model at WES. Widening the Wando Reach was not anticipated to be justified at the time of the ship simulation phase of the study. The 200-foot channel widener was investigated in the economic analysis for two-way traffic as dictated by comparable reaches in the harbor.

Channel Depth. Deep draft vessels currently calling on the port are required to either light load and/or utilize the tidal cycle to transit the navigation channel by maintaining a safe underkeel clearance distance of four feet. Economic costs and benefits were evaluated for channel depths in one-foot increments from 41 feet to 46 feet to determine the most beneficial design channel depth.

Entrance Channel. With deepening of the channel, the limits of the entrance channel will be extended to the depth of the natural ocean contour. The depth of the entrance channel will continue to be two feet deeper than the design channel depth of the inner harbor channel to allow for wave action experienced in the open waters of the ocean. During the pre-testing phase of the ship simulation study on the entrance channel, results indicated alternate channel widths warranted testing in the simulator. The existing 1000-foot channel width, an 800-foot channel width and a 600-foot channel width were tested. Figure 20 illustrates the final design for the entrance channel resulting from consensus during the Technical Review Conference. The entrance channel will be deepened to 47 feet with a width of 800 feet. The channel will be centered in the existing 1000-foot channel with the remaining 200 feet to continue to be maintained at 42 feet.

Figure 20
Entrance Channel Design



Inner Harbor Channel Improvements. Three channel areas of the inner harbor were considered for channel widening or realignments. The bend at the Shutes, Folly and Horse reaches was investigated for realignment to extend the length of channel for two-way traffic of large vessels. This reach is the last area of the harbor in which meeting and passing of large vessels is considered. Upriver of this area lies the Highway 17 bridges, Drum Island Bend, and a series of short transits that are navigational hazards which discourage two-way traffic.

Channel widening was considered in two other reaches of the inner harbor - the Wando and Daniel Island Reaches. The width of the Wando (400 feet) is insufficient for two-way traffic. Delays are experienced by vessels at the Wando Terminal waiting for vessels to navigate the Wando channel.

The Daniel Island Reach was investigated for widening primarily to facilitate the needs of the new container terminal along the Cooper River on Daniel Island. Various channel alignments were considered for optimum use of the new port facility and navigation considerations. The SCSPA and the Corps worked together to design the layout of the terminal in relationship with the channel and current flow patterns. The terminal will generate a dramatic increase in vessel congestion within the reach as a turning basin and seven-berth terminal is introduced. Two-way channel traffic combined with docked vessels at the new Terminal and Allied Pier, and turning vessels in the basin add to the complexity of a reach located immediately up river of a difficult navigational bend and two protruding 700-foot long training dikes (Figure 18, Section 3.6.2).

All navigation features of Charleston Harbor were evaluated in order to determine the benefits derived from channel deepening. Shem Creek and the Ashley River do not have deep-draft vessel traffic and therefore were not considered for improvements from this project. The vessels which use the pier at Tidewater Reach are typically cruise ships that have drafts less than 40 feet and would therefore not need additional channel depths and would not contribute to the economic benefits of this project. Upper Town Creek and the portion of Lower Town Creek above Columbus Street Terminal (including the Town Creek turning basin) do not require any additional channel depth since the Town Creek channels are no longer required for passage of large vessels. These areas of the existing authorized Federal navigation channel were not considered for deepening or channel improvements in this study.

4.1.3 **Dredging Quantities.** Design alternatives will extend the existing navigation channel from 40 feet deep to 46 feet deep at one-foot increments. In addition to deepening the existing channel alignment, the areas of channel realignment and dredging of Daniel Island Turning Basin will be taken to the selected design channel depth. Quantities for each depth alternative are listed in

Table 5. Deepening will include two feet of advance maintenance and two feet of allowable overdepth. All channel reaches will adopt the existing channel side slope of one vertical on four horizontal. Quantity amounts were derived from condition bathymetric surveys conducted after dredging for the existing authorized project. The quantities derived in Table 5 were calculated by deducting the existing maintenance quantity from the deepening prism.

Table 5
Dredging Quantities
(Cubic Yards)

REACH	PROJECT CHANNEL DEPTH (Feet Below MLLW)					
	41	42	43	44	45	46
Entrance Channel	4,927,615	7,163,234	9,207,002	11,338,574	13,541,781	15,378,581
Mt. Pleasant Range	28,850	55,781	81,508	108,353	135,589	162,825
Hog Island	224,539	407,963	599,754	797,185	1,000,377	1,208,422
Drum Island Bend	16,221	29,792	45,771	64,004	84,262	106,208
Drum Island	127,499	238,569	362,704	491,429	623,031	757,001
Custom House	30,873	64,607	106,866	152,316	198,175	245,680
Tidewater	37,139	71,537	111,785	153,632	196,152	239,228
Lower Town Creek	126,256	204,421	289,174	376,071	464,070	553,138
Turning Basin	45,471	95,941	156,574	221,100	287,561	355,355
Shipyard River	122,377	186,033	261,422	341,491	424,335	509,312
Daniel Island	160,577	269,394	381,487	496,359	614,031	734,730
Daniel Island Bend	140,682	230,996	327,840	429,625	534,515	641,332
Clouter Creek	200,992	361,311	528,936	700,996	877,361	1,057,801
Navy Yard Upper	141,993	230,385	322,736	417,573	514,573	613,753
Navy Yard Lower	40,273	80,447	131,034	188,490	249,896	313,959

Table 5
Dredging Quantities, Cont.
(Cubic Yards)

REACH	PROJECT CHANNEL DEPTH (Feet Below MLLW)					
	41	42	43	44	45	46
North Charleston	162,381	278,109	398,317	524,448	656,204	793,542
Filbin Creek	147,365	239,440	335,017	433,636	534,223	636,374
Port Terminal	97,356	175,727	257,492	341,321	427,733	515,459
Ordinance	80,846	161,001	244,931	329,810	415,606	502,350
Ordinance Turning Basin	44,996	74,962	106,441	139,562	174,240	210,113
Wando	80,601	212,881	373,516	545,626	727,219	915,091
Wando Terminal/Turn. Basin	129,051	268,296	447,372	635,771	827,036	1,020,172
Custom House Berth	125,930	140,740	155,560	170,370	185,190	200,000
North Charleston Berth	163,200	179,410	209,970	240,525	271,070	301,625
Allied Pier	27,780	33,340	38,890	44,450	50,000	55,560
Hess Pier	80,560	97,710	114,830	131,970	149,090	166,220
Shipyard Berth	7,640	10,191	12,740	17,600	22,460	27,320
Wando Berth	34,260	51,530	68,520	85,650	102,780	119,910

Table 5
Dredging Quantities, Cont.
(Cubic Yards)

REACH	PROJECT CHANNEL DEPTH (Feet Below MLLW)					
	41	42	43	44	45	46
NEW WORK QUANTITIES						
New Rebellion	1,106,600	1,144,100	1,181,600	1,219,100	1,256,700	1,554,500
New Horse/Shutes	2,525,940	2,634,430	2,742,905	2,851,375	2,960,010	3,060,218
Daniel Island Turning Basin	2,940,000	3,070,000	3,200,000	3,330,000	3,450,000	3,540,000
Daniel Island Widening	3,800,000	4,000,000	4,200,000	4,300,000	4,500,000	4,600,000
Daniel Island Berth	1,290,000	1,330,000	1,360,000	1,390,000	1,420,000	1,450,000
TOTAL	19,215,863	23,792,288	28,362,694	33,008,412	37,875,270	42,545,779

Quantities were calculated from the post-deepening surveys of the existing authorized navigation project.
Figures reflect 2 feet advance maintenance and 2 feet allowable overdepth.

4.1.4 **Increased Annual Maintenance.** An increase in annual dredging maintenance is expected due to each design alternative based on the sedimentation study conducted by WES. The sedimentation investigation was based on historical dredging quantities both before and after previous channel deepening projects and maintenance practices. The numerical model STUDH, part of the TABS-MD package was used to predict shoaling tendencies for a channel depth of 45 feet. The realignment at Shutes/Folly Reach and the alternate channel design plans for the Daniel Island Reach were tested in the model to investigate impacts to shoaling within the project. The existing project conditions were tested to determine a base condition used for comparison of the alternate plans. The channel realignments were then modeled at the 45-foot channel depth to determine changes resulting from the alternate plans. An overall increase of shoaling of 60% was estimated throughout the project limits. The most dramatic increase was experienced in the Daniel Island Reach where nearly 740% increase was calculated. This is due to the increase in channel area by nearly two times the existing area. This increase was considered too excessive for maintenance purposes and an alternative was sought. An additional alternate design plan was developed by WES to reduce the amount of predicted shoaling in this reach by including a contraction dike along the west side of the channel located to the north of Shipyard River and the Navy's Degaussing Pier. This plan reduced the estimated shoaling in this reach by nearly 200,000 cubic yards annually. The estimated increase in shoaling quantities listed in Table 6 reflect the implementation of the new contraction dike in conjunction with the two restored existing dikes (existing dike on Daniel Island will be removed to allow for channel widening).

Table 6
Estimated Increased Annual Maintenance
(Cubic Yards)

Channel	41	42	43	44	45	46
Entrance	16,000	32,000	48,000	64,000	80,000	96,000
Harbor	272,000	344,000	419,000	495,000	573,000	652,000

4.1.5 **Associated Improvements.** Improvements associated with the deepening project are primarily those involving deepening of the adjacent berthing areas consistent with the deepening alternative. Construction of the Daniel Island Turning Basin and berthing area will be dependant upon completion of the first phase of the new Daniel Island Terminal which is expected to occur in 2003.

4.2 Project Costs

4.2.1 **Construction Cost Estimates.** The initial cost estimate was based on quantities provided from the surveys taken of the harbor after the last deepening of the channel to the present authorized Federal project depth of 40 feet. Extensive geotechnical investigations of the harbor including subbottom profiling and vibracore borings were analyzed to determine the extent and means of recommended removal of material. The entrance channel estimates were determined assuming the use of a hopper dredge with 4000 cubic yard scows to transport the material to the ODMDS. In reaches of the inner harbor where material was calculated for offshore placement, clam shell dredges were figured in the estimate with 4000 cubic yard scows transporting the material to the ODMDS. In reaches where material was placed in various upland disposal sites it was assumed the work would be accomplished by an 18" hydraulic dredge. Estimates were determined for reaches with alternate disposal sites to determine the most cost effective dredged material disposal plan. The cost estimates reflect higher cost per total cubic yard for the shallower channel designs. This is reflected because of more efficient dredging practices for deeper material removal. Reaches scheduled for material to be removed by clamshell dredging is an example of this phenomenon. Clamshell dredged are utilized in areas in which dredged material is to be taken offshore for disposal. Dredges of this type utilize a bucket mechanism which digs the material from the channel in large amounts by lowering the open bucket to the bottom of the channel. The amount of material collected is determined by the weight of the bucket and the hardness of the material. The dredge operator attempts to get the maximum amount of material on each deployment of the bucket for peak efficiency. Therefore, the more efficient operating practice for the clamshell dredge is to dredge material in deep increments rather than skimming thin layers of material from the channel as a hopper dredge would.

4.2.2 **Project Investment Costs.** The total project cost includes the construction cost, Planning Engineering and Design (PED), Real Estate, Interest During Construction, and Construction Management. The construction time varies for each design depth. For the 41 and 42-foot project depth the estimated construction period is three years. A four-year construction period is required for channel depths of 43 to 45 feet and the 46-foot project requires a five-year construction period. Construction time is determined by the ability to pump into upland sites, dewater the material, raise the dikes, and repeat the process.

4.2.3 **Maintenance Costs.** The cost associated with additional maintenance dredging was calculated based on projected increases in shoaling estimates for each project design depth to an equivalent annual cost over 50 years. Maintenance costs for the inner harbor was calculated based upon current practice of upland disposal for material taken from the inner harbor. Material from the entrance channel will be taken to the ODMDS.

4.2.4 **Annual Costs.** The total estimated investment costs (total project cost plus interest during construction), were amortized over a project life of 50 years at the current Federal discount rate of 7.625% for each alternative. To this cost was added the increased maintenance cost for total annual costs as shown in Table 5 or expressed in 1995 price levels.

4.3 Comparative Environmental Effects

The comparative environmental effects have slight differences between the channel deepening alternatives. The major difference between these plans is the amount of material to be removed from the channel. Since the dredged material disposal sites remain constant throughout the deepening plans, there is no differential environmental impact from these plans.

The alternative channel realignment and widening plans would also have an impact on the amount of material removed from the harbor. This material has been tested and is being analyzed to determine suitability for offshore placement in the ODMDS or upland dredged material disposal sites. The new work areas encountered from the realignment and widening will temporarily impact those organisms dwelling in the immediate area of the project. Environmental impacts associated with dredging are discussed in the 404(b)(1) and the Environmental Assessment of this report.

4.4 Benefit Analysis

The economic feasibility of a deep draft navigation project is determined by comparing the benefits and costs associated with the project alternatives. National Economic Development (NED) benefits are the contribution of a project to the national output of goods and services. Typically, these benefits are the result of reduced transportation costs. NED costs are the economic value of the resources consumed in the construction, operation, and maintenance of the project. Any project alternative with positive net NED benefits is economically justified. The optimal plan is that which maximizes net NED benefits.

The benefits of turning basins and additional two-way traffic areas were measured in terms of reductions of delays and intra-harbor transit times associated with the construction of these features. The dollar value of these benefits was determined by applying estimates of vessel operating costs to time savings. Since the gangs used to unload vessels will already be scheduled before incoming vessels know that a channel is not available for transit, labor costs avoided were also considered in the evaluation of benefits for two-way traffic areas (inbound traffic only).

The benefits from deepening Charleston Harbor are measured as reductions in the future cost of transporting bulk commodities and containerized cargo. Transportation savings under with-project conditions result from the use of larger, more efficient vessels and the more efficient use of large vessels that already call on the harbor. These savings are measured by subtracting the cost of shipping commodities under with-project conditions from the cost under without-project conditions.

Per-ton transportation costs were computed for all vessel sizes, light loading conditions, and tidal requirements. A weighted average of these costs was computed using the projected fleet distributions.

Transportation savings per ton of cargo were computed by comparing the per-ton weighted average transportation costs under with and without-project conditions. These per-ton savings were applied to projected traffic levels to compute total savings by commodity group.

The benefits accruing to each project alternative were computed in this manner for each year from 2002 to 2052. Construction periods varied from three years for the 41 and 42-foot channels to 4 years for the 43 to 45-foot channels and 5 years for the 46-foot channel. A 50-year benefit stream was computed for each project alternative beginning with the first year that the project is fully operational. The present value of these streams of benefits and the equivalent average annual benefit were computed using the current Federal discount rate of 7.625 percent and a base year of 2002.

4.5 <u>Benefit-to-Cost Evaluation</u>

4.5.1 **Determination of Optimal Project Depth.** All channel deepening components were considered together in the determination of optimal project depth. However, since the Shipyard River reach is used almost exclusively by Charleston Harbor's only coal terminal, the optimal depth of this reach was evaluated independently after the optimal depth of the main channel was determined. The incremental justification of all other separable components of the channel deepening project was also investigated. The determination of the optimal depth of the total deepening project is described in this section; incremental analyses are described in Section 4.5.2.

The costs and benefits associated with the complete harbor deepening project are shown in Table 7. This includes the costs and benefits associated with deepening the main channel and all secondary channels to the specified depths. The total investment cost of each alternative is the sum of direct construction costs,

Table 7
Net Benefit Evaluation
Complete Harbor Deepening Project
(Thousands of 1995 Dollars)

	Project Draft in Feet					
Item	41	42	43	44	45	46
Costs						
General Navigation Features						
Contraction Dikes	3,569	3,569	3,569	3,569	3,569	3,569
Channel Deepening	34,093	44,918	51,798	59,596	65,407	73,916
Mitigation	20	20	20	20	20	20
Subtotal	37,682	48,507	55,387	63,185	68,996	77,505
Contingencies	5,652	7,276	8,308	9,478	10,349	11,626
Construction Management	1,600	1,600	2,000	2,000	2,000	2,400
PED	2,620	2,620	2,620	2,620	2,620	2,620
Monitoring ODMDS	500	500	500	500	500	500
Total	48,055	60,503	68,815	77,783	84,466	94,650
Aids to Navigation	78	78	78	78	78	78
Non-Federal Costs						
Real Estate	15	15	15	15	15	15
Berthing Areas	4,290	4,505	4,679	4,698	5,229	5,405
Disposal Diking	583	939	1,322	1,720	2,130	2,549
Subtotal	4,888	5,459	6,016	6,433	7,373	7,968
Contingencies	733	819	902	965	1,106	1,195
Total Non-Federal Costs	5,621	6,278	6,919	7,397	8,479	9,164
Total First Costs	53,754	66,859	75,812	85,258	93,023	103,892
IDC	9,844	12,601	13,578	15,402	16,704	18,060
Total Investment Cost	63,598	79,459	89,390	100,661	109,727	121,952
Average Annual Costs						
Interest	4,849	6,059	6,816	7,675	8,367	9,299
Amortization	126	158	177	200	218	242
Annual O & M	145	341	538	734	930	1,227
Total AAC	5,121	6,557	7,531	8,609	9,515	10,768
Average Annual Benefits						
Total AAB	8,183	10,840	13,901	16,404	17,856	18,757
B/C Ratio	1.60	1.65	1.85	1.91	1.88	1.74
Net Benefits	3,062	4,282	6,369	7,795	8,342	7,989

Source: Computations by the Charleston District; reflects 1995 dollars and the current federal discount rate of 7.625 percent.

administrative and design costs, real estate costs and interest that accrues from expenditures made prior to the base year. Direct construction costs include the cost of dredging and disposal of dredged material (shown together in Table 7), the cost of constructing and improving dikes at disposal sites, and the cost of mobilizing and demobilizing construction operations. Real estate, PED, and construction management costs are added to construction costs to determine total first costs. Computations of interest during construction reflect the varying construction schedules; interest during construction is added to first costs to determine total investment costs.

The present value of total investment costs is converted to an equivalent average annual cost for comparison with average annual benefits. First, total investment costs are adjusted to reflect the discounting of construction costs incurred after the base year. This yields the present value of the total investment. Average annual costs are determined by adding annual O&M charges to the interest and amortization of the present value of the total investment.

The present value of benefits includes both the discounted value of the 50-year stream of benefits and the present value of benefits that accrue during the construction of the project. All costs and benefits are expressed in 1995 dollars and all interest and discounting computations reflect the current federal discount rate of 7.625 percent and a base year of 2002.

Net NED benefits are maximized by deepening the harbor to 45 feet. The optimal project depth was determined by comparing total project costs and benefits as shown in Table 7. All benefits and costs for all components involving channel deepening were included in the determination of optimal project depth.

4.5.2 **Incremental Analysis.** Separate evaluations of benefits and costs were conducted for the main channel on the Cooper River and for each separable increment of construction, including deepening the Custom House reach to the Columbus Street Terminal; deepening the existing Wando River channel to the Wando Terminal; and deepening the Shipyard River channel. The optimal channel depth of 45 feet is economically justified for the main channel and for each separable increment of the total deepening project.

All of Charleston's coal traffic originates from the Shipyard River. Coal benefits account for the vast majority of benefits attributable to deepening Shipyard River. For this reason, the deepening of Shipyard River was evaluated at one-foot increments from 41 to 45 feet. A 46-foot channel was not evaluated since the optimal depth of the main channel was determined to be 45 feet.

Once the optimal project depth was determined, incremental evaluations were conducted for plans to realign the channel in the Shutes/Folly reaches to allow two-way traffic; plans to widen the Wando River channel to allow two-way traffic; and plans to construct a turning basin for vessels that will use the new Daniel Island Terminal. Table 8 lists the net benefits evaluation for the Daniel Island Turning Basin and the realignment for Shutes/Folly Reaches.

Providing two-way traffic on the Wando River was found to be infeasible by a wide margin. The delays associated with one-way traffic on the Wando are minor and infrequent. Benefits and costs for this project component are not shown.

With the construction of a 45-foot channel, the optimal depth of the new Daniel Island turning basin is also 45 feet. Without this turning basin, all ships using the Daniel Island Terminal must continue 6.0 miles past the terminal to the Ordinance Reach turning basin in order to turn and then travel 6.0 miles back to the Daniel Island Terminal.

The channel realignment in the Shutes/Folly reaches was found to be economically justified. When large ships transit the Shutes/Folly reaches of the Harbor, no other ships can safely pass that vessel. Outbound vessels must delay their departure from the terminal for an inbound vessel to clear the Shutes/Folly Reaches. Associated vessel delays can be as long as 2 hours and average delays are approximately 1 hour. Benefits associated with the Shutes/Folly realignment are derived from the elimination of these delays; delays associated with one-way traffic in other reaches of the harbor are not affected. Average delays are reduced by about 15 minutes with the realigned channel. The realigned channel is about 0.4 miles shorter than the original alignment. The reduced intra-harbor transit time associated with the realigned channel are another source of benefits.

Table 8
Charleston Harbor Study
Net Benefits Evaluation
Total Harbor Project
(Thousands of 1995 Dollars)

Item	Channel Deepening	Daniel Island Turning Basin	Shutes/Folly Realignment	Total Project
Summary of First Costs				
General Navigation Features	84,466	8,604	4,702	97,772
Other Federal Costs	78			78
Non-Federal Costs	8,479			8,479
Total First Costs	93,023	8,604	4,702	106,330
IDC	16,704	(423)	1,263	17,544
Total Investment Cost	109,727	8,181	5,965	123,873
Average Annual Costs				
Interest	8,367	624	455	9,445
Amortization	218	16	12	246
Annual O&M	930	70	10	1,010
Total Average Annual Costs	9,515	710	477	10,701
Average Annual Benefits				
Total AAB	17,856	832	823	19,511
B/C Ratio	1.88	1.17	1.73	1.82
Net Benefits	8,342	122	346	8,810

4.5.3 **NED Plan.** Each channel depth plan yielded positive benefit/cost ratios. The plan which yielded the greatest net benefits was the 45-foot channel design. The NED plan is normally the preferred alternative selected for Federal implementation as it maximizes the benefits to the nation and the return on the investment.

The NED plan analysis was computed using 1995 price levels and the current Federal discount rate of 7.625 percent.

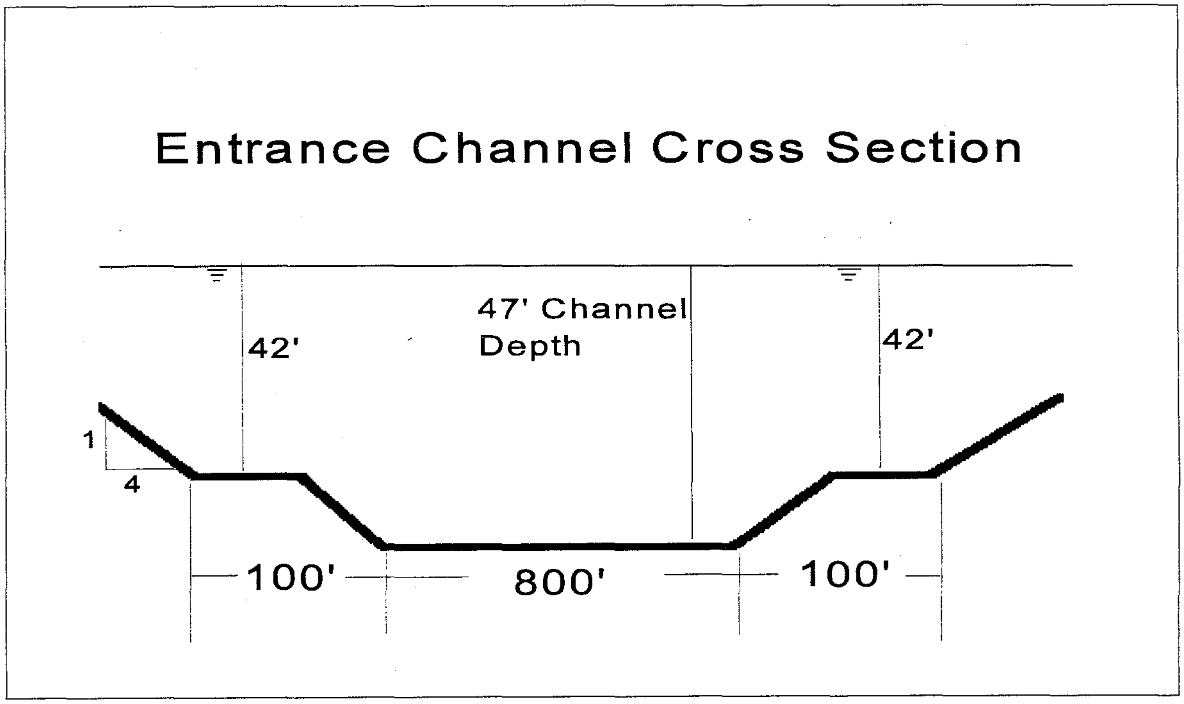
5. Selected Plan

5.1 Plan Components

5.1.1 **Description and Justification.** The selected plan, as well as the NED plan, was determined to be a 5-foot channel deepening to 45 feet below MLLW. The entrance channel will be at a depth of 47 feet below MLLW and extend oceanward to the 47-foot contour. Approximately 33,326,000 cubic yards of material will be excavated.

Entrance Channel. The depth of the entrance channel is required to be an additional 2-feet deeper than the project depth to account for pitch, roll and heave effects due to wave conditions experienced in open waters. The entrance channel will be deepened to 47 feet below MLLW by 800 feet wide with continued maintenance of the authorized 42 feet by 1000 feet wide on either side of the 47-foot depth. The entrance channel will extend from the 47-foot ocean contour to approximately station 0+00 between the Ft. Sumter and Mt. Pleasant Ranges where the channel has natural depths exceeding 60 feet. At this point the channel depth will transition to the 45-foot project depth. (See Figures 21 and 22)

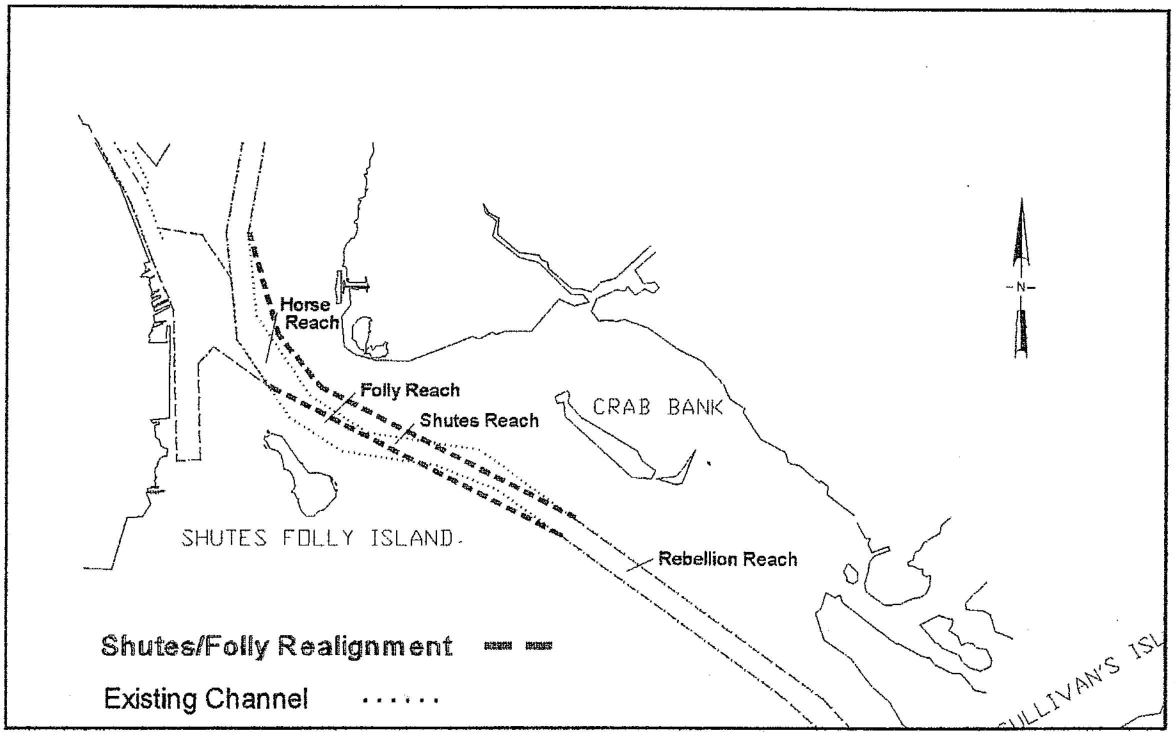
Figure 21
Recommended Entrance Channel



Inner Harbor. The inner harbor will be deepened to 45 feet below MLLW from station 0+00 to the North Charleston Terminal and turning basin. The Wando Reach and turning basin, Lower Town Creek, Custom House Reach, the turning basin at Columbus Street Terminal (Custom House Reach) and Union Pier, and Shipyard River Entrance Channel including Basin A are to be deepened to 45 feet.

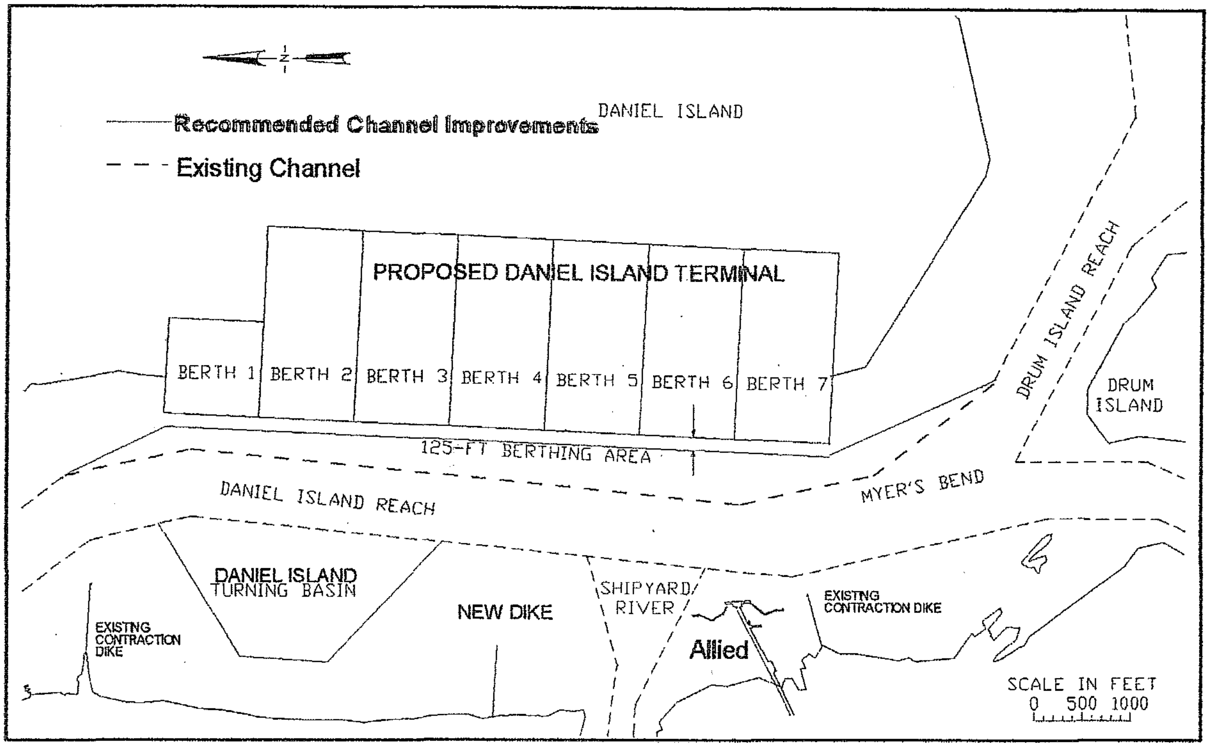
Channel Realignment/Widening. The Shutes and Folly Reaches located in the lower harbor, will be realigned to allow for extended reaches suitable for meeting and passing large vessels. The realignment will begin at Station 177+62 and end at Station 264+12 in Horse Reach. The channel width will remain at 600 feet. (See Figure 23)

Figure 23
Channel Realignment



The Daniel Island Reach will be widened along the east side of the channel to provide safe navigation for the increase in large commercial vessel traffic and size. The widening will begin at Myers Bend where the width of the channel will be increased from 600 feet to 875 feet. This width will taper back to 600 feet at Daniel Island Bend approximately 7500 feet up river of Myers Bend. The berthing area, channel widening and turning basin will be conducted in coordination with the future Daniel Island Terminal. (See Figure 24)

Figure 24
Recommended Channel Design for Daniel Island Reach

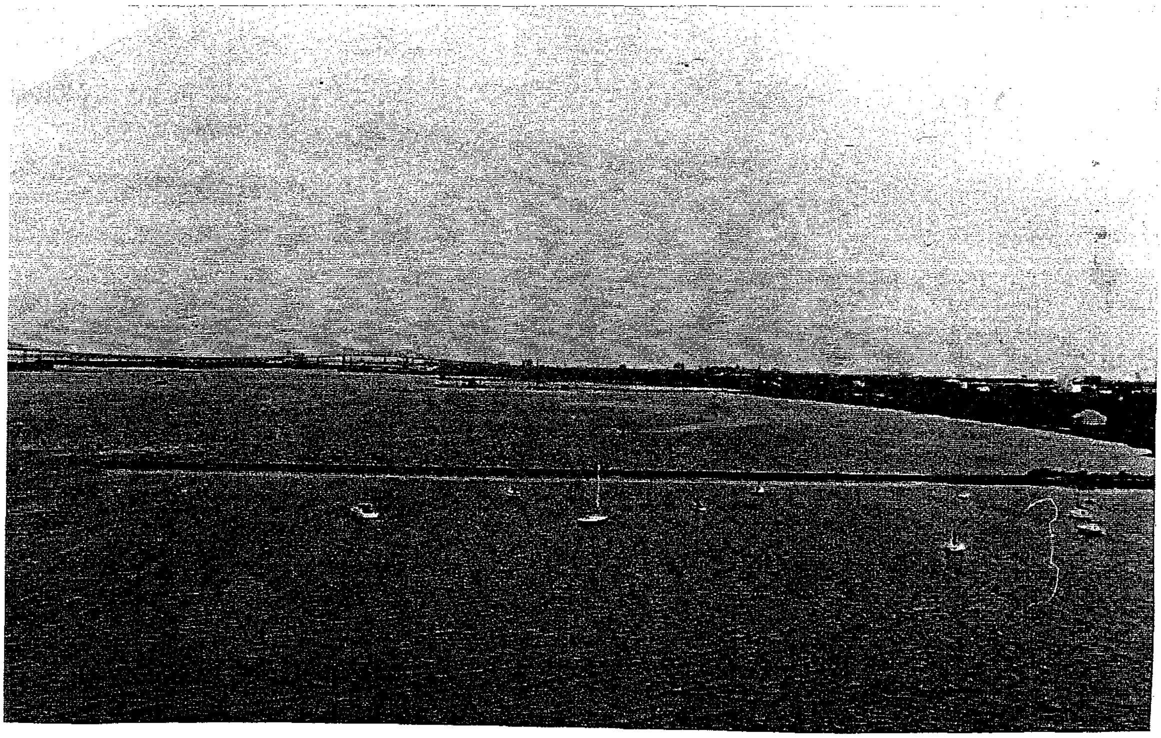


<u>Turning Basins</u>. A new turning basin will be constructed opposite the future Daniel Island Terminal along the west side of the channel in Daniel Island reach. This turning basin will be approximately 1400 feet X 1400 feet at the proposed project depth. The existing turning basins at the Wando Terminal, North Charleston Terminal, Columbus Street Terminal, and Basin A in Shipyard River will be deepened to 45 feet at their existing dimensions. (See Figure 22)

<u>Contraction Dikes</u>. The two existing contraction dikes located along the west side of Daniel Island reach will be restored to their original condition to assist in reducing the predicted shoaling of Daniel Island reach. Figure 25 depicts the existing contraction dike located at the Navy Shipyard. An additional contraction dike, approximately 700 feet long will be constructed within the 300 feet north of the Navy's Degaussing Pier on the same side of the channel as the Navy Shipyard. The restoration of the existing dikes along with the construction of the new dike is expected to reduce the shoaling in Daniel Island reach by fifty percent. Figure 26 illustrates a typical cross section view.

Figure 25

Existing Contraction Dike



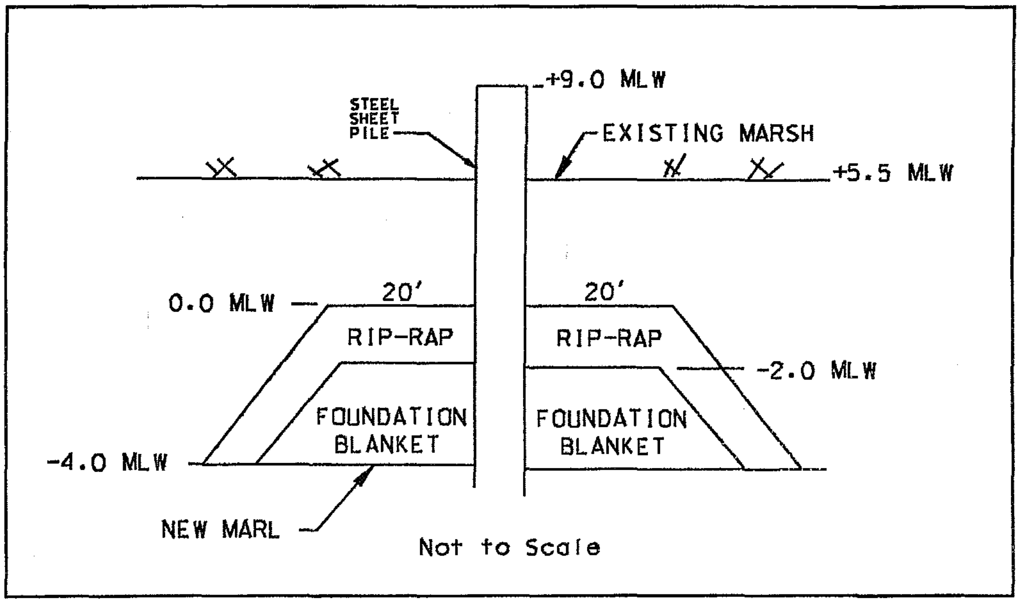
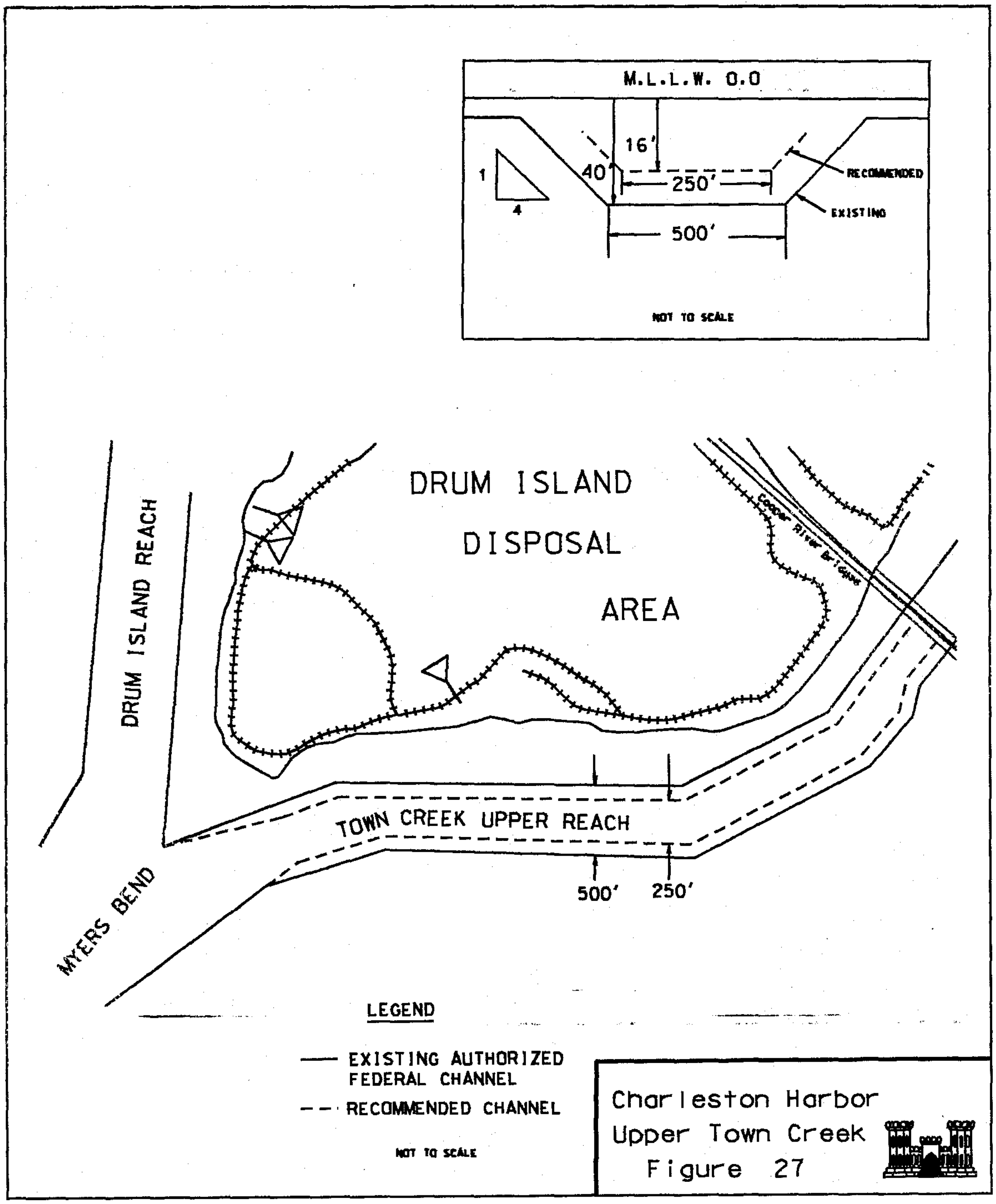


Figure 26: Dike Cross Section

Channel Modifications. The Upper Town Creek channel, from the Cooper River Bridges to Myers Bend, will be reduced to 250 feet wide by 16 feet deep. This channel was part of the main Federal channel prior to the existing Cooper River Channel. The need for the 500-foot wide channel at the project depth is no longer needed for the larger vessels. The channel continues to be used by tug operators and barges.



Charleston Harbor
Upper Town Creek
Figure 27

maintenance is anticipated for the recommended channel dimensions of 16 feet MLLW by 250 feet wide. Any adjustments to channel markers will be addressed at such time as the South Carolina State Highway Department begins construction of the new Highway 17 bridges.

5.1.4 **Operation and Maintenance.** ER 1165-2-131, *Local Cooperation Agreements for New Start Projects,* requires that where advance maintenance is practiced, the advanced maintenance quantities become part of the without-project condition. Removal of the material within the dimensions of the existing project should be treated as part of operations and maintenance. However, this principle applies only to that portion of the channel where advance maintenance dredging has been historically required for economic maintenance of the existing project.

Allocation of costs to the deepening project would include the dredging quantities to the new channel depths, less the quantities of sediment in the channel which would be dredged for normal maintenance of the existing project. A calculation of maintenance quantities and costs would be performed before the dredging. The calculation would be based on current predredging survey practices to identify maintenance quantities based on the shoaling condition at the time of the survey.

5.1.5 **Annual Maintenance.** The project area will undergo adjustment after construction. Once equilibrium is reached the areas of the channel with historical shoaling will continue the shoaling pattern. A dramatic increase of shoaling will be experienced in the Daniel Island Reach where the channel area essentially doubled. The estimated amount of annual maintenance required in the Daniel Island Reach is expected to be nearly 221,000 cubic yards with the restoration of the two existing contraction dikes and addition of the third. Without the contraction dikes, the maintenance quantity for the Daniel Island Reach would be in excess of 377,000 cubic yards annually. Increased shoaling quantities predicted on an annual basis are estimated to be 652,700 cubic yards with an increased maintenance cost for dredging and diking of $930,000. The present practice of advance maintenance would be applied to the maintenance of the new channel depth.

5.2 Disposal Plan

The least cost environmentally responsible disposal plan was developed. Considerations taken into account to reach this plan included the capacity of each disposal site, easement limits, and environmental concerns. The material removed from the widening of Daniel Island Reach and berthing area at Daniel Island Terminal will be taken to the ODMDS.

The ODMDS will be used for the reaches from the entrance channel to Drum Island

Reach including Wando, Custom House, Tidewater, and Lower Town Creek Reaches, and the turning basin at the Wando Terminal. This site can only be used for material which is determined to be suitable for offshore disposal by the Environmental Protection Agency.

Material from all remaining reaches will be taken to the Clouter Creek Disposal Site.

The Morris Island Disposal Site, the disposal site at the Naval Weapons Station, and Yellowhouse Creek Disposal Site were not found to be more economical than the others for initial project construction. The Drum Island disposal site has a limited capacity and was not projected to have sufficient capacity at the time of project construction to be considered for use by this project. The selected plan allows for conservation of valuable upland dredged material disposal sites while providing the least-cost construction plan for the project.

5.3 Environmental Impacts

5.3.1 **Environmental Effects.** This project is not expected to result in unacceptable environmental impacts. Temporary effects will be experienced during the construction period such as increased turbidity in the water from the dredges and offshore from material settling to the bottom in the ODMDS. Similarly, organisms will be displaced during construction but re-establishment will occur following dredging activity. The environmental assessment located in this report prior to the Exhibits, provides a more detailed explanation of the effects on the environment from this project.

5.3.2 **Cultural Resources.** Following coordination with the State Historic Preservation Office (SHPO), a magnetic and acoustic survey of the navigation channel and new work areas was conducted in the summer of 1994. SHPO requested that all new areas of the proposed channel be thoroughly surveyed as well as identifying the exact location of the USS Patapsco. The Patapsco was an iron clad vessel sunk in Charleston Harbor near Fort Sumter. The wreck had never been definitively located but thought to be near the Federal channel. Since the vessel went down with her crew, the SHPO was anxious to preserve the site. The survey resulted in the identification of 32 magnetic and/or acoustic anomalies. Of the 32 targets located by remote sensing, 26 could be identified as modern debris on the basis of data generated during the magnetic and acoustic survey. Of the remaining six targets, only two were located near the navigation channel where they might be subject to impacts from this project. A diving reconnaissance was conducted on these two sites in April 1995. Both targets were identified as modern debris. In addition to the insignificant targets, the Patapsco was located and determined to be outside the boundary of impact from the proposed project.

5.3.3 **Mitigation.** Two primary habitat types will be impacted by construction of the contraction dike along the Cooper River. The new 700-foot long dike will displace subtidal estuarine bottom with rip rap - marl type material. Subtidal bottom provides habitat for a variety of benthic and bottom dwelling organisms. These organisms will be displaced in favor of hard surface, reef type habitat and associated organisms. The existing contraction dikes attract a multitude of sport fishes and are favorite fishing sites for local sports fishermen.

A second type of habitat affected by the contraction dike will be wetlands. Less than one acre of wetlands will be displaced at the junction of the dike with the uplands. The value of tidal wetlands to the environment is well documented in the literature. Therefore, in-kind mitigation of the wetlands impacts will be addressed following a determination of the exact location and preliminary design of the contraction dike.

5.4 Plan Benefits

A summary of project costs and benefits is shown in Table 8. The total investment cost is $123 million, yielding a benefit/cost ratio of 1.82. The net average annual benefits for the selected plan are $8,810,000.

6. Plan Implementation

6.1 Design and Construction

PED is scheduled to begin in April 1996 and construction in 1998. During the PED phase, primary activities will involve geological investigations to determine the characteristics of material in the entrance channel extension for construction and preparation of plans and specifications.

6.1.1 **Construction Period.** The construction period is estimated to require four years to complete the project. Dredging in the entrance channel will be limited to the allowed period during the dredging window of 1 December thru 31 March. This window can be extended to 1 November thru 31 May if an observer is aboard the dredge during operation. Construction will begin with the entrance channel and continue up the Cooper River to the North Charleston Terminal with Lower Town Creek, Wando Reach and Shipyard River included.

6.1.2 **Project Monitoring Plan.** The project area will be monitored for changes in shoaling patterns by continued analysis of condition and pre- and post-dredging hydrographic surveys. The ODMDS will be monitored during the construction phase of the project based on the Monitoring and Management Plan and in coordination with resource agencies.

6.2 Cost Apportionment

The total FY 1995 project first cost for the selected plan is estimated to be $116,639,000 as shown in Table 9.

6.2.1 **Fully-Funded Cost.** The current fully-funded cost estimate for the selected plan, based on 1995 dollars, includes an estimate of interest during construction based on the tentative construction period of four years. The Federal and non-Federal shares in the cost of the project are based on the fully-funded cost estimate carried to the mid-point of construction.

6.2.2 **Non-Federal Cost Sharing.** For Federal deep-draft navigation projects between 20 feet and 45 feet deep the non-Federal cost share is 25 percent of the construction cost of the general navigation features. The non-Federal sponsor must also pay an additional 10 percent cash with credit for any lands, easements, rights-of-way, relocations, and disposal sites including diking costs (LERRD) applied against the additional 10 percent cash. Based on the guidance provided in EC 1165-2-141, March 15, 1988, this cost share formula also applies to the entrance channel which is dredged to depths below 45 feet (to 47 feet, exclusive

Table 9
Charleston Harbor Study Allocation of Costs for Recommended Plan and Without-Project Modifications
(Thousands of 1995 Dollars)

	Apportionment of Costs		
Item	Total	Federal	Non-Federal
Summary of First Costs			
GNF	97,773	73,330	24,443
Without Project Safety Mod.	10,309	7,732	2,577
GNF Total	108,082	81,062	27,020
Other Federal Costs			
Aids to Navigation	78	78	
Non-Federal Costs			
LERRD Costs			
Disposal Diking	2,449		2,449
Real Estate	17		17
Total LERRD	2,466		2,466
Berthing Areas	6,012		6,012
Total Non-Federal Costs	8,479		8,479
Total First Costs	116,639	81,140	35,499
10% Shared Costs less LERRD		(8,342)	8,342
Total		72,798	43,841

of overdepth). The increased depth in the entrance channel is necessary for safe navigation to provide adequate underkeel clearance to vessels experiencing magnified effects from ocean waves. In addition, all costs associated with deepening berthing areas to meet the channel depth of the NED plan will be paid by the users.

As provided in Section 101 of the Water Resource Development Act of 1986, the non-Federal share consists of 25 percent of the general navigation features to be paid during the construction and an additional 10 percent, less LERRD, to be paid over a period of not to exceed 30 years at an interest rate pursuant to Section 106 of the Act of 1986.

6.3 Division of Responsibilities

In addition to the cost sharing responsibilities discussed in the previous paragraph, the following paragraphs outline additional Federal and non-Federal responsibilities in connection with development of general navigation projects, as mandated by WRDA 1986, Public Law 99-662, and other pertinent laws and policy guidance.

6.3.1 **Federal Responsibility.** The Corps of Engineers will prepare and provide detailed plans and specifications necessary to award a contract. The Corps of Engineers will continue maintenance of the existing authorized Federal navigation channel and Federal navigation channels resulting from this project. The Corps of Engineers will provide necessary permits for construction of this project and assist in permitting needs associated with the new Daniel Island Terminal. Congress will authorize the project and appropriate Federal funds for its construction.

6.3.2 **Non-Federal Responsibility.** In addition to contributing the non-Federal share of the construction funds as described in paragraph 6.2.2 and that based on the guidance provided in ER 1165-2-131, *Local Cooperation Agreement for New Start Construction Projects,* the non-Federal partner will:

a) Provide and maintain, at its own expense, the local service facilities. All berthing areas will be maintained at the project depth of 45 feet at all commercial terminals, piers, and docks.

b) Provide all lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the construction, operation, and maintenance of the general navigation features and the local service facilities.

c) Provide all improvements required on lands, easements, and rights-of-way to enable the proper disposal of dredged or excavated material associated with the construction, operation, and maintenance of the general navigation features and the local service facilities.

d) Provide, during the period of construction, a cash contribution equal to the following percentages of the total cost of construction of the general navigation features:

*25 percent of the costs attributable to dredging to a depth in excess of 20 feet but not in excess of 45 feet;

e) Repay with interest, over a period of not to exceed 30 years following completion of the period of construction of the Project, an additional 0 to 10 percent of the total navigation features depending upon the credit given for the value of lands, easements, rights-of-way, relocations, and borrow and dredged or excavated material disposal areas provided by the Non-Federal Partner for the general navigation features. If the amount of credit exceeds 10% of the total cost of construction of the general navigation features, the Non-Federal Partner shall not be required to make any contribution under this paragraph, nor shall it be entitled to any refund for the value of lands, easements, rights-of-way, relocations, and dredged or excavated material disposal areas, in excess of 10% of the total cost of construction of the general navigation features.

f) For so long as the Project remains authorized, operate and maintain the local service facilities and any dredged or excavated material disposal areas, in a manner compatible with the Project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government.

g) Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the Non-Federal Partner owns or controls for access to the general navigation features for the purpose of inspection, and if necessary, for the purpose of operating and maintaining the general navigation features.

h) Hold and save the United States free from all damages arising from the construction, operation, and maintenance of the Project, any betterments, and the local service facilities, except for damages due to the fault of negligence of the United States or its contractors.

I) Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the Project, for a minimum of three years after completion of the accounting for which such books, records, documents, and other evidence is required, to the extent and in such detail as will properly reflect total cost of construction of the general navigation features, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 C.F.R. Section 33.20.

j) Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, and maintenance of the general navigation features. However, for lands that the Government determines to be subject to the navigation servitude, only the Government shall perform such investigation unless the Federal Government provides the Non-Federal Partner with prior specific written direction, in which case the Non-Federal Partner shall perform such investigations in accordance with such written direction.

k) Assume complete financial responsibility, as between the Federal Government and the Non-Federal Partner, for all necessary cleanup and response cost of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, or maintenance of the general navigation features.

l) To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA.

m) Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for construction, operation, and maintenance, of the general navigation features, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

n) Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled “Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army.”

o) Provide a cash contribution equal to the following percentages of total historic preservation mitigation and data recovery costs attributable to commercial navigation that are in excess of one percent of the total amount authorized to be appropriated for commercial navigation:

*25 percent of the costs attributable to dredging to a depth in excess of 20 feet but not in excess of 45 feet;

6.4 Non-Federal Partner's Support

6.4.1 **Non-Federal Partner's Views.** The South Carolina State Ports Authority enthusiastically supports the proposed project to deepen the federal navigation channel to a depth of 45 feet with channel improvements in the Shutes/Folly Reach and Daniel Island Reach. In addition, during the early stages of this phase of the study the SCSPA requested an accelerated study schedule in order to meet the deadline for submission to the Water Resource Development Act of 1996. The sponsor has provided full cooperation to meet this goal and is prepared to meet necessary financial obligations associated with this project.

6.4.2 **Non-Federal Partner's Financial Plan.** The non-Federal partner has provided a tentative financial plan. The plan has been reviewed and found to be in compliance with requirements for ensuring that the non-Federal partner has a reasonable plan for meeting its financial commitment. The non-Federal partner's plan is to fund their share of project costs from the South Carolina Legislature. In the event such funding is not available from the South Carolina Legislature, the South Carolina State Ports Authority is prepared to fund their portion of the project construction cost by an accumulation of cash before and during construction plus the sale, if required, of Revenue Bonds. The South Carolina States Ports Authority (SCSPA) is a state agency which generates revenues through assessment of port fees to shipping firms that use their facilities. The SCSPA has a positive cash flow and exercises sound management practices. SCSPA issued bonds in 1994 to finance the expansion of Wando Terminal. Bonds were also issued in 1988 to finance the 40-foot project. SCSPA has provided their share of feasibility study costs amounting to $1,360,000 from their funds without the aid of financing.

7. Coordination and Public Involvement

Throughout the study close coordination was maintained to ensure a thorough investigation was conducted on all issues. In addition, participation of harbor pilots, WES engineers, other Federal and state agency representatives, and SCSPA was on a regular basis. The SCSPA was given formal updates on study progress as requested as well as providing technical review to South Atlantic Division (SAD) and Headquarters at the Technical and Feasibility Review Conferences.

Close coordination with SCSPA engineers and planners was invaluable in the channel design for the Daniel Island Reach modeled in the ship simulation study at WES. By having both agencies interacting during the infancy of the modeling process, both sides were able to provide valuable insight on navigation and port terminal operation as well as retain critical needs for the respective goals. The Corps of Engineers was able to influence the location of the new terminal to ensure a safe navigation channel was provided while the SCSPA was able to make the best possible use of their land for container terminal operation.

The U.S. Fish and Wildlife Agency was involved throughout the study as required by the Fish and Wildlife Coordination Act of 1958, as amended. Their final report is included in this document.

Meetings were held with various environmental agencies to evaluate beneficial use of dredged material. Interest was expressed by the agencies, however, they are concerned about the suitability of the material for bird nesting habitat. Coordination with the resource agencies will continue through PED.

WES model studies included coordination with the harbor pilots, docking pilots, district personnel, SCSPA personnel, Coast Guard, and Navy personnel. The modeling process required historical data which was provided by all listed parties.

Aside from the agencies mentioned above, public involvement was included in this study by means of a published joint public notice dated 9 December 1994.

The Draft Feasibility Report was mailed to a comprehensive list of agencies and individuals to give them an opportunity to review and comment on the recommendations.

8. Conclusions and Recommendations

I have given full consideration to all significant aspects of this study in the overall public interest, including engineering and economic feasibility, as well as social and environmental effects. The selected plan for improvement described in this report provides the optimum solution for navigation improvements at Charleston Harbor, South Carolina.

I have also assessed the South Carolina State Ports Authority's financial capability and ascertain that it is reasonable to expect that ample funds will be available to satisfy the non-Federal partner's financial obligation for the project. The Authority's letter of intent to sponsor the project is included as an exhibit to this report.

I recommend that the existing Federal navigation project at Charleston Harbor, authorized by the River and Harbor Act of 1983, have the following improvements made;

1) The width of the Daniel Island Reach will increase from a continuous 600-foot wide channel to 875 feet wide at Myers Bend tapering back to 600 feet at Daniel Island Bend.

2) The entrance channel be modified to 800-foot wide at a depth of 47 feet below MLLW from the 47-foot ocean contour transitioning to a depth of 45 feet below MLLW near station 0+00. This channel will extend 16.3 miles oceanward from station 0+00 which is located within the Charleston Harbor jetties. The remaining 200 feet width will continue to be maintained at a depth of 42 feet below MLLW to the 42-foot contour.

3) The channel will continue from approximately station 0+00 at a depth of 45 feet below MLLW to the North Charleston Terminal including the Wando River, Shipyard River entrance channel and Turning Basin A, and Custom House Reach to station 73+33 of Lower Town Creek Reach. The widened Daniel Island Reach channel as described above will also be deepened to 45 feet below MLLW. The turning basins at the North Charleston, Wando, and Columbus Street Terminals will be included.

4) The existing channel alignment in the Shutes, Folly and Horse Reaches will be realigned. A new turning basin and berthing area will be included in this reach to accommodate the new Daniel Island Container Terminal.

5) Construction of a new contraction dike located approximately 200 feet to the north of the Navy's degaussing pier along the west side of Daniel Island Reach.

In addition, restoration of the two existing contraction dikes located along the west side of the Daniel Island Reach and the removal of the existing contraction dike on Daniel Island.

6) The Upper Town Creek Reach will have a channel width of 250 feet from the Cooper River bridges to Myers Bend with a channel depth of 16 feet below MLLW.

All structures will be distanced at least 125 feet from the edge of the Federal navigation channel. In addition, no dredging will be performed by the United States outside the Federal navigation channel. The non-Federal Sponsor shall comply with all requirements outlined in Section 6.3.2.

Further modifications may be made at the discretion of the Chief of Engineers when advisable. The total initial construction cost is estimated to be $116,639,000. Increased annual Federal maintenance costs associated with this project are estimated to be $1,010,000. The estimated annual total project cost, including maintenance costs, is $10,701,000. With estimated average annual benefits of $19,511,000 in delay savings and commodity costs, the proposed project is economically feasible with a B/C ratio of 1.82 and annual net benefits of $8,810,000, thereby warranting Federal participation. Accordingly, the non-Federal cost share is estimated to be $27,020,000 for 25 percent of the general navigation features. The partner shall pay an additional 10 percent of the cost of the general navigation features of the project in the amount of $10,808,000 plus interest, in cash payable over a period not to exceed 30 years. The value of lands, easements, rights-of-way, relocations, and dredging material disposal areas shall be credited towards the additional 10 percent.

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

Date: 26 Feb 96

THOMAS F. JULICH
Lieutenant Colonel, EN
Commanding

ENVIRONMENTAL ASSESSMENT

CHARLESTON HARBOR DEEPENING/WIDENING
CHARLESTON HARBOR, SOUTH CAROLINA

INTRODUCTION

A. Project Authority and Purpose

Resolutions adopted by the Senate on March 27, 1990 and by the House of Representatives on August 1, 1990 authorized the U.S. Army Corps of Engineers to study Charleston Harbor and determine if any modifications should be made to the existing Charleston Harbor Project, with particular emphasis on deepening and/or widening the federal navigation channel.

B. Project Location and Description

The Charleston Harbor federal navigation channel is located in Charleston Harbor, South Carolina which lies approximately midway along the South Carolina coastline. It is approximately 140 statute miles southwest of the entrance to Cape Fear River, North Carolina and 75 statute miles northeast of the Savannah River, (see Figure 1).

The proposed project consists of deepening Charleston Harbor from a depth of 40 feet to 45 feet below mean low water (MLW) with two (2) feet of advance maintenance and two (2) feet of allowable overdepth. Furthermore, the project will also include realignment of the channel at Horse Reach and Shutes/Folly Reach to improve navigation by straightening the channel. The entrance channel will be 47 feet deep and 800 feet in width from the 47-foot ocean contour to station 0+00 inside the jetties. The channel will slope upward to 45 feet and remain at 800 feet wide to a point adjacent to Sullivans's Island where it will narrow to 600 feet wide. The remainder of the navigation channel will remain at the present 500 to 800 feet wide with the following exceptions. The Daniel Island Reach will vary from approximately 600 feet to 875 feet in width for the proposed terminal access and include a turning basin approximately 1200 feet in length. Upper Town Creek will be reduced to 16 feet deep and 250 feet wide. The entrance channel will not be deepened in any area where the present depth is already at 47 feet. In addition, two existing contraction dikes located on the west side of the

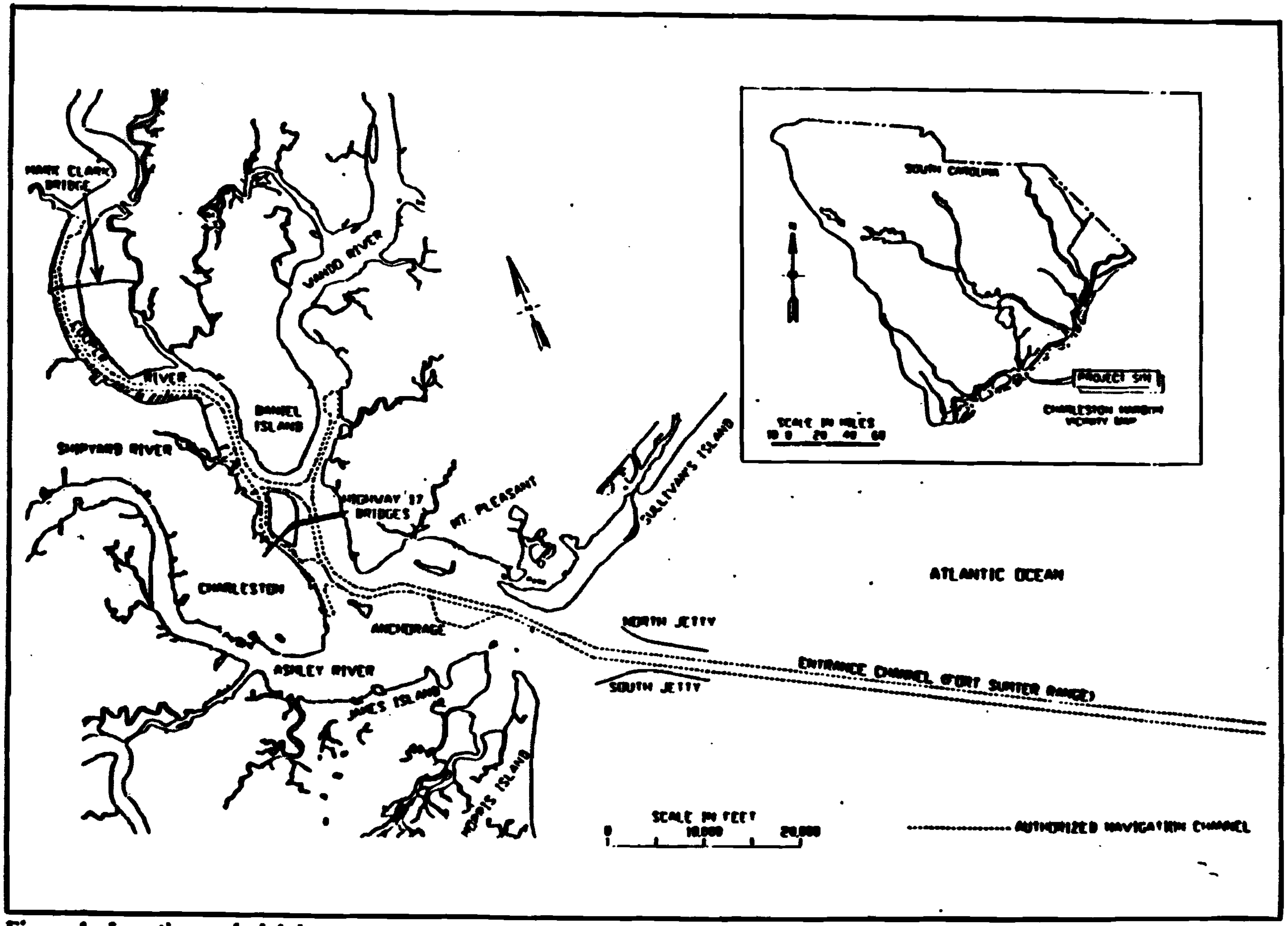


Figure 1. Location and vicinity map

Cooper River, across from the proposed new Daniel Island Terminal will be refurbished. The existing contraction dike located at Daniel Island will be removed and a new 700 foot long contraction dike located approximately 150 feet upstream of the degaussing pier on the west side of the Cooper River will be constructed, (See Figure 2).

ENVIRONMENTAL SETTING

A. General Description of the Area

The harbor covers an area of approximately 14 square miles and is formed by the confluence of the Ashley, Cooper, and Wando Rivers. The City of Charleston is located to the west of the harbor, James Island and Morris Island to the south, Mt. Pleasant and Sullivan's Island to the north and the Atlantic Ocean to the east. The majority of upland areas around Charleston Harbor are composed primarily of residential, commercial, and industrial development. Docking and maintenance facilities of the harbor are concentrated along the west shore of the Cooper River extending from Battery Point of the peninsular city to the mouth of Goose Creek.

The Cooper River has its origin at the confluence of its East and West Branches (locally termed "The Tee") from which it flows 32 miles southward to its outlet in Charleston Harbor. The East and West Branches of the Cooper River extend some 20 miles inland in a northward direction to their origins as small ill-defined channels in a low-lying area of Berkeley County known as Ferguson Swamp.

The Ashley River originates in the coastal plain and flows into the western part of Charleston Harbor. Areas of the river are bordered by historic plantations, a large portion of the Ashley River Basin is now occupied by residential or commercial development.

The Wando River originates in the coastal plain and flows into the eastern part of Charleston Harbor. Portions of the lower Wando River are bordered by marsh which changes to woodland in the upper reaches of the river. Development along the Wando River has been encouraged with recent completion of an interstate highway system. At present, residences and subdivisions are present along stretches of the river as are a shipyard and the State Port Authority's Wando River Terminal.

B. Water Quality

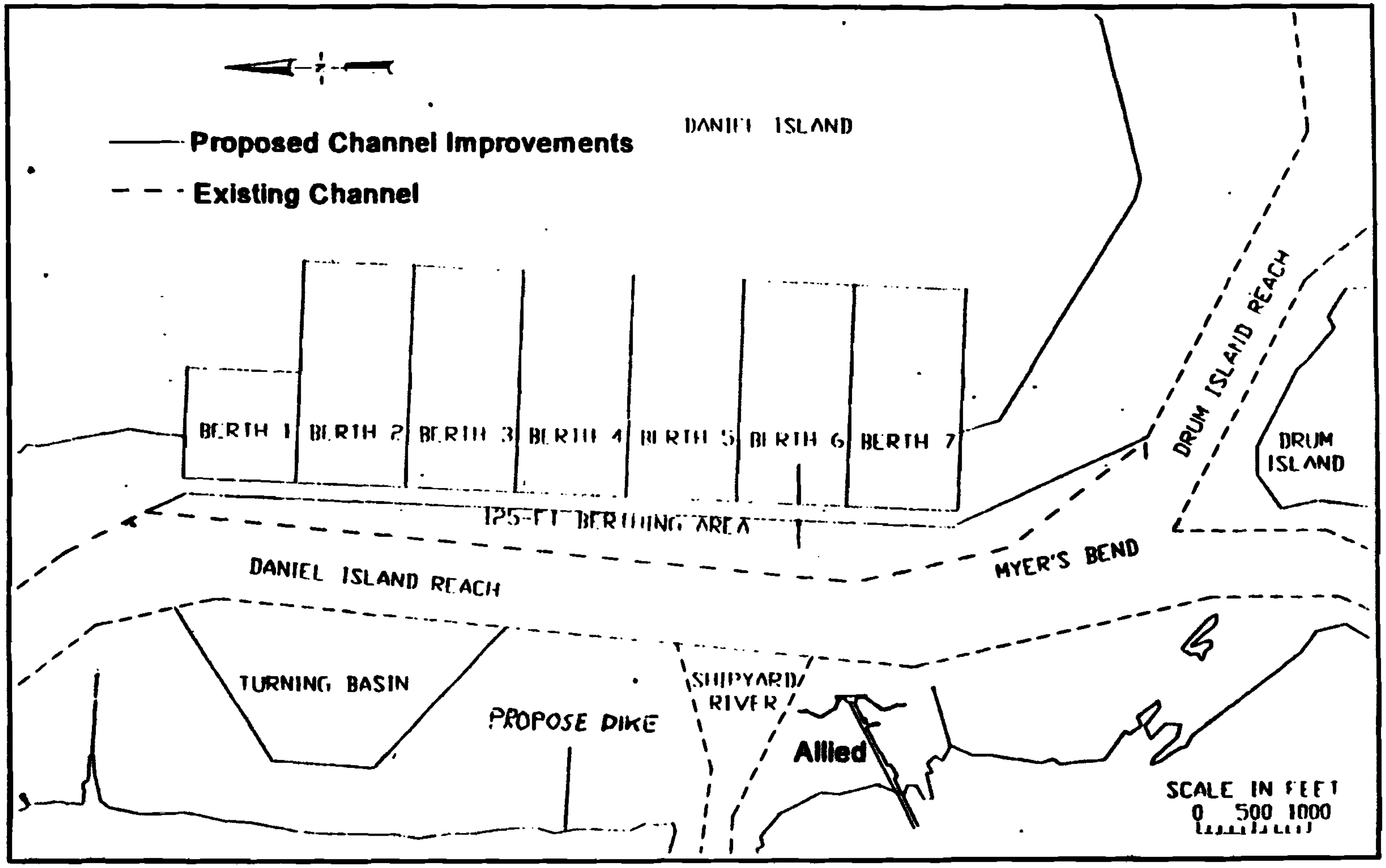


Figure 2: Daniel Island Terminal location

Water quality in Charleston Harbor is classified as SB by the South Carolina Department of Health and Environmental Control, (SCDHEC). The SB rating applies to tidal salt water suitable for primary and secondary contact recreation, crabbing, and fishing, except for the harvesting of clams, mussels, or oysters for market purposes or consumption. These waters are also suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora. Waters rated as SB should not have dissolved oxygen concentrations less than 4 mg/l and fecal coliform concentrations should not exceed a geometric mean of 200 colonies/100 ml based on five consecutive samples taken within a 30 day period.
Although these concentrations have been exceeded occasionally, recent review of data collected by SCDHEC indicate that water quality within the harbor basin often meets SB standards for dissolved oxygen and fecal coliform levels.

Water quality in the Wando River is classified SFH (Shellfish Harvesting Waters) for the portion of the river from its headwaters to a point 2.5 miles upstream of its confluence with the Cooper River. This classification applies to tidal saltwaters protected for shellfish harvesting. SFH water must maintain a daily average dissolved oxygen concentration of 5 mg/l or higher with a low of 4 mg/l and have median coliform concentrations of 14 colonies/100 ml with no more than 10% of the samples exceeding 43 colonies/100 ml. For the portion of the Wando River from its confluence with the Cooper River to a point 2.5 miles upstream, the river is classified as SA waters. SA waters have the same designated uses as SB waters, although the water quality standards are stricter for dissolved oxygen. SA waters require a daily average of dissolved oxygen of not less than 5 mg/l with a low of 4 mg/l.

C. Hazardous and Toxic Waste.

The proposed project is primarily located in the existing navigation channel where dredging occurs on a twelve to eighteen month rotation. Because of the frequent dredging activity, it was not expected that any hazardous or toxic waste would be encountered. However, bulk sediment chemistry was conducted on the sediments proposed for the deepening project. The analysis indicated that hazardous and toxic material is not present in the sediments.

D. Sediment Analysis.

To obtain Section 401 Water Quality Certification and Section 103 approval for ocean disposal of the material, sediment testing for physical, chemical, and biological parameters was conducted on maintenance and deepening material (including new work areas). Analytical results indicated that the vast majority of sampling sites required no further testing. However, polynuclear aromatic hydrocarbon (PAH) concentrations were notably higher at two sites, one in Shipyard River and ohe in the Cooper River near the proposed Daniel Island Terminal site. All analytical data was submitted to the Environmental Protection Agency (EPA) for review to determine if additional testing was needed for ocean disposal. Correspondence from EPA dated May 18, 1995 required no additional testing at any site, with the exception of PAH tissue testing at the two sites mentioned above. Bioaccumulation studies have been completed, and analytical results were received in October 1995 and submitted to EPA for review. Correspondence from EPA dated November 14, 1995 approved material from all but one site, CH-3, for ocean disposal.

E. Threatened and Endangered Species

The U.S. Fish and Wildlife Draft Coordination Act Report dated December 1994, advised the Corps that the following federally listed endangered (E) and threatened (T) species are known to occur in Charleston County, South Carolina:

West Indian manatee (Trichechus manatus) - E
Bald eagle (Haliaeetus leucocephalus) - E
Bachman's warbler (Vermvora bachmanii) - E
Wood stork (Mycteria americana) - E
Red-cockaded woodpecker (Picoides borealis) - E
Arctic peregrine falcon (Falco peregrinus tundrius) - T
Piping plover (Charadrius melodus) - T
Kemp's ridley sea turtle (Lepidochelys kempii) - E
Loggerhead sea turtle (Caretta caretta) - T
Leatherback sea turtle (Dermochelys coriacea) - E
Green sea turtle (Chelonia midas) - T
Shortnose sturgeon (Acipenser brevirostrum) - E
Canby's dropwort (Oxypolis canbyi) - E
Pondberry (Lindera melissifolia) - E
Sea-beach pigweed (Amaranthus pumilus) - T
Chaff-seed (Schwalbea americana) - E

The National Marine Fisheries Service advised on January 11, 1995 that the following endangered (E) and threatened (T) species and critical habitats are listed under that agencies jurisdiction in South Carolina:

Finback whale (Balaenoptera physalus) - E
Humpback whale (Megaptera novaeangliae) - E
Right whale (Eubaleana glacialis) - E

Sei whale (Balaenoptera borealis) - E
Sperm whale (Physeter catodon) - E
Green sea turtle (Chelonia mydas) - T
Hawksbill sea turtle (Eretmochelys imbricata) - E
Kemp's (Atlantic) ridley sea turtle (Lepidochelys kempi) - E
Leatherback sea turtle (Dermochelys coriacea) - E
Loggerhead sea turtle (Caretta caretta) - T
Shortnose sturgeon (Acipenser brevirostrum) - E

Species proposed for listing - None
Listed critical habitat - None
Proposed critical habitat - None

Additional correspondence from the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) dated March 6, 1995 and January 30, 1995, respectively, provide documentation that the District has concluded it consultation responsibilities under Section 7 of the Endangered Species Act.

F. Cultural Resources

The City of Charleston is one of the oldest permanent settlements in the United States and has many areas and structures of great significance in the history of the country from the Revolutionary War and the Civil War to the Reconstruction period. Prominent among these are:

1. Charleston Historical District located on the lower third of peninsular Charleston.

2. Fort Sumter National Monument located off an island at the entrance to Charleston Harbor.

3. Site of Old Charles Town located on Albemarle point.

4. Castle Pinckney located on Shute's Folly.

5. Middleton, Magnolia and Drayton Hall Plantations located along the Ashley River and Boone Hall Plantation located in Mount Pleasant.

Following coordination with the State Historic Preservation Office (SHPO), a magnetometric survey of the navigation channel and new work areas was conducted in the summer of 1994. The survey resulted in the identification of 32 magnetic and/or acoustic anomalies. Of the 32 targets located by remote sensing, 26 could be identified as modern debris on the basis of data generated during the magnetic and acoustic survey. Of the remaining six targets, only two were located near the navigation channel where they might be subject to impacts from this project. A diving reconnaissance was conducted on these two sites in April 1995. Both targets were identified as modern debris. The draft archeological report for this project was submitted to the SHPO on June 1, 1995 with a request for comments. Final copies of the archeological report were received by this office in August 1995. Correspondence from the SHPO office dated September 7, 1995 provided concurrence with the district determinations that no cultural or historic resource would be impacted by this project (see EA Appendix).

POTENTIAL IMPACTS OF THE PROPOSED ACTION

A. Benthic Impact.

One of the most significant short - term impacts of hydraulic dredging is the destruction of benthic invertebrates in the path of the dredge cutterhead. The greatest concentration of benthic invertebrates in the Charleston Harbor estuary occur in and around salt marshes in lieu of the deeper channeled areas. Much of the salt marsh in the project area provides suitable habitat for invertebrates including fiddler crabs, oysters, and mollusks such as the common marsh perewinkle snail. Polychaete worms, are found on a wide variety of substrates and are common in salt marshes. Deepening in the present navigation channel, where maintenance of reoccurring shoals are dredged on a 12 to 18 month rotation, will not significantly effect benthos. The majority of benthic impacts will be located in the realignment areas of Horse reach and Shute's/Folly reach; Channel widening of the Daniel Island reach; construction of a new contraction dike; and the new ships turning basin. The benthic impacts in these areas would however, be temporary as invertebrates including polychaetes will recolonize the disturbed areas in a short time.

B. Water Quality.

1. Temporary changes in water quality at the dredging and disposal sites are expected; however, permanent changes in water quality due to this project are not anticipated or expected. A Section 401 Water Quality Certification was issued for upland disposal of dredged material associated with the project by the South Carolina Department of Health and Environmental Control (SCDHEC) on May 2, 1995. Further, the SCDHEC, Office of Ocean and Coastal Resource Management provided

certification that the deepening project was consistent with the Coastal Zone Management Program by letter on March 10, 1995 (see EA Appendix). An amended Coastal Zone Consistency was received on February 1, 1996 and the Section 401 is anticipated in March 1996 for placement of the contraction dike, refurbishment of the existing dikes, removal of the Daniel Island contraction dike, and dredging of the proposed Daniel Island Turning Basin.

2. Correspondence from the South Carolina Department of Natural Resources dated February 6, 1995 reported that the top of the Cooper Formation lies between the approximate elevations of -10 and -60 feet mean sea level with thickness varying from 200 to 260 feet. As a result, no adverse impacts to the existing aquifers is expected as a result of deepening Charleston Harbor a maximum of five feet (see EA Appendix).

3. Hydrodynamic, salinity intrusion and sedimentation models were conducted by the Army Corps of Engineer, Waterways Experiment Station for this project. The numerical models were used to develop the channel velocities and water levels for the base condition and the proposed conditions in support of the ship simulation and the sedimentation study. The salinity intrusion model indicated that no significant difference was found between the existing -40 foot channel and the proposed -45 foot channel. Because the channel will be deeper and wider in specified areas, the sedimentation model indicated that there will be an increase in the expected sedimentation compared to present conditions. It is however, considered a manageable and acceptable increase. Additional information and detail concerning the models are found in Section 4.1.4 Increased Annual Maintenance.

C. Endangered/Threatened Species.

Official lists of endangered/threatened species have been requested and received from the USFWS and the NMFS (see Section E, ENVIRONMENTAL SETTING). The only potential impacts of harbor deepening on the listed species are as follows:

There are potential impacts to threatened/endangered sea turtles related to hopper dredging in the entrance channel. However, these impacts will be reduced/eliminated by the use specialized equipment, monitoring by trained observers, and/or compliance with a dredging window (1 November - 31 May, or whatever the window may be at the time of dredging). Further, hydraulic dredging (pipeline) discharging into scows will be utilized to remove the harder material (coquina) and during the turtle season when hopper dredges cannot be used. In addition, measures to provide manatee protection if construction occurs during summer months (June through September) has been included in the project and will be incorporated in the plans and specifications. The USFWS and the NMFS have concurred with this determination and have indicated that Section 7 Consultation with the District has concluded, (see EA Appendix).

Further, recommendations provided by the USFWS in the Draft Coordination Act Report, 1994 have been responded to in this document and/or have been taken into consideration for planning and contract purposes (see EA Appendix).

D. Land Disruption.

Not applicable.

E. Wetlands. Construction of the new contraction dike will require the excavation of a corridor through a fringe of Spartina wetlands. This excavated corridor will be approximately 80 feet wide by 1000 feet in length total (approximately 500 feet will be in marsh). This corridor will be excavated down to -10 MLLW. Once the corridor is excavated to the approximate dimension a dredge will be used to pump approximately 280,000 cubic yards of marl on the bottom of the excavated corridor bringing the bottom up to elevation - 4.0 MLLW. After the marl base is in place, 0.5 " corrugated metal sheet pilings will be driven into it creating the desired contraction dike. Approximately 4,000 cubic yards of 12" to 24" stone will be placed along both sides of the sheet piles for the entire length of the dike for stabilization. A layer of riprap will then be placed on top of the stone to act as a cap to hold the stone in place. Stockpiled marsh material from the original excavation will be returned to the 80 by 500 foot marsh area and placed on each side of the sheet pile contraction dike to the same elevation and slope as the original and adjacent marsh. Spartina is expected to quickly reestablish itself naturally in this disturbed area. All marl , stone foundation blanket and riprap will be below elevation - 00 with approximately 5.5 feet of fine grained material on top of the 80 foot by 500 foot marsh area. The contraction dike will be anchored on its landward end with riprap. Some of the riprap anchor will by necessity, be toed into the edge of the marsh to prevent scouring on high tides.

F. Noise.

There would be an increase in the ambient noise level during the dredging phase of the project. However, the noise level would be no different than that experienced during normal maintenance dredging.

G. Air Quality.

Any increase in air pollution would be due to exhaust from the dredging equipment. The increase would be minor and temporary. Further, the entire state of South Carolina is an attainment area for standard pollutants at this time. The dredge is a mobile source and is not regulated by the state of South Carolina. It is not anticipated that the dredged material will be rehandled in a dry state after its initial placement.

H. Flora.

Not applicable.

I. Fishery.

Given the length of the study area and the scope of the proposed project, the fishery resource of Charleston Harbor would not be significantly impacted by the proposed project. This premise is substantiated in the Final Environmental Impact Statement for the Charleston Harbor Deepening Project, Charleston Harbor and Shipyard River, South Carolina, U.S. Army Engineer District, Charleston, South Carolina, April 1976, and associated references as listed in that document.

J. Cultural Resources.

The cultural resource investigation is complete. No cultural or historical resources were identified in the study area.

K. Dredged Material Disposal.

1. Quantities of material dredged and proposed disposal locations are identified and described in Section 3.2.3.

2. The environmental impact statement (EIS) written for the designation of the Charleston Ocean Dredged Material Disposal Site (ODMDS) addressed impacts associated with the disposal of dredged material at the site. Further studies indicating the presence of live bottoms in the western portion of the site have resulted in avoidance of disposal in that area and the development of an EPA/Corps Management and Monitoring Plan for the ODMDS. In addition, suitable material, ie. rock, marl, coquina, are utilized for construction of a berm within the disposal area to

prevent/reduce impacts to the live bottom areas whenever possible. Impacts associated with this dredging activity would be the same as those addressed in the ODMDS EIS and covered by the management plan.

3. All of the upland dredged material disposal sites proposed for use during this project are existing sites and have been utilized for dredged material disposal for many years. These areas are utilized on a consistent basis for dredged material disposal, so would not be suitable for management as wildlife habitat. Ultimately, the use and value of these areas will remain the same following completion of the proposed project.

4. Other alternative disposal sites other than those mentioned above are discussed in the Daniel Island Alternatives Study, 1993. Based on that study, the disposal sites proposed for use in this project are considered the least environmentally damaging and provide the least cost alternatives.

UNAVOIDABLE ADVERSE IMPACTS

Adverse environmental effects associated with this project are as follows:

There would be a temporary increase in noise and air pollution during the construction phase of the project.

There would be a temporary increase in turbidity which would have a temporary impact on water quality at the dredging and ocean disposal locations.

Impacts to benthic organisms at dredging sites is expected.

Impacts to Spartina marsh is expected at the construction site for the proposed contraction dike.

ALTERNATIVES TO THE PROPOSED ACTION

Alternatives to the proposed action include:

A. Various depths for deepening the navigation channel were examined. Proposed depths include -41 to -46 feet mlw. The economic evaluation for this project will play a significant role in determining the final project depth.

B. Alternatives for realignment were considered by WES and studied using sedimentation and ship simulation models. The proposed realignment is expected to provide optimum navigation with minimal sedimentation and environmental impacts.

C. The no-action alternative is not considered a viable option because of the navigation hazard associated with the present alignment, and because the purpose of the study was to determine if modifications to the present channel were advisable. Studies indicate that the proposed project modifications are advisable.

D. Disposal options for the material included ocean disposal and upland disposal at dredged material disposal areas. A meeting was held in September 1994 with state and federal agencies to discuss possible beneficial uses of the dredged material. Potential uses included nesting habitat, and beach or island renourishment. Potential locations for disposal included Morris Island Beach, Folly Beach, Bird Key, Castle Pinckney, Crab Bank, Morris Island Lighthouse, Ft. Sumter, placement for drift to beaches south of Charleston, and Daniel Island.

The chief drawback for use of proposed dredged material for any of the sites within the harbor is the grain size. Only suitable material which would be predominantly sand could be used for bird nesting or island renourishment. Material from the entrance channel is dredged using a hopper dredge. Placement of material on beaches would require the use of a hydraulic dredge which would increase the cost of disposal. An economic evaluation was conducted on the placement of material on Morris Island Beach as a beneficial use. Morris Island was studied because it is the closest potential site to the entrance channel, it is a disposal area for dredged material, and the oceanward side of the island is eroding. However, the benefit/cost ratio would not support this as a disposal site. Further, the local sponsor has indicated that any additional expense to the dredging and disposal activity would not be acceptable. State agencies expressed an interest in the beneficial uses of suitable material, but indicated that no funds were available to assist with the projects.

At the present time, additional coordination with resource agencies and the local sponsor is underway to determine the possibility of placing some material at Castle Pinckney and Crab Bank. Depending on the type of material and the logistics of placing the material in a beneficial location near the proposed sites, these locations may still be viable options.

CONCLUSIONS

The proposed action does not constitute a major Federal action significantly affecting the quality of the human environment, therefore, the preparation of an

Environmental Impact Statement (EIS) is not required. In addition, this project is consistent, to the maximum extent practicable, with the South Carolina Coastal Zone Management Program. Finally, the proposed action has been thoroughly assessed and coordinated and will not significantly affect the environment.

FINDINGS OF NO SIGNIFICANT IMPACT
CHARLESTON HARBOR DEEPENING/WIDENING PROJECT
IN
CHARLESTON COUNTY, SOUTH CAROLINA

Based upon the attached Environmental Assessment and in consideration of other pertinent documents, I conclude that the environmental effects of the proposed Charleston Harbor Deepening/Widening Project are not significant and the preparation of an Environmental Impact Statement is not warranted. Specific factors considered in making the determination include the following:

1. Wetlands would not be significantly affected.

2. No land use changes would occur.

3. Air quality would not be significantly affected.

4. Water quality would not be significantly affected.

5. The project would have a negligible impact on fish and wildlife resources.

6. Construction activity would enhance shipping traffic and result in no significant effect on recreational boating.

7. The proposed action is in full compliance with the Endangered Species Act.

Thomas F. Julich
Lieutenant Colonel, U.S. Army
District Engineer

8 Mar 96
DATE

EA APPENDIX

EA APPENDIX INDEX

APPENDIX A

404(b)(1) EVALUATIONS

404(b)(1) Evaluation

Charleston Harbor Deepening Project
Charleston, South Carolina

I. PROJECT DESCRIPTION

a. Location. The project area is the Charleston Harbor federal navigation channel located in Charleston Harbor, South Carolina. The harbor in located approximately midway along the South Carolina coastline, being approximately 140 statute miles southwest of the entrance to Cape Fear River, North Carolina, and 75 statute miles northeast of the Savannah River.

b. General Description. The project consists of deepening Charleston Harbor from 40 feet to 42 feet as a minimum depth and 45 feet as a maximum depth below mean low water (MLW) with two (2) feet of advance maintenance and two (2) feet of allowable overdepth. Furthermore, the project will also include realignment of the channel at Horse Reach and Shutes/Folly Reach to improve navigation by straightening the channel. The navigation channel will be 800 feet in width beyond the jetties. Just prior to reaching the jetties from the ocean, the channel will remain at the present 1000 feet in width, returning to 800 feet at a point within the jetties. From 800 feet, it will reduce further to 600 feet wide adjacent to Sullivan's Island. No changes are proposed for the rest of the navigation channel which varies from 500 feet to 800 feet in width, with two exceptions. The Daniel Island Reach will vary from approximately 600 feet to 875 feet in width for proposed terminal access, and the Horse Reach and Shutes/Folly Reach, where realignment is proposed, will be 900 feet to 1000 feet in width. The entrance channel is expected to extend out to the 51-foot ocean contour. However, it should be noted that the entrance channel will not be deepened in any area where the present depth is already at 47 feet.

c. Authority and Purpose. This project is being undertaken as part of the following study authority: "Pursuant to Senate and House resolutions adopted on 27 March 1990 and 1 August 1990, respectively (the latter published as House Document Numbered 100-27, 100th Congress, 1st Session), the Charleston District, through the Board of Engineers for Rivers and Harbors, was requested to review the reports of the Chief of Engineers on Charleston Harbor, South Carolina with a view to determining whether any modifications of the project are advisable at this time, with particular view toward deepening and/or widening."

d. General Description of Dredged or Fill Material. Core borings were conducted during the previous deepening project. Borings collected at that time were collected at depths sufficient to address this deepening project also. Additional borings have been collected during the feasibility phase of this project. From the borings, it is concluded that there are three types of material that will be encountered during the deepening project. The three types are overburden soils, the Cooper Marl formation and Coquina. Overburden soils consist of sands, silts, clays and loose shell formations overlying the predominate Cooper Marl or Coquina. The Cooper Marl formation is a consolidated, fine grained, impure calcareous deposit that lies between the elevations of -10 and -60 feet mean sea level with thicknesses varying from 200 to 260 feet in the project area. The marl is composed primarily of an olive-brown to olive sandy clayey silt with occasional layers of very silty clayey fine sand. Overlying the Cooper Marl at locations in the entrance channel is a light gray calcareous cemented sandy shell hash referred to as Coquina. Coquina is also the predominate material beneath the overburden soils in some locations in the entrance channel.

e. Description of the Proposed Discharge Site. Placement of the dredged material is expected to occur over a period of years during individual dredging contracts. Because ± 35 million cubic yards will be dredged, the majority of the material, if suitable, will be disposed of at the Charleston Ocean Dredged Material Disposal Site, (ODMDS). Additionally, disposal of the material will be made to upland contained disposal areas within economical pumping distance, where there is sufficient area for disposal or where the material is not suitable for ocean disposal. Existing upland areas which are under consideration for disposal include Clouter Creek Disposal Area, Daniel Island Disposal Area (if still under easement), Morris Island Disposal Area, the Naval Weapons Station Disposal Area, and Drum Island Disposal Area.

f. Description of Disposal Method. Hopper dredging will be used to dredge loose material in the entrance channel for ocean disposal. Hydraulic dredging (pipeline) discharging into scows will probably be utilized to remove the harder material (coquina) and during the turtle season when hopper dredges cannot be used. A clamshell dredge or hydraulic dredge will be used to excavate material in the inner channel if suitable for ocean disposal. The material will be placed in barges and transported to the ODMDS for disposal. Material determined to be unsuitable for ocean disposal or material that is located in the upper channel where the distance to the ODMDS makes transportation of the material economically infeasible will be hydraulically dredged, and the dredged material will be disposed of at an upland disposal site.

II. Factual Determinations.

a. Physical Substrate Determinations.

(1) Substrate Elevation and Slope. Present depths in the Charleston Harbor navigation channel include 42 feet plus two (2) feet of advance maintenance and two (2) feet of allowable overdepth in the entrance channel, and 40 feet plus two (2) feet of advance maintenance and two (2) feet allowable overdepth in the inner channel. This depth is maintained throughout the channel with the following exceptions: 38 feet in the Shipyard River Entrance Channel and Turning Basin A; 30 feet in Shipyard River Connector Channel and Turning Basin B, and 40 feet in Town Creek with 4 foot horizontal to 1 foot vertical side slopes. The side slopes will remain unchanged; however, the depth of the channel will be deepened to 42 feet minimum to

45 feet maximum with two (2) feet of advance maintenance and two (2) feet of allowable overdepth.

(2) Sediment Type. Sediment types are discussed in detail in part I.d. of this document.

(3) Dredged/Fill Material Movement. Dredged material will be moved by hopper dredge, hydraulic dredge and/or clamshell dredge and transported to the Charleston ODMDS for disposal. A hydraulic dredge will be utilized for pipeline transport and disposal of material at existing upland disposal sites.

(4) Physical Effects on Benthos. Benthic animals in the vicinity of the dredging activity will be impacted. These impacts should be temporary in duration allowing for reestablishment following dredging activity.

(5) Actions Taken to Minimize Impacts. Hopper dredging will be conducted during the approved "window" of December 1 to March 31 (or whatever the window may be at the time of dredging) to avoid impacting sea turtles. As an alternative, a new drag head has been developed by the Army Corps of Engineers, Waterways Experiment Station which acts as a turtle excluder. This device may be used if agreement is reached by environmental resource agencies and if applicable at the time. Monitoring of the return water from the upland disposal areas will be conducted in order to minimize the discharge concentrations of total suspended solids (TSS) and other parameters as per a 1989 agreement with SC Department of Health and Environmental Control (SCDHEC).

b. Water Circulation, Fluctuation and Salinity Determinations.

(1) Water. Temporary impacts related to dredging and the return water from upland disposal area would be expected; however, permanent impacts to the aquatic ecosystem are not anticipated or expected.

a. Salinity. Impacts to the salinity gradient with particular reference to industries located along the Cooper River were addressed through a study conducted by the Army Corps of Engineers, Waterways Experiment Station, (ACOE-WES). The study indicated that no change in the salinity gradient was expected. Additionally, impacts to the salinity concentrations in the harbor are not expected.

b. Water Chemistry. Temporary changes to water chemistry in the vicinity of dredging/disposal may occur. These changes should be no different than those occurring during maintenance dredging and are considered minimal and temporary in nature.

c. Clarity. Water clarity may be reduced at project depths where dredging is occurring or at the outfall pipe of the upland disposal; however, reduced clarity within the total water column would not be expected. Again, the changes in clarity should be no different than those occurring during maintenance dredging activity.

d. Color. Not applicable.

e. Odor. Not applicable.

f. Taste. Not applicable.

g. Dissolved Gas Levels. A temporary, minor decrease in dissolved oxygen may occur at the dredging location project depth related to suspension of bottom sediments during dredging activity. Any impacts should quickly return to normal following dredging activity. Dissolved oxygen levels at the outfall pipes of upland disposal areas is usually higher due to the turbulence associated with the outfall structures.

(h) Nutrient Levels. Nutrient levels may temporarily increase at the dredging location project depth due to increased turbidity which may result in a release of nutrients from the disturbed sediments. Increased levels would be temporary in nature, returning to normal following dredging.

(i) Eutrophication. Not applicable.

(2) Current Patterns and Circulation.

(a) Current Patterns and Flow. Studies by ACOE-WES have been conducted to determine the optimum channel locations to minimize sedimentation rates. Some changes in current patterns are expected in relation to the realignment of the channel; however, these changes are not expected to have significant environmental effects. Furthermore, if sedimentation rates can be minimized, the frequency of maintenance dredging in the harbor may be reduced also, thereby further lessening impacts from dredging. It should also be noted that if a new State Ports Authority terminal is constructed at the proposed location on Daniel Island, an additional contraction dike is proposed for construction on the west side of the Cooper River just north of Shipyard River. The two existing contraction dikes on the west side of the Cooper River will be refurbished, and the existing contraction dike on the east side of the Cooper River will be removed.

(b) Velocity. As the channel is straightened, velocities may increase in the channel where the realignment is made; however, these changes are not expected to have a significant environmental effect.

(c) Stratification and Hydrologic Regime. No changes are anticipated.

(3) Normal Water Level Fluctuations. Not applicable.

(4) Salinity Gradients. Effects on salinity gradients are addressed in Section II.b.(1)(a) of this document.

(5) Actions That Will Be Taken to Minimize Impacts. Contraction dikes will assist in maintaining present currents near Daniel Island if the proposed terminal is constructed. The only other location where currents are expected to change is at Horse Reach and Shutes/Folly Reach where realignment of the channel will be made. None of these changes in the present project are expected to cause significant environmental impacts.

c. Suspended Particulate/Turbidity Determinations.

(1) Expected Changes in Suspended Particulates and Turbidity Levels in Vicinity of Disposal Site. The return water from the disposal areas would be the only source of turbidity in the vicinity of the disposal site. Provided that the sites are operated as designed, there may be minor increases in TSS levels at the outfall but no permanent impacts are anticipated or expected.

(2) Effects on Chemical and Physical Properties of the Water Column.

(a) Light Penetration. No impact on light penetration is expected at the dredging site. A possible short-term decrease in light penetration resulting from a temporary increase in localized turbidity at the outfall pipes from the disposal areas may occur.

(b) Dissolved Oxygen. DO concentrations in the return water are usually 4.0 mg/l or higher depending on the season due to the turbulence associated with the outfall structures.

(c) Toxic Metals and Organics. Toxic metals and organics are not expected to be found in the new work material due to the depth and the type of material present. Cooper Marl and Coquina would not have toxic levels of contaminants. Initial testing addressing the return water has been conducted. Contaminant levels were not at toxic levels. Additional testing is scheduled to determine sediment contaminant levels and to conduct bioassay testing.

(d) Pathogens. Not applicable.

(e) Aesthetics. Aesthetic impacts are not expected at the disposal areas. The dredging site impacts would be limited to the visual impact of the dredge and the floating pipeline. These impacts would not be any different than those occurring during regular maintenance dredging.

(3) Effects on Biota

(a) Primary Production, Photosynthesis. There should not be a disruption in primary production, photosynthesis at the dredging site or the disposal site.

(b) Suspension, Filter Feeders. Organisms at the dredging site will be impacted. Following dredging, a rapid recovery is expected.

(c) Sight Feeders. A minimal, temporary disruption with rapid recovery is possible. Most sight feeders are transient and can relocate until dredging operations are complete.

(4) Actions Taken to Minimize Impacts. Impacts associated with the actual dredging operation of the hopper or hydraulic dredge are minimal and it is unlikely that further minimization is possible. Clamshell dredging usually creates more turbidity than hopper or hydraulic dredging, not only due to the actual dredging, but also due to overflow from the scow. Depending on the type of material being dredged and the location of the dredging, overflow may be reduced or eliminated to minimize the turbidity levels. Impacts at the ODMDS will be minimized by placing suitable hard material on the L-shaped berm that prevents fine material from drifting onto the live bottoms located to the west of the ODMDS. Impacts associated with the return water from upland disposal areas will be minimized by operation of the disposal area and by monitoring and inspections by COE personnel as discussed in part II.a.5.

d. Contaminant Determinations. Availability of contaminants is discussed in part II.c.(2)(c) of this document. Furthermore, there are specific locations addressed in the public notice for this project identifying where the navigation channel will be relocated. These new work areas have not been dredged and recent depositions may prove to have higher level of contaminants than areas of the channel that are dredged on a regular maintenance schedule. Sediment testing and bioassays will be conducted in January 1995 to determine the suitability of the material for ocean disposal. If unsuitable, this material will be placed in an upland disposal area and monitored during the dredging activity.

e. Aquatic Ecosystem and Organism Determinations.

(1) Effects on Plankton. Any effects on planktonic growth will be dependent on the concentration of turbidity resulting from the dredging and disposal operations. Any effects would be minimal and temporary in duration and would not result in unacceptable adverse impacts.

(2) Effects on Benthos. Any benthic activity at the dredging site (navigation channel) would be interrupted. Benthic activity at the ODMDS may be

impacted depending on the quantity, placement and duration of the discharges. This is a dispersive site, so the fine material that is placed there migrates elsewhere following dredging.

(3) Effects on Nekton. Effects on nekton are not expected. Free swimming organisms that do not rely on currents for their movement can move out of the way of the dredge or material disposal. As discussed earlier in part II.a.(5) above hopper dredging will be conducted during the "dredging window" or turtle deflectors will be utilized.

(4) Effects on the Aquatic Food Web. Temporary, localized effects may occur in the vicinity of the dredging and disposal activity. Effects would be related to sedimentation/turbidity and would rapidly return to normal following completion of the construction activity.

(5) Effects on Special Aquatic Sites. Not applicable.

(6) Threatened and Endangered Species. Impacts to sea turtles and Right Whales are possible; however, they are unlikely due to techniques utilized to minimize/eliminate these impacts. These techniques are discussed in parts II.a.(5) and II.e.(3) above and part II.e.(8) below.

(7) Other Wildlife. Impacts would be related to turbidity and are addressed above.

(8) Actions Taken to Minimize Impacts. Techniques to minimize/eliminate impacts to sea turtles are discussed in part II.a.(5) and part II.e.(3) above. Additionally, individuals are required to be present on the hopper dredges to watch for and prevent impact with Right Whales. Techniques to minimize turbidity include proper management and inspections of the upland disposal area, and monitoring of the return water.

f. Proposed Disposal Site Determinations.

(1) Mixing Zone Determinations. Not applicable.

(2) Determination of Compliance with Applicable Water Quality Standards. The Cooper River and Charleston Harbor Water Quality Classification is SB meaning that these are "tidal saltwaters suitable for primary and secondary contact recreation, crabbing and fishing, except harvesting of clams, mussels, or oysters for market purposes or human consumption. Also suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora." The Wando River is classified as SA waters which are "tidal saltwaters suitable for primary and secondary contact recreation. Suitable also for uses listed above for Class SB waters

with the same exception." No conflict with applicable water quality standards is anticipated.

(3) Potential Effects on Human Use Characteristics.

(a) Municipal and Private Water Supply. Not applicable.
(b) Recreational and Commercial Fisheries. Not applicable.
(c) Water Related Recreation. Not applicable.

(d) Aesthetics. Not applicable.

(e) Parks, National and Historical Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves. Not applicable.

g. Determination of Secondary and Cumulative Effects on the Aquatic Ecosystem. Effects from the deepening project should be no different than those associated with the general operation and maintenance dredging of the harbor which are minimal and do not result in long term impacts.

III. Findings of Compliance With the Restrictions on Discharge.

a. No significant adaptations of the guidelines were made relative to this evaluation.

b. Alternative disposal sites are limited due to the quantity of material that will be dredged. The six existing disposal sites which may be used for this deepening project include the Charleston ODMDS, Clouter Creek Disposal Area, Daniel Island Disposal Area (if easement is still in place), Morris Island, the Naval Weapons Station Disposal Area, and Drum Island Disposal Area. Disposal locations will be related to the location of the dredging operation, the quality and the quantity of material. Realignment alternatives have been subject to studies conducted by ACOE-WES. The chosen alternative for realignment will straighten out the bend near Horse Reach and Shutes/Folly Reach thereby improving navigation by reducing the hazards of a sharp turn in the channel. The final depth of the project is expected to be 42 feet with two feet of advance maintenance and two feet of allowable overdepth. This is based on the present economic review. It is possible that the project may be deepened to 45 feet with the 4 feet of advance maintenance and allowable overdepth. However, this will be based on the completed economic review. One other alternative is "no action". Under a "no action" alternative, shipping traffic and navigation would continue as it is now. However, as stated in part I.c. of this evaluation, the authority and purpose of the study is to review the project to see if modifications are advisable. The study has determined that modifications are advisable in order to improve navigation for shipping traffic. Providing that there are no significant environmental impacts identified and associated with deepening/widening/realignment, the project is expected to go to construction phase.

c. The proposed deepening project described in this evaluation would not cause or contribute to violations of any known applicable state water standard.

d. The proposed project will not violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

e. The proposed project will not violate the Endangered Species Act of 1973.

f. The proposed project will not violate any specified protection measures for marine sanctuaries designated by the Marine Protection, Research, and Sanctuaries Act of 1972.

g. The proposed disposal of dredged material will not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. The life stages of aquatic life and other wildlife will not be adversely affected. Significant adverse effects on aquatic ecosystem diversity, productivity and stability, and recreational, aesthetic and economic values will not occur.

h. Appropriate steps to minimize potential adverse impacts of the discharge on aquatic systems include proper management of the disposal areas, inspections and monitoring of the return water. Additionally, a location for the disposal of material being placed at the Charleston ODMDS will be specified in contracts and the placement monitored.

i. The proposed project will not cause unacceptable adverse impacts to any significant historic sites.

j. On the basis of the guidelines, the proposed disposal sites for the discharge of dredged material are specified as complying with the requirements of these guidelines, with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects on the aquatic ecosystem.

George H. Hazel

GEORGE H. HAZEL
Lieutenant Colonel, EN
Commanding

20 Jan 95
DATE

Amendment
404(b)(1) Evaluation

Charleston Harbor Deepening Project
Charleston, South Carolina

This amendment addresses changes and additions to the Charleston Harbor Deepening Project as described in the 404(b)(1) Evaluation dated 20 January 1995.

I. **General Description**. The proposed project consists of deepening Charleston Harbor from 40 feet to 45 feet below mean low water (MLW) with two feet of advance maintenance and two feet of allowable overdepth. Furthermore, the project will also include realignment of the channel at Horse Reach and Shutes/Folly Reach to improve navigation by straightening the channel. The navigation channel will be 47 feet deep and 800 feet in width from the 47-foot ocean contour to station 0+00 inside the jetties. The channel will slope upward to 45 feet and remain at 800 feet wide to a point adjacent to Sullivan's Island where it will narrow to 600 feet wide. The remainder of the navigation channel will remain at the present 500 to 800 feet wide with the following exceptions. The Daniel Island Reach will vary from approximately 600 feet to 875 feet in width for the proposed terminal access and include a turning basin approximately 1200 feet in length. Upper Town Creek will be reduced to 16 feet deep and 250 feet wide. The entrance channel will not be deepened in any area where the present depth is already at 47 feet. In addition, two existing contraction dikes located on the west side of the Cooper River, across from the proposed Daniel Island Terminal (Terminal X) will be refurbished. The existing contraction dike located at Daniel Island will be removed, and a new 700 foot long contraction dike, located approximately 150 feet upstream of the degaussing pier on the west side of he Cooper River, will be constructed. In addition, the degaussing line will be removed prior to deepening and relaid following deepening of the channel. Lastly, a turning basin is proposed for construction on the west side of the Cooper River directly across from the proposed Terminal X, (see Figure 1).

II. **Suspended Particulate/Turbidity Determinations**.

(1) **Toxic Metals and Organics**. Testing has been completed for the project. Section 401 Water Quality Certification (WQC) and Coastal Consistency for the project were issued on May 2, 1995 and March 10, 1995, respectively, for the entire project with the exception of the Daniel Island Turning Basin and the contraction dikes. Coastal Consistency for these additions to the project was issued February 14, 1996. Water Quality Certification is expected in March 1996. Further, correspondence from EPA approved disposal of material from all sites except material removed from Shipyard River at the Charleston Ocean Dredged Material Disposal Site (ODMDS). Material from Shipyard River must be placed at an upland disposal site.

III. Aquatic Ecosystem and Organism Determinations.

(1) **Threatened and Endangered Species**. The Atlantic and shortnose sturgeon and manatee are also endangered species which may be affected by the dredging operation. However, measures to provide manatee protection if construction occurs during summer months (June through September) have been included in the project and will be incorporated in the plans and specifications. Further, recommendations provided by the U.S. Fish and Wildlife Service in the Draft Coordination Act Report, 1994 have been responded to in this document and/or have been taken into consideration for planning and contract purposes.

IV. Findings of Compliance with Restrictions on Discharge.

(1) Disposal sites which will be utilized during the deepening project include the Charleston ODMDS and the Clouter Creek Disposal Site.

(2) The final depth of the project is expected to be 45 feet deep with two feet of advanced maintenance and two feet of allowable overdepth.

(3) On the basis of the guidelines, the proposed disposal sites for the discharge of dredged material are specified as complying with the requirements of these guidelines, with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects on the aquatic ecosystem.

THOMAS F. JULICH
Lieutenant Colonel, EN
Commanding

8 Mar 96
DATE

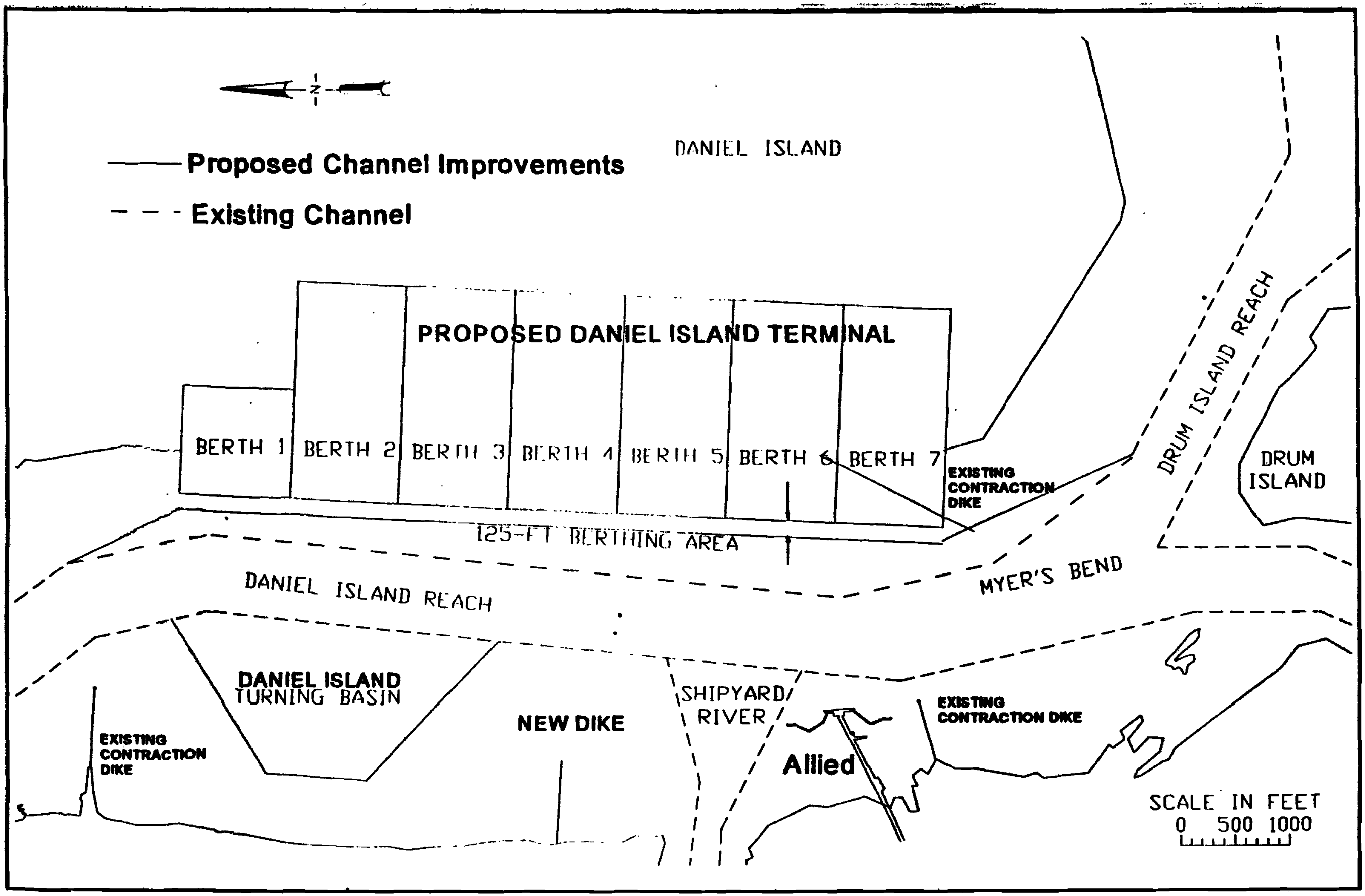


Figure 1: Location of Proposed Improvements

APPENDIX B

SECTION 401 JOINT PUBLIC NOTICE

JOINT
PUBLIC NOTICE
P.O. Box 919
Charleston, South Carolina 29402-0919
and
THE SOUTH CAROLINA DEPARTMENT OF HEALTH
& ENVIRONMENTAL CONTROL

NOTE: THIS IS A CORPS OF ENGINEERS CIVIL WORKS PROJECT

CESAC-EN-PR 9 December 1994
Refer to: P/N 94-1R-498
Charleston Harbor Deepening/Widening Project
Charleston, South Carolina

The Charleston District, Corps of Engineers, Charleston, South Carolina proposes to perform the work described herein with due consideration and review being given to the relevant provisions of the following laws:

1. The Rivers and Harbors Act of 1899 (33 U.S.C. 403).

2. The Clean Water Act (33 U.S.C. 1251. et. seq.).

3. The Coastal Zone Management Act of 1972, as amended (16 U.S.C. 1531, et. seq.).

The purpose of this notice is to advise all interested parties of dredging activity in Charleston Harbor where dredged material will be placed in diked upland disposal areas and in the Charleston Ocean Dredged Material Disposal Site.

In order to give all interested parties an opportunity to express their views

NOTICE

is hereby given that written statements regarding the proposed work will be received at this office until

12 O'CLOCK NOON, MONDAY, 9 JANUARY 1995

from those interested in the activity and whose interest may be affected by the proposed work.

This public notice addresses the new work (deepening/widening or realigning) of the Charleston Harbor federal navigation channel, the disposal of the dredged material and diked upland disposal area return waters. It also addresses the results of modified elutriate and column settling tests conducted on sediments collected from

eleven stations in Charleston Harbor. Additionally, it addresses the results of monitoring efforts performed on return waters from two upland disposal areas during the 1994 dredging cycle.

BACKGROUND

Charleston Harbor is the largest seaport in South Carolina and is ranked as the second largest container port on the East Coast of the United States. The harbor is a natural tidal estuary formed by the confluence of the Cooper, Ashley and Wando Rivers and located approximately midway along the South Carolina coastline, being approximately 140 statute miles southwest of the entrance to Cape Fear River, North Carolina, and 75 statute miles northeast of the Savannah River. The existing Charleston Harbor federal navigation project provides for a 40-foot deep navigational channel, 26.97 miles in length, from the 42-foot ocean contour to the North Charleston Terminal on the Cooper River; a 2.08 mile long 40-foot deep channel in the Wando River extending from the Cooper River to the Wando Terminal; a 38-foot deep channel in Shipyard River Entrance Channel and Turning Basin A; a 30-foot deep channel in Shipyard River Connector Channel and Turning Basin B; and a 40-foot channel in Town Creek.

PROPOSED PROJECT

The study authority for the feasibility phase of this project is as follows: "Pursuant to Senate and House resolutions adopted on 27 March 1990 and 1 August 1990, respectively (the latter published as House Document Numbered 100-27, 100th Congress, 1st Session), the Charleston District, through the Board of Engineers for Rivers and Harbors, was requested to review the reports of the Chief of Engineers on Charleston Harbor, South Carolina with a view to determining whether any modifications of the project are advisable at this time, with particular view toward deepening and/or widening."

Recommended improvements for Charleston Harbor consist of deepening Charleston Harbor from 40 feet to 42 feet as a minimum depth and 45 feet maximum below mean low water (MLW) with 2 feet of allowable overdepth and 2 feet of advance maintenance.

In addition, the navigation channel will be 800 feet in width beyond the jetties. Within the jetties it will remain 1000 feet wide, reducing to 600 feet wide near Sullivan's Island and remaining at 600 feet in width for the rest of the federal navigation channel, with the exception of the Daniel Island Reach which will vary from approximately 875 feet to 600 feet in width for proposed terminal access. The entrance channel is expected to extend out to the 51-foot ocean contour. Furthermore, the project will also include realignment of the channel at Horse Reach and Shutes/Folly Reach to improve navigation by straightening the channel.

Modified elutriate tests were conducted with sediment collected from eleven sites in Charleston Harbor. In addition, a column settling test was conducted with sediment composited from the eleven sampling sites. The analytical results from the modified elutriate tests indicate that all concentrations were below detection limits with the exception of silver and arsenic. However, both of these parameters were below the EPA Water Quality Criteria for Chemicals of Concern in Marine Waters, Acute Concentration Levels.

During the deepening project, dredged material will be placed in existing upland disposal areas and at the Charleston Ocean Dredged Material Disposal Site. Potential upland disposal sites include the Clouter Creek Disposal Site, Daniel Island Disposal Site and Morris Island Disposal Site. Sediment chemistry and bioassay testing are planned to determine which material will be suitable for ocean disposal.

Monitoring of the return water from the existing upland disposal areas utilized in Charleston Harbor was conducted during the dredging operation and maintenance activity in 1993 and 1994. On two occasions when it was possible to collect influent samples, the percent removal of total suspended solids exceeded 99.0%. Monitoring information is available at the Charleston District office upon request.

This project is consistent, to the maximum extent practicable, with the South Carolina Coastal Zone Management Program. By this notice, the Charleston District requests concurrence from the South Carolina Department of Health and Environmental Control (SCDHEC) Office of Ocean and Coastal Resource Management (OCRM) that the proposed activity is consistent with the State's Coastal Zone Management Program. Concurrence is conclusively presumed if no state action is received within 45 days of receipt of this notice.

This document serves as a public notice on behalf of the SCDHEC for water quality certification (WQC). A certification is required from the SCDHEC stating that the proposed construction (dredging) and return water from upland contained disposal areas will be conducted in a manner consistent with the Clean Water Act. By this notice, the Charleston District requests SCDHEC to issue that certification. A Section 404(b)(1) Evaluation has been completed and determines that the proposed activity will have no significant adverse effects. The 404(b)(1) Evaluation is available at the Charleston District Office.

Persons wishing to comment or object to State Certification are invited to submit same in writing to the South Carolina Department of Health and Environmental Control, 2600 Bull Street, Columbia, South Carolina 29201, within thirty (30) days of the date of this notice.

Any person may request, in writing, within the comment period specified in this notice, that a public hearing be held to consider this application. Requests for a public hearing shall state, with particularity, the reasons for holding a public hearing.

Based on review of available information and evaluation of the proposed activity through the 404(b)(1) procedures, it is determined that the proposed project will not result in significant adverse impacts to the environment.

If there are any questions concerning this public notice, please contact Ms. Robin Coller-Socha of the Environmental Resources Section at telephone number 803/727-4696 or FAX number 803/727-4260.

THOMAS W. WATERS, P.E.
Chief, Engineering and
Planning Division

JOINT
PUBLIC NOTICE

Charleston District, Corps of Engineers
P.O. Box 919
Charleston, South Carolina 29402-0919
and
THE SOUTH CAROLINA DEPARTMENT OF HEALTH
& ENVIRONMENTAL CONTROL

NOTE: THIS IS A CORPS OF ENGINEERS CIVIL WORKS PROJECT

CESAC-EN-PR January 5, 1996

Refer to: P/N 95-1R-406
Amendment to:
Charleston Harbor Deepening/Widening Project
Charleston, South Carolina

The Charleston District, Corps of Engineers, Charleston, South Carolina, proposes an amendment to public notice 94-1R-498 published on December 9, 1994. The amendment includes the work described herein with due consideration and review being given to the relevant provisions of the following laws:

1. The Rivers and Harbors Act of 1899 (33 U.S.C. 401).

2. The Clean Water Act (33 U.S.C. 1251, et. seq.).

3. The Coastal Zone Management Act of 1972, as amended (16 U.S.C. 1531, et. seq.).

The purpose of this notice is to advise all interested parties of additions to the deepening/widening project as described in P/N 94-1R-498. The additions include refurbishment of two existing contraction dikes and construction of a new contraction dike and turning basin. The refurbishment of existing contraction dikes and construction of the proposed contraction dike are necessary to reducing shoaling in the Daniel Island reach by 50 percent. (see Figures 1 & 2).

In order to give all interested parties an opportunity to express their views

NOTICE

is hereby given that written statements regarding the proposed work will be received at this office until

12 O'CLOCK NOON, January 22, 1996

from those interested in the activity and whose interest may be affected by the proposed work.

PROJECT INFORMATION

The existing contraction dikes for refurbishment on the west side of the Cooper River are located downstream of Shipyard River and upstream of the U.S. Navy degaussing pier. The proposed contraction dike will be located approximately 100 to 200 feet upstream of the U.S. Navy degaussing pier, between the two existing contraction dikes.

Marl from the Charleston Harbor Deepening Project will be used to provide a base for the proposed dike. Approximately 30 feet of marl equaling 180,000 cubic yards of material will be placed as a base with a 12 inch foundation blanket equaling 4000 cubic yards of 6" - 12" stone and 3 feet of riprap equaling 12,000 cubic yards. The material will be placed by barge. The dike will be approximately 1000 feet in length, 300 feet of which is vegetated wetlands, (see Figures 3, 4 and 5).

- The two existing dikes will be repaired by replacing the sheet pile or by placement of rock around the existing dikes. No change in the existing footprint is expected. Again, all work will be conducted by water access.

In addition to the contraction dikes, a turning basin located north of Shipyard River and south of the existing contraction dike (see Figure 2) is proposed for construction. The turning basin will be deepened to the same depth as Charleston Harbor which is 45 feet plus two feet of maintenance and two feet of overdepth for a total depth of 49 feet. Material from the turning basin (3 million cubic yards) will be placed in the Clowder Creek diked disposal area. The total area of benthic impact will be approximately 80 acres. Testing requirements for upland disposal of the material were coordinated with SCDHEC and test results will be submitted to SCDHEC following completion of the testing regime.

ADDITIONAL CONSIDERATIONS

This project is consistent, to the maximum extent practicable, with the South Carolina Coastal Zone Management Program. By this notice, the Charleston District requests concurrence from the South Carolina Department of Health and Environmental Control (SCDHEC) Office of Ocean and Coastal Resource Management (OCRM) that the proposed activity is consistent with the State's Coastal Zone Management Program. Concurrence is conclusively presumed if no state action is received within 45 days of receipt of this notice.

The document serves as a public notice on behalf of the SCDHEC for water quality certification (WQC). A certification is required from the SCDHEC stating that the proposed construction, and any return water from upland contained disposal areas will be conducted in a manner consistent with the Clean Water Act. By this notice the Charleston District requests SCDHEC to issue that certification. Persons wishing to comment or object to State Certification are invited to submit same in writing to the South Carolina Department of Health and Environmental Control, 2600 Bull Street, Columbia, South Carolina 29201, within fifteen (15) days of the date of this notice.

Any person may request, in writing, within the comment period specified in this notice, that a public hearing be held to consider this application. Requests for a public hearing must state, with particularity, the reasons for holding a public hearing. These requests should be made to SCDHEC at the address listed above.

The Corps of Engineers is soliciting comments from the public; federal, state, and local agencies and officials, and other interested parties in order to consider and evaluate the impacts of this proposed activity. Any comments received will be considered by the Corps of Engineers to determine whether to proceed with the project. Comments are used in the preparation of finalizing the Environmental Assessment pursuant to the National Environmental Policy Act.

If there are any questions concerning this public notice, please contact Mr. Jim Preacher, Chief of the District's Environmental Resources Section (EN-PR) at telephone number: 803/727-4264, FAX number: 803/727-4260.

Richard Jackson

RICHARD M. JACKSON, P.E.
Chief, Planning Branch

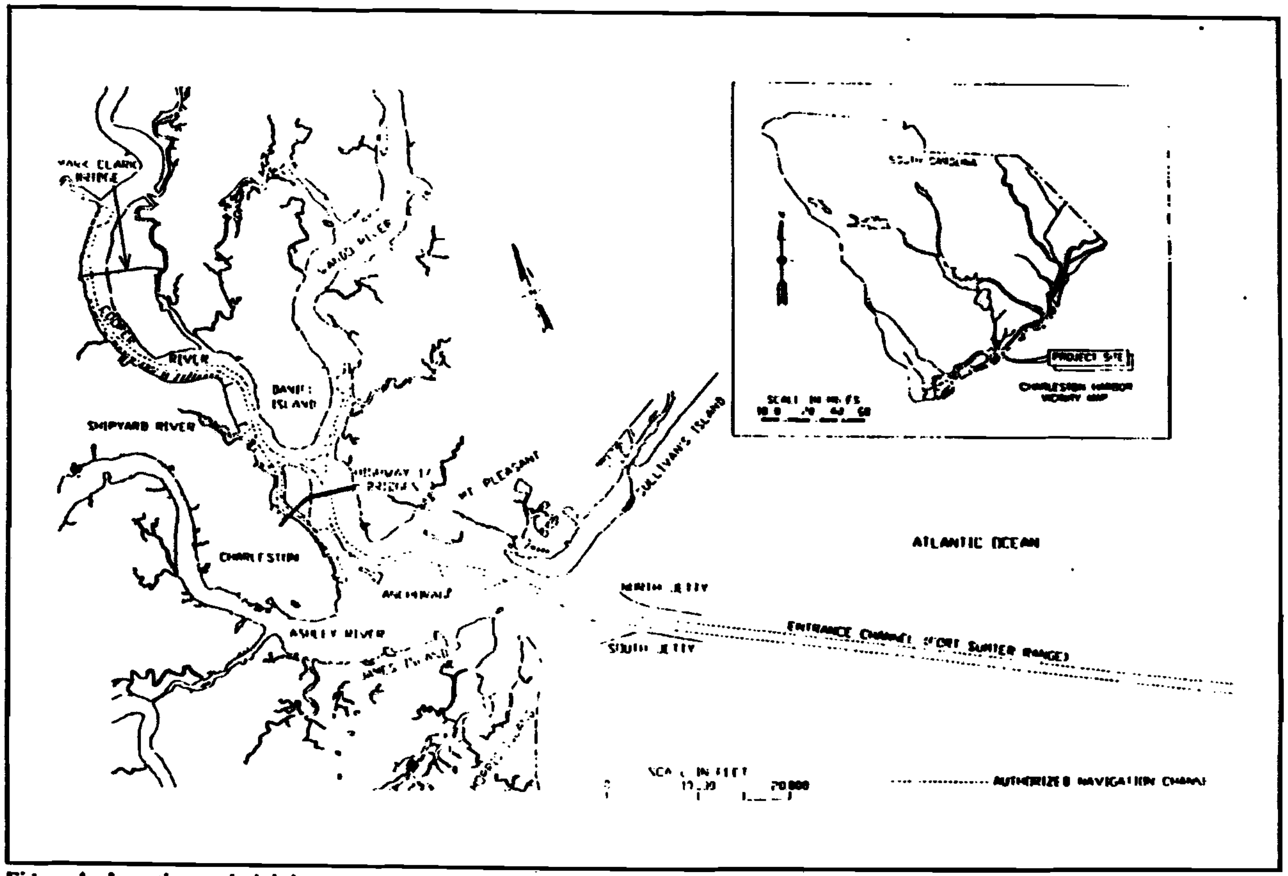


Figure 1. Location and vicinity map

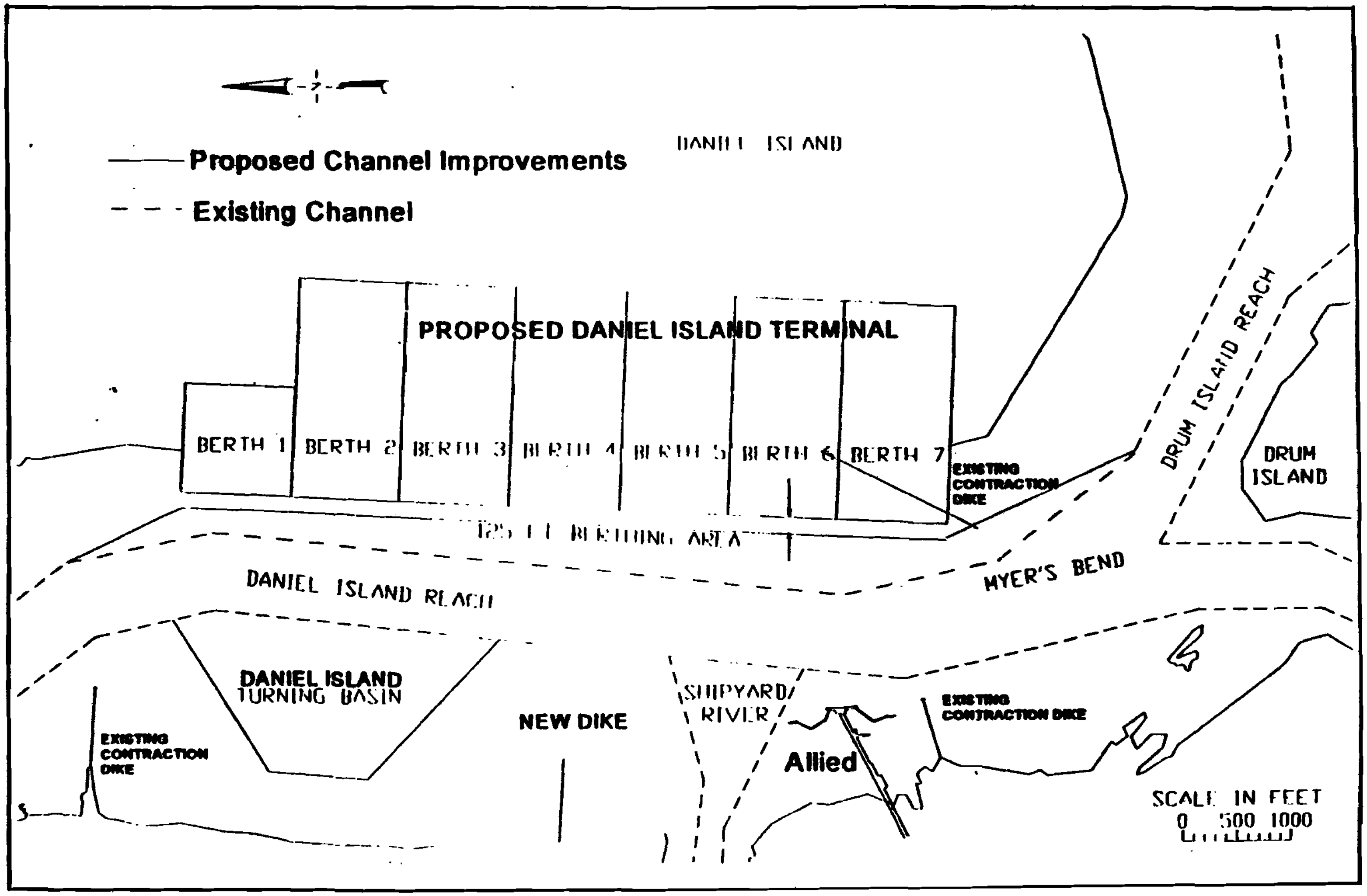
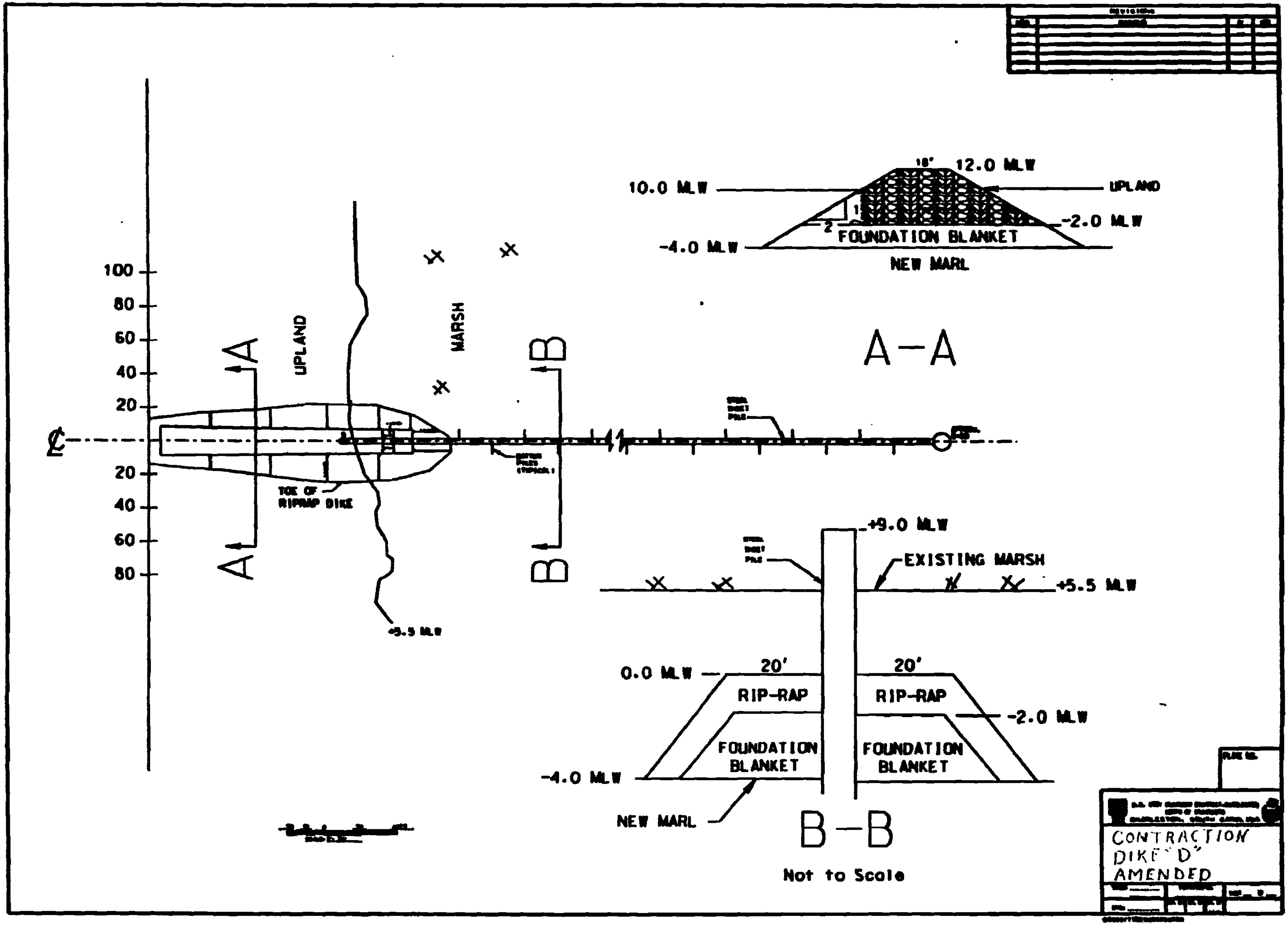


Figure 2: Location of Proposed Improvements



CONTRACTION
DIKE "D"
AMENDED

APPENDIX C

U.S. FISH AND WILDLIFE
FINAL COORDINATION ACT REPORT

United States Department of the Interior

TAKE PRIDE IN AMERICA

FISH AND WILDLIFE SERVICE
P.O. Box 12559
217 Fort Johnson Road
Charleston, South Carolina 29422-2559

January 29, 1996

Lt. Colonel Thomas F. Julich
District Engineer
U.S. Army Corps of Engineers
P.O. Box 919
Charleston, S.C. 29402-0919

Re: Fish and Wildlife Coordination Act Report on the Charleston Harbor Deepening Project

Dear Colonel Julich:

Enclosed please find the above-referenced report submitted in partial fulfillment of Section 2(b) of the Fish and Wildlife Coordination Act (FWCA) (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). The report is based on the information contained in the October, 1995 Charleston Harbor Draft Feasibility Report with Environmental Assessment and supplemental information provided by Charleston District personnel. The majority of the comments received from the Charleston District on the draft FWCA report have been addressed in this report.

Due to time constraints the report is being forwarded for attachment to the Feasibility Report for Division level review without the comments or concurrence of either the National Marine Fisheries Service or the South Carolina Department of Natural Resources. Coordination with these agencies is ongoing. This report should be modified to incorporate letters of concurrence and/or adoption of recommended changes from these agencies prior to its being considered complete.

Sincerely yours,

Steven S. Gilbert
Acting Field Supervisor

/SG

FISH AND WILDLIFE COORDINATION ACT REPORT
ON
CHARLESTON HARBOR DEEPENING STUDY

Prepared by:
Steven S. Gilbert

Under the Supervision of
Roger L. Banks, Field Supervisor
Division of Ecological Services
Charleston, South Carolina

January, 1996

U.S. Fish and Wildlife Service
Southeast Region
Atlanta, Georgia

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EXECUTIVE SUMMARY

The purpose of this U.S. Army Corps of Engineer's (Corps) study was to determine if any modifications should be made to the currently authorized Charleston Harbor project, with particular emphasis on deepening and widening. The feasibility study evaluates deepening existing channels two to five feet in one foot increment alternatives. It also evaluates channel navigation improvements and improvements to support a new container cargo port terminal on the southwest end of Daniel Island. This fish and wildlife coordination act report evaluates fish and wildlife resources within the Charleston Harbor study area in both current and future scenarios, identifies potential impacts associated with the proposed project and alternatives, and makes recommendations to reduce impacts to fish and wildlife resources.

Charleston Harbor, a natural harbor approximately 14 square miles in area, is formed by the confluence of the Ashley River, Cooper River, and Wando River and lies approximately midway along South Carolina's Atlantic coast. The currently authorized navigation project for Charleston Harbor includes a 42-foot deep entrance channel, a 40-foot deep, 600-foot wide channel in the Cooper River to Goose Creek, and a 40-foot deep, 400-foot wide channel in the Wando River to the Wando terminal.

The Charleston Harbor study area supports significant fish and wildlife resources including marine hard bottom faunal assemblages and estuarine emergent wetlands. Charleston Harbor estuary supports large populations of penaeid shrimp and blue crab which are harvested both commercially and recreationally. Estuarine fish are also abundant in the study area and provide an important recreational harvest.

The juxtaposition of these habitats with major port development causes the potential for significant environmental impacts. Impacts which may result from the proposed project include loss/modification of benthic organisms and habitat at the dredge site, use of capacity at existing disposal sites promoting pressure for the need for new sites, endangered sea turtle mortality caused by hopper dredging in the entrance channel, disruption and/or mortality of immigrating or emigrating aquatic organisms, and direct and secondary habitat alterations resulting from navigational accommodation and construction of new or expanded port facilities and/or related industrial development.

The Service recommends the following measures to reduce the impact of the proposed project on fish and wildlife resources.

1. Review through interagency committee (i.e., Corps, Service, SCDNR, NMFS) the necessity and particulars of a dredging window for the "throat" of the harbor entrance between the jetties. This process should start by utilizing the methodology described in LaSalle (1991) and concentrate on important windows for ingress and egress of key resources such as penaeid shrimp, blue crab, flounder, and red drum.

2. Establish a dredging window for hopper dredge work based on seasonally restricting work to periods when the water temperature is below 16 degrees Celsius. Coordinate with the National Marine Fisheries Service to implement this and any other necessary measures avoiding hopper dredging impacts to endangered sea turtles.

3. Dispose of suitable materials at the ODMDS in accordance with the signed management plan agreement. Also, in accordance with this plan, coordinate with appropriate agencies to plan for detailed monitoring of disposal operations which track the fate of the materials and their ecological effects (especially for large volumes of fine sediments).

4. Develop, in association with water quality agencies and resource agencies, a water quality management/monitoring plan. The plan should address potential harbor deepening water quality impacts, control measures, and monitoring both at the dredge sites and at disposal areas.

5. Avoid deepening any areas for which modeling indicates a high sedimentation rate.

6. Bulk sediment sampling should be conducted in accordance with the Ocean/Inland Testing Manuals for all areas with the exception of those which meet the exclusion criteria based on sediment grain size. The results of all sediment testing including the completed elutriate tests should be provided to the Service for review.

7. Conduct an alternatives analysis for the new contraction dike in the Cooper River. The analysis should, within engineering efficiency constraints, evaluate location, alignment, and construction alternatives consistent with reduction in impact on intertidal habitats, especially those vegetated with emergent marsh.

CHARLESTON HARBOR DEEPENING STUDY

FWCA AGENCY COORDINATION

The following report has been coordinated with the National Marine Fisheries Service (NMFS) and the South Carolina Department of Natural Resources (SCDNR). Letters of concurrence from these agencies are attached as Appendix A. It should be noted that the NMFS letter requests coordination with their Protected Species Branch.

INTRODUCTION

AUTHORITY

Resolutions by the Senate Committee on the Environment and Public Works adopted March 27, 1990 and the Committee on Public Works and Transportation of the United States House of Representatives adopted August 1, 1990 authorized this U.S. Army Corps of Engineers (Corps) study. The Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) (FWCA) authorizes the U.S. Fish and Wildlife Service's (Service) involvement in this study. The Service prepared this report with funds transferred from the Corps under the National Letter of Agreement between our agencies for funding of FWCA activities.

PURPOSE AND SCOPE

The purpose of the Corps' study was to determine if any modifications should be made to the existing Charleston Harbor Project, with particular emphasis on deepening and/or widening the channel. This draft FWCA report describes existing fish and wildlife resources within the Charleston Harbor study area, the future of these resources with and without the project, evaluates the selected plan and alternatives, and identifies fish and wildlife conservation measures and recommendations.

PRIOR STUDIES AND REPORTS

The Service provided a FWCA Report on the currently authorized deepening project (40 foot Channel) in 1980 and a supplemental FWCA report on mitigation alternatives for this project in 1986. In 1982 the Service provided a FWCA Report on Charleston Harbor Wando River extension project. In 1991 the Service provided a FWCA Report on a proposal to deepen Shipyard River from 38 to 40 feet.

DESCRIPTION OF THE STUDY AREA

GENERAL DESCRIPTION

Charleston Harbor, a natural harbor approximately 14 square miles in area, is formed by the confluence of the Ashley River, Cooper River, and Wando River and lies approximately midway along South Carolina's Atlantic coast. The harbor is flanked by the City of Charleston on the western shore; James Island, a residential community, and Morris Island, a barrier island used as a dredged material disposal area, on the south; the community of Mount Pleasant and Sullivan's Island, a developed barrier island, on the north; and the Atlantic Ocean on the east (Figure 1).

The harbor substrate is composed predominately of sand, silt, and clay (Van Dolah et al. 1990). An average tidal range of 5.2 feet has contributed to the development of a fringe of regularly flooded marsh around a large portion of the Harbor. Marsh areas of up to one mile in width occur between Sullivan's Island and Morris Island and the adjoining mainland. The Harbor proper contains approximately 5,200 acres of regularly flooded marsh, the Wando 6.400 acres, the Ashley 4,300 acres and the Cooper 9,200 acres (U.S. Fish and Wildlife Service 1980). Due in part to the turbid conditions of the waters, the Harbor does not contain any substantial acreage of submerged vegetation with the exception of some algal growth. The majority of macrophytic primary production in the Harbor takes place in the fringing salt marshes. Nutrient inputs from these marshes and the river systems feed the Harbor's detrital based food web.

The majority of upland areas around Charleston Harbor contain either residential or commercial development. Daniel Island, which extends northward from the confluence of the Cooper and Wando rivers, currently supports agricultural activities and a diversity of wildlife habitats. Interstate highway access has recently been completed to Daniel Island, stimulating plans for major new residential, commercial, and port developments. The majority of the remaining undeveloped upland areas adjacent to the Harbor were formerly wetlands which are presently serving as dredged material disposal areas. It is estimated that within the Harbor approximately 6,300 acres of regularly flooded marsh have been lost due to dredged material disposal practices, while approximately 100 acres have been created as a result of past open water disposal practices (U.S. Fish and Wildlife Service 1980).

The Wando and the Ashley rivers originate within the coastal plains region, as once did the Cooper River, and consequently provide minor freshwater inflow. The Cooper River Rediversion Project, authorized by the River and Harbor Act of 1968 and completed in 1985, has rediverted, into the Santee River, the major portion of freshwater originating in the Santee

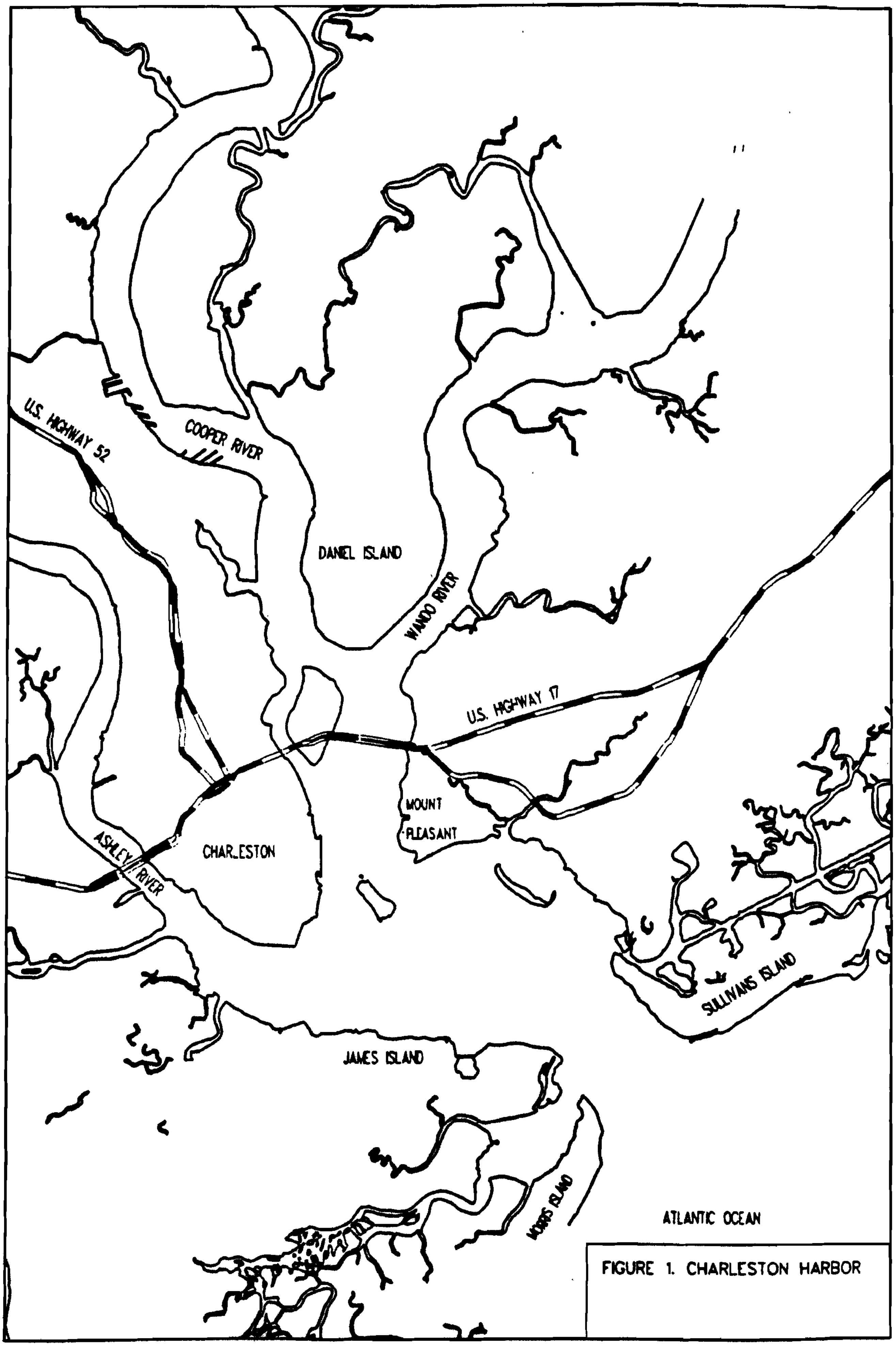

FIGURE 1. CHARLESTON HARBOR

River Basin. The project is designed to decrease shoaling in Charleston Harbor caused by construction of the South Carolina Public Service Authority's Santee-Cooper hydroelectric project during the 1940's which diverted water from the Santee River Basin into the Cooper River. Rediversion of this freshwater flow has reduced the post-1940 average discharge of 15,600 cfs to an average discharge of 4,500 cfs at Pinopolis Dam on the Cooper River (Van Dolah et al. 1990).

EXISTING NAVIGATION PROJECT

The Water Resources Development Act of 1986 (PL 99-662) (WRDA) authorized the deepening of Charleston Harbor from 35 to 40 feet generally in accordance with the plan recommended in the Chief of Engineers Report dated 27 August 1981. The project as implemented consists of the following:

a. Deepening Cooper River Channel from 35 to 40 feet (from 35 to 42 feet in the ocean bar and entrance channel) from the 42-foot ocean contour to Goose Creek, a distance of 26.9 miles;

b. Widening Cooper River Channel to 500 feet between river miles 12.6 and 14.7;

c. Enlarging turning basin diameter at head of Cooper River to 1,400 feet;

d. Deepening Town Creek channel to 40 feet;

e. Enlarging Columbus Street turning basin to 1,400 feet;

f. Deepening the first tangent and the lower turning basin in Shipyard River from 30 to 38 feet;

g. Easing a bend in Cooper River Channel at river mile 7.3 by diminishing the inside angle through widening.

h. Realigning portions of Cooper River Shipyard River and Town Creek Channels to insure 125 feet clearance between pier head lines and edge of channel.

The WRDA also authorized a 40-foot deep, 400-foot wide channel in the Wando River to the South Carolina State Ports Authority terminal. The project also routinely includes two feet of advance maintenance dredging and two feet of overdepth dredging.

The entrance channel is maintained with a hopper dredge and the material is placed in an Ocean Dredged Material Disposal Site (ODMDS). The remaining channels are maintained by hydraulic pipeline dredging and the material is placed in existing diked disposal areas.

WATER QUALITY

Water quality in the majority of the harbor is rated as SB by the South Carolina Department of Health and Environmental Control (SCDHEC), although some tributaries have ratings of SA and SFH (see Table 1). The SB rating applies to tidal salt water suitable for primary and

Table 1. **Water Quality Classifications of Charleston Harbor and its Tributaries to the Point of Salt Water Influence**

Waterbody	**Classification**	**Location**
Wando River	SFH	From headwaters to a point 2.5 miles N. of confluence with Cooper River
Wando River	SA	From 2.5 miles N. of confluence with Cooper River to confluence with Cooper River
Ashley River	SA	Total salt water influenced portion to Charleston Harbor (although lowered D.O. requirement for portion from Church Creek to Orangegrove Creek
Cooper River	SB	Total salt water influenced portion
Charleston Harbor	SB	From the Battery to the Atlantic Ocean

Class SFH = Shellfish Harvesting Waters - tidal saltwaters protected for shellfish harvesting.

Class SA = tidal waters suitable for primary and secondary contact recreation. Suitable also for uses listed in Class SB with the same exception.

Class SB = tidal saltwaters suitable for primary and secondary contact recreation, crabbing, and fishing, except harvesting of clams, mussels, or oysters for market purposes or human consumption. Also suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora.

secondary contact recreation, crabbing, and fishing, except for the harvesting of clams, mussels, or oysters for market purposes or consumption. These waters are also suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora (SCDHEC 1993). Waters rated as SB should not have dissolved oxygen concentrations less than 4 mg/l and fecal coliform concentrations should not exceed a geometric mean of 200 colonies/100 ml based on five consecutive samples taken within a 30 day period. Although these concentrations have been exceeded occasionally, recent reviews of data collected by SCDHEC indicate that water quality within the harbor basin often meets SB standards for dissolved oxygen and fecal coliform levels (Chestnut 1989; Davis and Van Dolah 1990).

The Ashley River and portions of the Wando River have a water quality classification of SA. Although SA waters have the same designated uses as SB waters, the water quality standards are stricter for dissolved oxygen (daily average of not less than 5 mg/l with a low of 4 mg/l, treated wastes, toxic wastes, deleterious substances and colored or other wastes (SCDHEC 1993). Water quality in the Wando River was recently upgraded to SFH above the Wando Terminal. This rating applies to tidal salt waters protected for shellfish harvesting and for uses listed in Class SA and Class SB. SFH water must maintain a daily average dissolved oxygen concentration of 5 mg/l or higher with a low of 4 mg/l and have median coliform concentrations of 14 colonies/100 ml with no more than 10% of the samples exceeding 43 colonies/100 ml (SCDHEC 1993).

FISH AND WILDLIFE RESOURCE CONCERNS AND PLANNING OBJECTIVES

In addition to providing significant wetlands and fish and wildlife habitat, Charleston Harbor has a long history of development as a major port. Charleston Harbor is currently a leading container port in the south Atlantic region. Associated with the port are major industrial and commercial facilities.

The juxtaposition of fish and wildlife habitats with major port development causes the potential for significant environmental impacts. Direct impacts of channel dredging and other project features include:

(1) Loss/modification of benthic organisms and habitat at the dredge site;

(2) Loss/modification of habitat at the dredged material disposal site;

(3) Hydraulic modifications which in turn potentially affect circulation patterns, tidal exchange, sedimentation patterns and salinity distribution;

(4) Water quality degradation at the dredge site and/or the disposal site.

(5) Endangered sea turtle mortality caused by hopper dredging in the entrance channel.

(6) Loss of tidal marsh, flats and shallow subtidal habitats associated with construction of the new contraction dike.

Potential secondary impacts (impacts induced by the project) include habitat alterations resulting from construction of new or expanded port facilities. Such impacts may involve dredging and/or filling of tidal marsh, intertidal flats and other estuarine habitats.

Loss of habitat at the dredged material disposal site has historically, and continues to be, one of the most obvious significant impacts of channel development. In Charleston Harbor approximately 6,300 acres of wetland habitat, primarily estuarine emergent habitat, has been lost. Deepening Charleston Harbor will require use of capacity in existing disposal areas including the Charleston ODMDS.

The Charleston ODMDS is one of the most active, frequently used sites in the South Atlantic Bight. Originally, the management plan for ocean dredged materials disposal associated with the Charleston Harbor complex called for two sites. The permanently designated ODMDS was approximately 3 X 1.5 nautical miles in size. This site was designated to receive all dredged material from maintenance dredging in the harbor and entrance channels. Surrounding the permanent ODMDS, was a larger disposal site. This site encompasses an area of approximately 5 X 3 nautical miles, and was designated for one time use in conjunction with the Charleston Harbor 40-foot deepening project.

Based on the above design, monitoring activities began in 1985 to assess the fate and impact of dredged material placed within the ODMDS. Detailed bathymetric monitoring of the ODMDS and surrounding area have generally been conducted annually by the Corps since 1985. The primary objectives of these bathymetric surveys were to: (1) document the location and configuration of mounds created with dredged material, which was placed along narrow corridors within the ODMDS, and (2) determine whether these mounds were stable.

Monitoring of bottom sediment characteristics and biological communities in the area was conducted primarily by the South Carolina Department of Natural Resources (SCDNR) working under contract to the Corps. This latter effort, which was conducted in 1987, focused largely on obtaining baseline data on the structure and composition of benthic communities and sediment characteristics (physical and chemical) in and around the permanently designated ODMDS (Winn et al. 1989). The SCDNR benthic sampling program was designed around the corridor disposal concept with a network of stations positioned to intercept the migration of material over the bottom, if it occurred, and assess changes in the benthic communities or surface sediment characteristics resulting from the movement of dredged material. The 1987 baseline survey detected minor changes in benthic community structure and sediment composition related to a disposal operation completed in 1986, and some movement of the material was detected away from the disposal site (Winn et al., 1989). However, this movement did not appear to significantly alter sediment composition or benthic communities outside the ODMDS.

In the Fall and Winter of 1989-1990, local fishermen reported that disposal operations occurring in the permanently designated ODMDS were impacting a live bottom area within the western quarter of that area. Until that time, no significant live bottom areas were known to exist within or near either disposal area. Subsequent video mapping of the sea floor conducted by the EPA in the vicinity of the ODMDS confirmed several areas of live bottom within and beyond the boundaries of both sites. As a result of this survey, management strategies were developed to avoid disposal on the mapped live bottom areas. Studies to assess the impact of dredged material re-suspension and disposal plume turbidities on sessile live bottom fauna at one representative site within the ODMDS were initiated.

Based on the above, a Site Management Plan was developed through interagency coordination of the Corps, EPA, the Service, and the SCDNR. The plan was completed and signed by the Corps and the EPA in March of 1993. This plan requires that material suitability for ocean disposal be verified by the Corps and agreed to by EPA, places no seasonal restrictions on use of the site, specifies placement of materials at exact locations based on agreement between EPA and the Corps, and requires electronic verification of placement by dredging contractors as part of monitoring requirements. Fine grained materials are to be placed in the eastern portion of the site while coarse-grained materials not used for other beneficial purposes (i.e., beach nourishment) are to be used to expand a "deflection berm" providing an L-shaped barrier for protection of off-site resources to the south and west of the ODMDS. Since there is a high likelihood that the majority of materials from this project would be placed at the ODMDS, it is important to insure compliance with this management plan.

Ongoing baseline studies within and surrounding the ODMDS continue. Two annual assessments were conducted in 1993 and 1994. These sampled benthic assemblages and sediment characteristics at 200 stations during one intensive summer sampling period. These reports are due to be released shortly.

Although the Corps of Engineers does not have immediate plans to develop any new upland disposal sites, it is logical to assume that at some time in the future a number of other disposal area sites may need to be considered for future deepening and maintenance of Charleston Harbor. In anticipation of the loss of the Daniel Island disposal site due to development of the island, the Charleston Harbor Disposal Area Study funded by the South Carolina Coastal Council evaluated 20 sites in the project area based on environmental and engineering constraints. Results of this study may be used as a tool for initial analysis of any new disposal areas for future maintenance of the Charleston harbor project.

One of the greatest potential impacts of harbor deepening is the hydraulic modification which will result in changes in circulation, sedimentation, and salinity patterns (Allen and Hardy 1980). Increased erosion and/or sedimentation due to changes in circulation patterns may degrade wetlands and fish/shellfish habitat. Increases in ocean derived sediments introduced into the harbor may lead to increased maintenance dredging and the need for additional dredged material disposal areas in the future. Although there has not been documentation of the sources of sediment deposition in the harbor, nor strong documentation of the success of the Rediversion Project at significantly lowering such deposition, there has been speculation that ocean derived sandy sediments may be contributory to the shoaling rates and hence maintenance dredging burden in Charleston Harbor. Salinity and sediment type are major factors controlling distribution of benthic populations in the Charleston Harbor estuary, although the relationship of these parameters with faunal distribution patterns is not very strong in the lower harbor area encompassed by this project (Van Dolah et al. 1990). Salinity is a major factor influencing plant species composition in tidal marshes (Pearlstine et al. 1990) and availability and distribution of nursery areas. According to a model run by the Corps' Waterways Experiment Station, the project would not result in a change in salinity patterns in the harbor.

At the dredging site, potential water quality impacts include increased turbidity and oxygen demand, and release of contaminants and nutrients - particularly free sulfides, hydrogen sulfide, and ammonia. Good maintenance and dredging practices can limit water quality impacts of pipeline dredging. Overflow from hopper dredges can cause high turbidity levels (Allen and Hardy 1980). At open water disposal sites water quality impacts are similar to the above, but of greater magnitude due to the release of larger amounts of dredged material into the water column.

Dickerson et al. (1991) reported that hopper dredging in several southeastern entrance channels has caused high sea turtle mortalities due to entrainment by the draghead. Van Dolah et al. (1992) concluded, after a 15 month survey of the Charleston Harbor entrance channel, that sea turtle densities were sufficient to warrant concern over mortality from hopper dredging.

The following planning objectives were developed considering the above problems.

1. Avoid impacts to estuarine wetlands in the Charleston Harbor study area.

Estuarine wetlands provide the highest quality fish and wildlife habitat in the Charleston Harbor study area. Harbor development and maintenance have resulted in loss of approximately 6,300 acres of wetlands due to filling and dredged material disposal. Future harbor activities should avoid or minimize the use of these highly valuable habitats.

2. Avoid impacts to marine live bottom habitat in the vicinity of the Charleston ODMDS.

Offshore live bottoms provide productive and diverse invertebrate and fish habitat and are important to recreational fisheries. The predominant offshore marine sand bottoms provide only low value invertebrate and fish habitat. Therefore live bottom habitat needs to be protected.

3. Maintain water quality suitable for management of diverse and productive fish and wildlife populations in Charleston Harbor.

Good water quality is an essential component of productive wetland wildlife habitat. Currently, water quality in most of the study area is suitable for most fish and wildlife purposes. Proper planning needs to ensure that harbor development would not degrade water quality.

4. Avoid hopper dredging impacts to endangered sea turtles.

Available information indicates that hopper dredging in the Charleston Harbor entrance channel could cause substantial sea turtle mortality. Measures need to be implemented to avoid impacts to these endangered species. These measures should include state of the art avoidance measures such as those currently in use by the Charleston District in cooperation with the National Marine Fisheries Service including use of the new draghead designed for this purpose and limiting the temporal window for dredging to periods to those outside of the turtle's presence.

5. Avoid design alternatives which would inordinately increase the need for future maintenance dredging.

Increased maintenance dredging increases disturbances to benthic communities and water quality. It also puts pressure on the limited disposal space available.

EXISTING FISH AND WILDLIFE RESOURCES

AQUATIC SYSTEMS

Aquatic systems in the study area provide high value fish and wildlife habitat. Marine and estuarine wetland systems as described by Cowardin et al. (1979) are common in the study area.

Marine System

The near shore ocean community , which delimits the eastern boundary of the study area may be classified as marine, subtidal, unconsolidated bottom habitat (Cowardin et al. 1979). This community is comprised of surf zone, a shallow inshore water region, and a deep-water offshore area. Bottom sediments, which are predominantly sand, provide low value fish habitat (Barans and Burrell 1976). Vascular plants are absent from the near shore community, although phytoplankton and seaweeds are present where sufficient light penetration and suitable substrate occur.

Widely scattered outcrops of rock, relict worm tube reefs, and other materials provide vertical relief and attachment sites for sessile benthic invertebrates. The physical cover and sessile invertebrates attract motile invertebrates and fish. These "live bottoms" are rich in abundance and diversity of invertebrates and fish and are important to the recreational marine fishery (Sandifer et al. 1980).

The ocean beach (to the high water line), sand bars, and sand flats in the study area are classified as marine, intertidal, unconsolidated shore (Cowardin et al. 1979). These intertidal beaches, sand bars, and flats experience almost continuous changes as they are exposed to erosion and deposition by winds, waves, and currents. Sediments are unstable and vegetation is absent. Wave action, long shore currents, shifting sands, tidal rise and fall, heavy predation, and extreme temperature and salinity fluctuations combine to create a rigorous environment for macroinvertebrates, the predominant fauna.

Zooplankton, benthic invertebrates, fishes, birds, mammals, and reptiles are all important faunal components of the marine system. Important game fishes in inshore waters include spot, croaker, flounder, spotted seatrout, sheepshead, bluefish, southern kingfish, black drum, and red drum. Some of the world's most popular big gamefish are found in deeper offshore waters, including king mackerel, wahoo, dolphin, blue and white marlin, swordfish, and sailfish. Numerous shorebirds and wading birds utilize the study area's marine habitats. Aquatic mammals, including various whale and dolphin species, occur in the marine waters.

Estuarine Systems

The estuarine system consists of open water tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have access (either open, partly obstructed, or sporadic) to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from land.

Brackish and salt marshes of the study area are classified within the estuarine system, as are mud flats, oyster reefs, stream beds, and shorelines. Classes of the estuarine system present include emergent wetlands, unconsolidated bottom, stream bed, unconsolidated shore, and reef.

Intertidal, emergent wetlands are the most conspicuous class of the estuarine system in the study area. These include salt and brackish water marshes. The low salt marsh is regularly flooded by daily tides and extends from about mean sea level to the mean high water (MHW) level. Low salt marsh is monospecific, being vegetated with smooth cordgrass. The high marsh occurs above MHW, is flooded irregularly by spring and storm tides, and has a varied plant composition. Halophytes occurring in abundance include black needlerush, saltmeadow cordgrass, saltgrass, sea ox-eye, glasswort, saltwort, sea lavender, and marsh aster.

Brackish water marshes represent a transition zone between salt marshes and tidal freshwater marshes. Plant species found in the more seaward brackish marshes are quite similar to those of the upper high marsh zone of the salt marsh. Pure stands of black needlerush may occur in these marshes. Saltmarsh bulrush, aster, marsh elder, sea-myrtle, panic grass, saltmeadow cordgrass, sea ox-eye, broomsedge, and seaside goldenrod also may be present. Giant cordgrass occasionally appears along upland borders of the more seaward brackish marshes. As salinity decreases, giant cordgrass generally replaces needlerush as the dominant plant.

These emergent wetlands are highly productive natural systems that provide spawning, nursery, and feeding habitat for important commercial and sport fishes. An estimated 95 percent of all commercial finfish and shellfish and most marine sport fishes inhabit estuarine areas during all or part of their life cycles. Estuarine emergent marshes also provide valuable habitat for various waterfowl and other wildlife species, including wading birds, shorebirds, and mammals such as the marsh rabbit, marsh rice rat, river otter and mink

Estuarine intertidal shorelines, sand bars, and mud flats are classified as intertidal, unconsolidated shore (Cowardin et al. 1979); these are typically grouped together as intertidal flats. Peterson and Peterson (1979) define intertidal flats as those portions of the unvegetated bottom of sounds, lagoons, estuaries, and river mouths which lie between the high and low tide marks. These areas occur along shorelines of islands and of the mainland and as emergent bottoms in areas unconnected to dry land. Intertidal flats are composed of sandy and muddy sediments in a wide range of relative proportions. Intertidal flats also provide valuable habitat for benthic invertebrates which are heavily preyed on by fish, wading birds, and shorebirds. Over 50 species of fish live and feed on intertidal flats during high tide. As many as 16 species of fish are, at least in part, dependent on prey which lives or forages on the flats (Peterson and Peterson 1979). These areas are also extremely important feeding areas for wading birds and shorebirds.

Estuarine, intertidal, reef habitat is represented primarily by oyster reefs occurring in estuarine intertidal zones. The American oyster can tolerate a wide range of salinity, temperature, turbidity, and oxygen tension and is therefore adapted to the periodic changes in water quality that characterize estuaries. Oysters often build massive, discrete reefs in the intertidal zone. Oyster reefs occur throughout the project area but are closed for recreational and commercial harvest due to unacceptable water quality. Water quality in the Wando River upstream of the Wando terminal is suitable for shellfish harvest. Closed oyster reefs still perform a variety of ecological functions in support of the estuarine system. These include stabilization of erosional processes, modification of long-term changes in tidal stream flow and overall marsh physiography, mineralization of organic carbon and release of nitrogen and phosphorus in usable forms, and provision of stable islands of hard substrate in otherwise unstable environments. This latter function is particularly important from an estuarine habitat perspective (Bahr et al. 1981).

FISH AND SHELLFISH

Fishery resources within Charleston Harbor and the project area consist of numerous estuarine and marine species. Demersal fish species which are typically associated with the lower water column and substrate of Charleston Harbor include star drum, croaker, bay anchovy, Atlantic menhaden, spotted hake, weakfish, spot, blackcheek tonguefish, white catfish, and silver perch (Van Dolah et al. 1990, Shealy et al. 1974). Other fish species which are of commercial or recreational value and are commonly found within Charleston Harbor include flounder, red drum, spotted seatrout, bluefish, Atlantic croaker, spot and black drum. Life histories and population dynamics of several of these species was recently investigated in the Charleston Harbor estuary and other State waters (Wenner et al. 1990).

Four anadromous fish species, American shad, blueback herring, hickory shad, and striped bass, and one catadromous species, American eel utilize Charleston Harbor and its tributaries as migration routes and spawning areas. The shortnose sturgeon, an endangered species, has been documented as rarely occurring within Charleston Harbor (Van Dolah et al. 1990).

Fishes which commonly reside within the intertidal marshes of the project area include mummichog, sheepshead minnow, Atlantic silverside, and bay anchovy. Other species which frequent intertidal marshes include both species of mullet and several species of Sciaenids. Tidal pools in the high marsh areas are inhabited by species such as sailfin molly and mosquitofish.

Charleston Harbor estuary supports large populations of penaeid shrimp and blue crab which are harvested both commercially and recreationally. The shrimp fishery is South Carolina's largest commercial fishery, averaging 3.24 million pounds (11.8 million dollars) annually during recent years. The Charleston Harbor estuary contributed approximately 20% of the state's total 1978-1987 shrimp landings. Annual commercial landings of blue crab averaged 6.17 million pounds (1.7 million dollars) during recent years, with Charleston Harbor accounting for about 8% of the statewide total (Van Dolah et al. 1990). Charleston harbor also supports one of the state's highest utilized estuaries for recreational bait shrimping representing 43, 44, and 45 percent of statewide recreational shrimping use for 1988, 1989, and 1990, respectively (Joe Carson, SCDNR, personal communication). If these percentages are applied to the 13,366 issued licenses for 1994, the importance of this area for recreational use is impressive.

ENDANGERED SPECIES

The Charleston Harbor study area supports a number of endangered and threatened species (Table 2). Maintenance and enhancement of habitat for endangered and threatened species is an important Service goal. The species listed in Table 2 should be taken into consideration during the alternatives analysis for this project including potential needs for future new disposal sites.

Table 2. **Federal Endangered (E), and Threatened (T), Species Occurring In Charleston County, South Carolina.**

West Indian manatee (Trichechus manatus) - E
Bald eagle (Haliaeetus leucocephalus) - E
Bachman's warbler (Vermivora bachmanii) - E
Wood stork (Mycteria americana) - E
Red-cockaded woodpecker (Picoides borealis) - E
Arctic peregrine falcon (Falco peregrinus tundrius) - T
Piping plover (Charadrius melodus) - T
Kemp's ridley sea turtle (Lepidochelys kempii) - E
Loggerhead sea turtle (Caretta caretta) - T
Leatherback sea turtle (Dermochelys coriacea) - E
Green sea turtle (Chelonia midas) - T
Shortnose sturgeon (Acipenser brevirostrum) - E
Canby's dropwort (Oxypolis canbyi) - E
Chaff-seed (Schwalbea americana) - E
Pondberry (Lindera melissifolia) - E
Sea-beach pigweed (Amaranthus pumilus) - T

FUTURE OF FISH AND WILDLIFE RESOURCES WITHOUT THE PROJECT

Threats to the above-described fish and wildlife resources of the Charleston Harbor area are primarily related to continued growth and development of the surrounding areas. Charleston's population is projected to increase by more than 50% from 500,000 to almost 800,000 over the next twenty years (Charleston Harbor Project, 1994). Direct loss of valuable aquatic and aquatic-related habitats from commercial and residential developments are not anticipated to be cumulatively significant due to in-place regulatory mechanisms and a public awareness of the value of these systems. However, increased population size is directly associated with increasing nutrient loads by increasing the demand for sewage treatment, industrial discharges, and stormwater runoff. The Charleston Harbor Project, funded by the National Oceanographic and Atmospheric Administration's Office of Coastal Resource Management through a Special Area Management Plan managed by the South Carolina Office of Ocean and Coastal Resource Management, has identified eutrophication as the most serious potential threat to the sustained health of the Charleston Harbor estuary (Charleston Harbor Project, 1994).

Such eutrophication could cause changes in dissolved oxygen levels and other water quality characteristics. This in turn could result in shifts in estuarine community structure affecting primary nursery areas and important feeding areas for many recreationally and commercially important species. Such trends could be controlled through careful planning, controlled growth, and control of both point and non-point discharges.

SELECTED PLAN AND ALTERNATIVES

As described in the Draft Feasibility Report for this project, the selected plan consists of deepening Charleston Harbor from 40 feet to 42 feet (minimum) or 45 feet (maximum) below mean low water with 2 feet of allowable overdepth and 2 feet of advance maintenance dredging (except for the entrance channel).

The navigation channel would be 800 feet in width seaward of the jetties and slope out to the 47 foot ocean contour. The channel would widen to 1000 feet just outside the jetties and return to an 800 foot width within the jetties, reducing further to 600 feet in width near Sullivan's Island. The width would remain at 600 feet for the rest of the federal navigation channel with the exception of the Daniel Island Reach which would vary from approximately 600 feet to 875 feet in width for proposed terminal access and the Horse and Shutes/Folly Reach where realignment to straighten the channel would result in a 900 to 1000 foot wide channel.

Dredged material from the deepening would be placed in existing upland disposal areas and at the Charleston ODMDS. Potential upland disposal sites include the Clouter Creek Disposal Site, the Daniel Island Disposal Site, the Navy Weapons Station Disposal site, the Drum Island Disposal Site and the Morris Island Disposal Site (see figure 2). Sediment chemistry and bioassay testing are planned to determine which material would be suitable for ocean disposal.

Project modifications which are proposed specifically to accommodate a new port facility at the southwest end of Daniel Island include: (1) construction of a 1000 foot long sheet pile contraction dike; (2) repairing two existing contraction dikes within their original footprint; (3) constructing an approximately 80 acre, 49 foot deep turning basin in subtidal bottoms; and (4) placement of approximately 3 million cubic yards of dredged material in the Clouter Island diked disposal area. As currently proposed, the new contraction dike would involve excavation of an 80 foot (bottom width) by -10 foot (MLW) canal through 300 feet of marsh, backfilling the excavated area with marl "crush and run" and rip-rap, constructing the sheet pile wall into the stone base, and restoring the excavated area to grade with excavated marsh materials.

Alternatives appear to be limited. A "no action" option would maintain the harbor at its previously authorized design depth of 40 feet plus 2 feet of allowable overdepth and 2 feet of advance maintenance (2+2). Depth options of 42 feet (and 2+2) to 45 feet (and 2+2) at one foot increments represent the primary alternatives considered with the exception of alternatives for material disposal. As described above these latter alternatives are limited to use of existing upland sites and/or the Charleston ODMDS. Some alternatives for the new contraction dike have been considered. As originally presented in the draft feasibility report, the contraction dike through marsh habitat was proposed as a solid fill marl causeway. Alternatives for location of the new terminal facility are not addressed in the study.

DESCRIPTION OF POTENTIAL IMPACTS

DREDGING IMPACTS

Loss of organisms at the dredge site results from physical removal by the dredge. Depending on the depth dredged, all or most of the resident organisms may be physically removed. Some studies indicate that benthic organisms will recolonize the dredge site (Allen and Hardy 1980). However, in a shipping channel, maintenance dredging of shoaling areas occurs at regular intervals, and may limit recovery of benthic populations. Van Dolah et al. 1990 found some evidence of reduced benthic populations in the Cooper River, which is more heavily developed for port and industrial activities, compared to the less developed Ashley River and Wando River. In the case of the project currently under consideration, most of the dredging would occur in current, deep, maintained channels. Therefore, in these areas, the post project conditions would be similar to pre-project conditions. However, conversion of shallow, soft

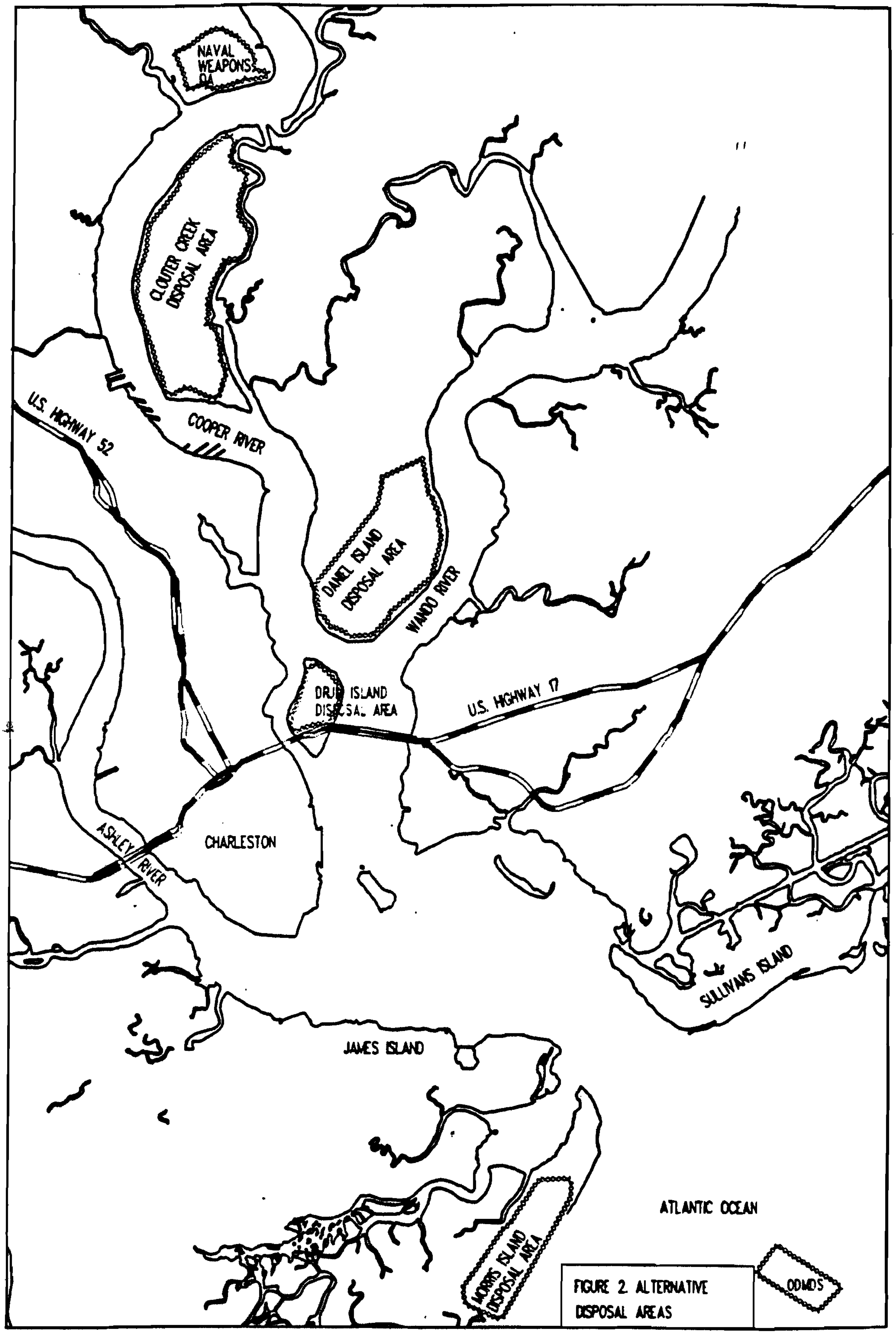

FIGURE 2. ALTERNATIVE DISPOSAL AREAS

bottom benthic faunal communities to deeper water disturbed communities is anticipated at the realignments for the Horse and Shutes/Folly Reaches and along the margins of the deepened channel whose top width will expand due to deepening. Additional conversions may occur with construction of a turning basin and docking accommodation at the site of the new ports terminal.

The impacts of dredging on the more motile components of the Charleston Harbor system will depend upon their ability to avoid the immediate vicinity of the dredge and their individual tolerance to suspended particles generated by dredge operation. Impacts on weaker larval and post-larval organisms which may be present in high concentrations during seasonal immigrations are expected to be greater. The ability of these less motile organisms to avoid dredge entrainment is questionable and suspended particles block gills and food filters of larval fish and invertebrates (Grant 1973). These phenomena are summarized by the U.S. Army Corps of Engineers, Charleston District (1978):

> *Action of the dredge cutterhead poses a threat of physical injury or mortality to any creature in its path. However, the mobility of fish populations enables them to avoid this danger, with the exception of weakly mobile embryonic or larval stages which are susceptible to adverse effects when they occur in the vicinity of dredging activity. Actual mortality of these early life forms in significant numbers is unlikely unless they occur in great density however.*

LaSalle (1991) suggests several key criteria in determining whether significant potential impacts may warrant establishment of a dredging "window". One key factor is whether site morphometry allows for organisms to bypass the dredge operation. Since immigration/emigration routes for important estuarine and marine organisms are not confined to the dredged channel area for much of Charleston Harbor, these effects are not likely to be significant. However, organism ingress/egress is largely confined to the dredged channel in the relatively narrow "throat" entrance to the harbor between the jetties and further investigation into a seasonal window for dredging in this area may be appropriate.

Potential water quality impacts at the dredging site include increased turbidity and oxygen demand, and release of contaminants and nutrients - particularly free sulfides, hydrogen sulfide, and ammonia. Good maintenance and dredging practices can limit water quality impacts of pipeline dredging. Overflow from hopper dredges can cause high turbidity levels (Allen and Hardy 1980).

In response to previous concerns relative to hydraulic modification from deepening the harbor channel potentially causing changes in circulation, sedimentation, and salinity patterns, a study was initiated by the Waterways Experiment Station of the Corps of Engineers. Although we have not reviewed the finalized study, our understanding is that modeling efforts have demonstrated no significant changes in these parameters of concern.

Dredging by hopper dredge in the outer entrance channel may result in the incidental take of threatened and endangered sea turtles. Such incidents have been well documented in the literature (Dickerson et al. 1991; National Marine Fisheries Service, 1991). Loggerhead (Caretta caretta) and Kemp's ridley (Lepdochelys kempi) turtles have been shown to frequent the Charleston Harbor entrance channel when water temperatures are above 16 degrees Celsius (Van Dolah et al. 1993). A seasonal window for hopper dredge operations may be necessary to avoid these impacts. It is our understanding that the Charleston District intends to comply with the dredging restrictions in the November 1991 National Marine Fisheries Service generic biological opinion on channel dredging which should serve to limit impacts on the turtles.

DISPOSAL IMPACTS

Loss of habitat at the dredged material disposal site has historically, and continues to be, one of the most obvious significant impacts of channel development. In Charleston Harbor approximately 6,300 acres of wetland habitat, primarily estuarine emergent habitat, has been lost. Deepening Charleston Harbor will require use of capacity in existing disposal areas including the Charleston ODMDS promoting additional pressures for development of new disposal areas.

Water quality may be affected by return waters from upland disposal sites. However, Charleston District reports two sampling events when the removal of suspended solids exceeded 99 percent. Rupture of disposal dikes at existing areas is relatively infrequent but could be disastrous for adjacent sensitive marsh and mudflat systems.

At open water disposal sites such as the ODMDS water quality impacts can be of concern due to the release of large amounts of dredged material into the water column. Recent baseline studies at the ODMDS which measured response of sponge respiration rates have shown that live bottom communities adjacent to fine material dumping sites can be adversely affected (Bob Van Dolah, SCDNR, personal communication). While following the current management plan for the ODMDS will limit such impacts, it may be important to include detailed monitoring of the fate and ecological effects of the materials disposed of at the ODMDS.

NEW CONTRACTION DIKE IMPACTS

This analysis is based on the current proposal (construction of a 1000 foot sheet pile structure). Most impacts relate to the construction of the sheet pile wall through the marsh rather than the physical presence of the wall itself. In consideration of sloughing and slope stabilization along the proposed 80 foot (bottom width) by 10 foot (MLW) deep excavated canal and deposition of excavated materials adjacent to the cut, an estimated 320 foot wide by 300 foot long (2.2 acre) marsh area would be affected. Provided that the marsh is successfully restored as proposed, these impacts may be relatively short-term (approximately four to five growing seasons). Degree of impact and recovery will be dependent upon sensitivity in design and implementation as well as careful monitoring and remediation if necessary of the marsh recovery.

SECONDARY (INDIRECT) IMPACTS

The primary purpose of the proposed deepening is to improve commercial navigation primarily for the port and port related industries. Expanded port facilities are important economically for the Charleston area. However, such expansions may result in physical impacts to fish and wildlife resources through direct and indirect affects on habitat and water quality. These impacts may take place at expanded port facilities such as the new container terminal proposed at Daniel Island or at associated industrial sites which are induced by the new or expanded port facilities.

Since the proposed project would use only existing dredged material disposal sites, direct affects of creating new or expanded sites for these purposes are absent. However, as mentioned earlier, use of existing capacity by this project may indirectly require creation of new or expanded disposal sites in the future. This is particularly true in light of the project's predicted increase in annual shoaling quantities of 780,000 cubic yards (Draft Feasibility Report, page 50).

COMPARISON OF IMPACTS OF ALTERNATIVE PLANS

As mentioned earlier, alternatives to the project are primarily limited to alternative depths. While the no action alternative would reduce or eliminate the impacts, maintenance of the currently authorized 40 foot deep channel with 2 feet of overdredging and 2 feet of advanced maintenance would still result in the class of impacts typical of dredge operations in shoal buildup areas.

Similarly, selection of a shallower depth alternatives, rather than the 45 foot alternative, would entail conversion of incrementally less undredged bottoms along the channel margins and generate a reduced amount of material to be disposed.

It is unclear how integrally related the dredging of the turning basin and construction of the compression dike for a new terminal at Daniel Island are to the project and planning alternatives. Should the terminal be located further up the Cooper River at the navy base, site specific impacts of the various options would have to be explored at that time.

RECOMMENDATIONS

Based on the projected impacts above, The Service recommends the following actions/plan modifications to reduce the potential impacts of the project on fish and wildlife resources.

1. Review through interagency committee (i.e., Corps, Service, SCDNR, NMFS) the necessity and particulars of a dredging window for the "throat" of the harbor entrance between the jetties. This process should start by utilizing the methodology described in LaSalle (1991) and concentrate on important windows for ingress and egress of key resources such as penaeid shrimp, blue crab, flounder, and red drum.

2. Establish a dredging window for hopper dredge work based on seasonally restricting work to periods when the water temperature is below 16 degrees Celsius. Coordinate with the National Marine Fisheries Service to implement this and any other necessary measures avoiding hopper dredging impacts to endangered sea turtles.

3. Dispose of suitable materials at the ODMDS in accordance with the signed management plan agreement. Also, in accordance with this plan, coordinate with appropriate agencies to plan for detailed monitoring of disposal operations which track the fate of the materials and their ecological effects (especially for large volumes of fine sediments).

4. Develop, in association with water quality agencies and resource agencies, a water quality management/monitoring plan. The plan should address potential harbor deepening water quality impacts, control measures, and monitoring both at the dredge sites and at disposal areas.

5. Avoid deepening any areas for which modeling indicates a high sedimentation rate.

6. Bulk sediment sampling should be conducted in accordance with the Ocean/Inland Testing Manuals for all areas with the exception of those which meet the exclusion criteria based on sediment grain size. The results of all sediment testing including the completed elutriate tests should be provided to the Service for review.

7. Conduct an alternatives analysis for the new contraction dike in the Cooper River. The analysis should, within engineering efficiency constraints, evaluate location, alignment, and construction alternatives consistent with reduction in impact on intertidal habitats, especially those vegetated with emergent marsh.

POSITION OF THE U.S. FISH AND WILDLIFE SERVICE

The direct impact areas for the proposed project are largely limited to areas already disturbed for these purposes (i.e., dredging and deepening existing deep navigation channels; disposing of materials in existing disposal areas). As a result, the project should not result in significant and unacceptable impacts to fish and wildlife resources provided that the Service's recommendations (above) are incorporated into the project. The Service favors the shallower 42 foot depth project because of reduced dredge activity and volume both initially and for future maintenance activities. This alternative should be selected over the 45 foot depth alternative unless there is an overriding economic justification for choosing the latter. Environmental documentation in compliance with the National Environmental Policy Act (NEPA) has not been initiated for the new port terminal facility. Therefore, the work proposed in accommodation of the proposed Daniel Island port terminal appears premature and predecisional relative to NEPA alternatives analyses for port location.

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Appendix A

FWCA Letters of Concurrence From the National Marine Fisheries Service and the South Carolina Department of Natural Resources

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9721 Executive Center Drive North
St. Petersburg, Florida 33702-2432

February 5, 1996

Mr. Roger Banks
Supervisor
Charleston Field Office
U.S. Fish and Wildlife Service
P.O. Box 12559
Charleston, South Carolina 29412

Dear Mr. Banks:

The National Marine Fisheries Service has reviewed the Fish and Wildlife Coordination Act Report on the Charleston Harbor Deepening Study. The report describes fish and wildlife resources in the study area, identifies potential effects on those resources, and provides recommendations for reducing possible impacts.

We concur with the findings made in your agency's report and we endorse implementation of the recommendations provided. By copy of this correspondence we hereby notify the Charleston District of their need to coordinate with our Protected Species Branch personnel concerning possible impacts to shortnose sturgeon and sea turtles. Related correspondence should be addressed to Mr. Charles Oravetz at the letterhead address.

We appreciate the opportunity to review the subject document.

Sincerely,

David H. Rackley

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

South Carolina Department of
Natural Resources

James A. Timmerman, Jr., Ph.D.
Director

February 22, 1996

Mr. Roger Banks
U.S. Fish & Wildlife Service
P.O. Box 12559
Charleston, SC 29422-2559

Dear Mr. Banks:

Personnel of the South Carolina Department of Natural Resources have reviewed the Fish and Wildlife Coordination Act Report on Charleston Harbor Deeping Study and concur in its findings and recommendations.

Sincerely,

Robert E. Duncan
Environmental Programs Director

Rembert C. Dennis Building • 1000 Assembly St • P.O. Box 167 • Columbia, S.C. 29202 • Telephone: 803/734-400
EQUAL OPPORTUNITY AGENCY
PRINTED ON RECYCLED PAPER

APPENDIX D

ENVIRONMENTAL CORRESPONDENCE

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

September 7, 1995

Mr. Richard Kimmel
U.S. Army Corps of Engineers
Wilmington District, Environmental Section
P.O. Box 1890
Wilmington, NC 28402-1890

Re: Underwater Archaeological Site Survey at Charleston Harbor, Charleston, South Carolina

Dear Mr. Kimmel:

Thank you for the opportunity to examine the final draft. Its contents appear to be consistent with state and federal guidelines for the identification and documentation of cultural resources.

We concur with the finding of the Corp's consulting archaeologist that targets FA-01 and CL-15 are not archaeological sites or cultural materials worthy of further investigation. Consequently, we have no objection to the proposed harbor and channel improvements anticipated by your office.

These comments have been provided to assist you with your responsibilities under Section 106 of the National Historic Preservation Act as amended. If you have any questions or comments regarding this matter, please contact me at 803\734-8478.

Sincerely,

Lee Tippett

Lee Tippett
Staff Archaeologist
State Historic Preservation Office

cc: Mr. Ralston Cox, Advisory Council
Mr. Jim Woody, SAC, U.S. Army Corps of Engineers

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

January 9, 1996

Lt. Col. Thomas F. Julich
District Engineer, Corps of Engineers
Charleston District
P. O. Box 919
Charleston, SC 29402-0919

Re: Charleston Harbor Deepening
Draft Feasibility Report and
Environmental Assessment

Attn.: Mr. Braxton Kyzer

Dear Col. Julich:

Thank you for your letter of January 2, 1996, and a copy of the "Draft Feasibility Report and Environmental Assessment for Charleston Harbor, South Carolina".

We have reviewed the sections that address cultural resources and have no additional comments.

We appreciate the opportunity to comment. If you have questions, please call me at 803/734-8615.

Sincerely,

Nancy Brock

Nancy Brock, Supervisor
Review and Compliance Branch
State Historic Preservation Office

South Carolina Department of
Natural Resources

James A. Timmerman, Jr., Ph.D.
Director
Alfred H. Vang
Deputy Director for
Water Resources

February 6, 1995

Ms. Robin Socha
EN-PR
Dept. of the Army
Charleston District, Corps of Engineers
P.O. Box 919
Charleston, SC 29402-0919

RE: Charleston Harbor Deepening Project

Dear Robin,

I have reviewed the 404(b)(1) Evaluation for the Charleston Harbor Deepening Project for any potential adverse impacts on underlying aquifers. The project involves deepening the Charleston Harbor from 40 feet to between 42 and 45 feet below mean low water.

According to SCDNR-WRD records, the top of the Cooper Formation lies between the approximate elevations of -10 and -60 feet mean sea level in the project area, with thickness varying from 200 to 260 feet. This formation acts as the upper confining layer to the Santee Limestone. The aquifers of the Santee Limestone and the underlying Black Mingo Formation contain salt water in the vicinity of Charleston Harbor.

In light of hydrogeologic conditions, no adverse impacts to aquifers are expected as a result of deepening Charleston Harbor by a maximum of five feet. Should you need additional information, please feel free to contact this office.

Sincerely,

Brenda L. Hockensmith P.G

Brenda L. Hockensmith, P.G.
Senior Hydrologist

cc: Rod Cherry, Section Chief
A. Drennan Park, Regional Hydrologist
file

South Carolina Department of
Natural Resources

James A. Timmerman, Jr., Ph.D.
Director

January 18, 1995

LTC George H. Hazel
District Engineer
U.S. Army Corps of Engineers
P.O. Box 919
Charleston, SC 29402-0919

REF: P/N 94-1R-498 - Charleston Harbor Deepening & Widening Project
Charleston County

Dear Colonel Hazel:

The South Carolina Department of Natural Resources has reviewed the above refenced public notice which proposes the deepening, widening and realignment of the federal navigation channel for Charleston Harbor, South Carolina.

The plan consists of deepening Charleston Harbor from the existing project depth of 40 feet to 42 feet as a minimum depth and 45 feet as a maximum depth below MHW with 2 feet of allowable overdepth and 2 feet of advance maintenance.

The navigation channel would be 800 feet wide beyond the jetties. Within the jetties the channel width would remain at 1000 feet, reducing to 600 feet wide near Sullivan's Island and remmaining at 600 feet wide for the remainder of the federal navigation project. The width of Daniel Island Reach would vary from approximately 875 feet to 600 feet for proposed terminal access. The entrance channel would extend to approximatly the 51 foot ocean contour. Channel realignment would include Horse Reach and Shutes Folly Reach to improve navigability

Dredged material is proposed to be placed in existing upland disposal areas and at the Charleston Ocean Disposal Site(ODMDS). Potential upland disposal sites include Clouter Creek Disposal Site, Daniel Island Disposal Site and Morris Island Disposal Site.

The U.S. Fish and Wildlife Service has submitted to you a comprehensive draft Fish and Wildlife Coordination Act Report on the project, dated December, 1994, which provides an overview of the possible impacts to fish and wildlife resources that might occur as a result of the project and recommendations of measures to provide for optimum protection of those resources.

The DNR was consulted during the preparation of the report and has reviewed it in detail. We concur with its findings and recommendations and request that they be accepted as the position of the Department of Natural Resources

Sincerely,

Robert E. Duncan
Environmental Programs Director

cc: OCRM/Moore
USFWS
USEPA
NMFS

South Carolina
DHEC
Department of Health and Environmental Control
2600 Bull Street, Columbia, SC 29201

Promoting Health, Protecting the Environment

Post-it® Fax Note 7671

Date 5-9-95	# of pages ▶ 2
To Robin Socha	From Heather Stalworth
Co./Dept. Corps	Co. DHEC
Phone #	Phone # 731-5301
Fax # 727-4260	Fax #

May 2, 1995

U.S. Army Corps of Engineers
Charleston District
P.O. Box 919
Charleston, SC 29402-0919

Re: Certification in Accordance with Section 401 of the Clean Water Act, as amended.

U.S. Army Corps of Engineers
Dredging
Charleston Harbor
Charleston County
P/N 94-1R-498

Dear Sir:

We have reviewed plans for this project and determined there is a reasonable assurance that the proposed project will be conducted in a manner consistent with the Certification requirements of Section 401 of the Federal Clean Water Act, as amended. In accordance with the provisions of Section 401, we certify that this project, subject to the indicated conditions, is consistent with applicable provisions of Sectio[illegible]3 of the Federal Clean Water Act, as amended. We also hereby certify that there are no applicable effluent limitations under Sections 301(b) and 302, and that there are no applicable standards under Sections 306 and 307.

This certification is subject to the following conditions:

1. Dredging must be limited, when possible, to the winter months when D.O. concentrations are highest and biological activity is lowest (Nov. 1 through Mar. 31).

2. Monitoring reports from the chosen disposal sites should be routinely submitted to the Department's Division of Water Quality for review.

The S. C. Department of Health and Environmental Control reserves the right to impose additional conditions on this Certification to respond to unforeseen, specific problems that might arise and to take any enforcement action necessary to ensure compliance with State water quality standards.

Sincerely,

Sally C. Knowles

Sally C. Knowles, Director
Division of Water Quality
and Shellfish Sanitation
Bureau of Water Pollution Control

SCK:HWS
cc: Army Corps of Engineers,
Charleston District
Trident District Office
OCRM

South Carolina
DHEC
artment of Health and Environmental Control
4130 Faber Place, Suite 300
Charleston, SC 29405

Office of Ocean and Coastal Resource Management
H. Wayne Beam, Ph.D., Deputy Commissioner
Christopher L. Brooks, Assistant Deputy Commissioner

(803) 744-5838
(803) 744-5847 (fax)

February 1, 1996

Mr. Richard M. Jackson, P. E.
Charleston District Corps of Engineers
Post Office Box 919
Charleston, South Carolina 29402-0919

Re: Amendment to Charleston Harbor
Deepening Widening Project
Charleston county
Federal Consistency

Dear Mr. Jackson:

The staff of the Office of Ocean and Coastal Resource Management (OCRM) certifies that the above referenced project is consistent with the Coastal Zone Management Program. This project approval is based upon revised plans submitted to SCDHEC/OCRM on January 31, 1996, and marked as such. Except as shown on these plans, no construction is to occur in any wetland areas. These plans do not include approval for construction of the proposed Daniel Island Terminal Facility.

Interested parties are provided ten days from receipt of this letter to appeal the action of the OCRM.

Sincerely,

Robert D. Mikell
Director of Planning and
Federal Certification

JHA
JHA/23197/jk

cc: Dr. H. Wayne Beam
Mr. Christopher L. Brooks
Mr. H. Stephen Snyder

South Carolina
DHEC
Department of Health and Environmental Control
4130 Faber Place, Suite 300
Charleston, SC 29405

Commissioner: Douglas E. Bryant

Board: Richard E. Jabbour, DDS, Chairman
Robert J. Stripling, Jr., Vice Chairman
Sandra J. Molander, Secretary

John H. Burriss
William M. Hull, Jr., MD
Roger Leaks, Jr.
Burnet R. Maybank, III

Promoting Health, Protecting the Environment

Office of Ocean and Coastal Resource Management

H. Wayne Beam, Ph.D., Deputy Commissioner
(803) 744-5838

Christopher L. Brooks, Assistant Deputy Commissioner
(803) 744-5847

March 10, 1995

LTC George H. Hazel
District Engineer
U. S. Army Corps of Engineers
Post Office Box 919
Charleston, South Carolina 29402-0919

Re: Charleston Harbor Deepening/
Widening Project
Charleston County
P/N# 94-1R-498
Federal Consistency

Dear Col. Hazel:

The Office of Ocean and Coastal Resource Management concurs with the recommendations of the U. S. Fish and Wildlife Service.

The staff of the Office of Ocean and Coastal Resource Management (OCRM) certifies that the above referenced project is consistent with the Coastal Zone Management Program to the maximum extent practicable. This certification shall serve as the final approval by the OCRM.

Interested parties are provided ten days from receipt of this letter to appeal the action of the OCRM. The action approved herein shall become final ten days from receipt of this letter provided no appeal is received.

Sincerely

H. Stephen Snyder

H. Stephen Snyder
Director of Coastal Zone
Management Division

JHA/21231/AB/jk
cc: Dr. H. Wayne Beam
Mr. Christopher L. Brooks
Mr. Robert D. Mikell
Mr. Ed Duncan
Ms. Sally Knowles
U. S. Environmental Protection Agency

recycled paper

Planning Branch

FEB 14 1995

Mr. Roger L. Banks
U.S. Fish and Wildlife Service
P.O. Box 12559
Charleston, South Carolina 29422-2559

Dear Mr. Banks:

The U.S. Army Corps of Engineers, Charleston District has reviewed the Draft Fish and Wildlife Coordination Act Report on the Charleston Harbor Deepening Study and offers the following comments on the report:

1. Page iii, second paragraph - The channel in the Cooper River to Goose Creek is generally 600 feet in width and the channel in the Wando River to the Wando terminal is 400 feet in width.

2. Page iii & iv - Service Recommendations

a. "Review through interagency committee (i.e., Corps, Service, SCDNR, NMFS) the necessity and particulars of a dredging window for the "throat" of the harbor entrance between the jetties. This process should start by utilizing the methodology described in LaSalle (1991) and concentrate on important windows for ingress and egress of key resources such as penaeid shrimp and red drum."

The deepening work in the entrance channel may be conducted in conjunction with maintenance contracts involving hopper or hydraulic dredges depending on the type of material that is scheduled to be dredged. Our office will review the LaSalle methodology in consideration of the recommended species.

b. "Prepare an analysis of the effect of the project on the provided endangered and threatened species list for Service and National Marine Fisheries Service concurrence."

Correspondence to complete the above is underway.

c. "Establish a dredging window for hopper dredge work based on seasonally restricting work to periods when the water temperature is below 16 degrees Celsius. Coordinate with the National Marine Fisheries Service to implement this and any other necessary measures avoiding hopper dredging impacts to endangered sea turtles."

A dredging window of December 1 to March 31 for avoidance of sea turtles is presently in place for hopper dredging and is adhered to by the Corps of Engineers (COE). However, the COE has spent $3.5 million on a turtle research program. A draghead that will prevent or significantly reduce entrainment of sea turtles by hopper dredges was developed. If these dragheads continue to function as expected and become available, they may be used in lieu of a dredging window, following coordination with state and federal resource agencies.

d. "Dispose of suitable materials at the ODMDS in accordance with the signed management plan agreement. Also, in accordance with this plan, coordinate with appropriate agencies to plan for detailed monitoring of disposal operations which track the fate of the materials and their ecological effects (especially for large volumes of fine sediments)."

A contract is presently underway to start testing the proposed dredged material to determine suitability for ocean disposal. This information will be available prior to any deepening. Because of the quantity of the material, it is expected that the deepening work will be conducted in conjunction with maintenance dredging contracts over a period of years. The Charleston District has a monitoring and management plan in place for the Charleston ODMDS that was written through coordination with a resource agency "task force". Intensive monitoring of the site has been conducted for the last two years and is continuing. Monitoring will continue as agreed upon in the management plan but will probably be modified with consideration given to the dredging project scope of work and the recommendations of the task force.

e. "Develop, in association with water quality agencies and resource agencies, a water quality management/monitoring plan. The plan should address potential harbor deepening water quality impacts, control measures, and monitoring both at the dredge sites and at disposal areas."

The 404(b)(1) for this project addresses impacts, minimization measures and discusses the monitoring of upland disposal sites as per agreement with the South Carolina Department of Health and Environmental Control (SCDHEC). Contracts for dredging activities address environmental issues as required by law, and COE Quality Assurance Personnel oversee the dredging contracts and inspect/monitor the dredging operations to ensure compliance. Monitoring/testing of effluent at the disposal areas will continue as per the agreement with SCDHEC.

f. "Avoid deepening any areas for which modeling indicates a high sedimentation rate."

The channel realignment was proposed in order to eliminate a navigation hazard - the sharp turn at Horse Reach and Shutes/Folly Reach, and to accommodate larger shipping traffic. It is possible that the realignment may cause additional shoaling which cannot be avoided, but unusually high sedimentation rates are not expected.

g. "Bulk sediment sampling should be conducted in accordance with the Ocean/Inland Testing Manuals for all areas with the exception of those which meet the exclusion criteria based on sediment grain size. The results of all sediment testing including the completed elutriate tests should be provided to the Service for review."

Total and dissolved modified elutriate tests have been performed in accordance with the Inland Testing Manual and using the methods developed by WES. These tests have been performed on material identified for placement in existing upland disposal areas as required by SCDHEC for Section 401 Water Quality Certification. Results of these analyses are enclosed. As noted in item 4. above, physical, chemical and biological testing of the proposed dredged sediments began in mid-January 1995, with initial results expected in March 1995. Results will be made available to anyone or any agency who requests the information.

3. Page 2 - Change 3000 cfs to 4500 cfs in the second full paragraph. Prior to implementation of the rediversion project in 1986, WES investigated various flow releases from Pinopolis Dam. The amount of 4500 cfs weekly average was recommended and has been in practice ever since the beginning of the project.

4. Page 3, Figure 1 - Label Morris Island and Mt. Pleasant.

5. Page 4, Existing Navigation Project - It should be noted that some changes were made to the authorized project as discussed below:

a. The turning basin diameter at the head of the Cooper River was enlarged to 1,400 feet.

b. The first tangent and the lower turning basin in Shipyard River were deepened to 38 feet. Deepening of the upper Shipyard River channel was deferred.

c. Widening about 2,000 feet of the upper Shipyard River Channel to 250 feet was deferred.

d. Enlargement of the two Shipyard River turning basins was deferred.

e. Enlarging and deepening the anchorage basin at the junction of the Cooper and Ashley Rivers to 40 feet was deferred.

f. The Columbus Street turning basin was relocated and enlarged to 1,400 feet.

6. Page 4, second to the last paragraph - Advance maintenance dredging is conducted prior to overdepth dredging. Please list advance maintenance before overdepth dredging in the report.

7. Page 6, last paragraph (3) - Models conducted by WES indicate that the deepening project will not cause any affects to the salinity distribution in the harbor.

8. Page 7, third paragraph (6) - As described in the public notice for 401 Water Quality Certification and in the 404(b)(1) Evaluation, this project does not address the impacts associated with new or expanded port facilities because the COE is not responsible for construction of port facilities. The South Carolina State Ports Authority will address impacts related to additional port facilities when the facility(s) and proposed location(s) are determined.

9. Page 8, middle of the third paragraph - The contractors are not "disposal" contractors, they are "dredging" contractors.

10. Page 8, last paragraph - The COE does not intend to develop any new upland disposal sites in the foreseeable future.

11. Page 9, first paragraph - Why would there be an increase in ocean derived sediments introduced into the harbor following the deepening project? Please explain.

12. Page 10, #4 - The COE has spent $3.5 million over the last few years on a turtle research study. A new draghead has been developed in an attempt to reduce/eliminate the impacts to sea turtles from hopper dredging. Additionally, the Charleston District has cooperated with the National Marine Fisheries Service in trawling prior to dredging, and in dredging only during the turtle "window". Other "measures" are not referenced in the report. What additional measures are needed?

13. Page 15, last paragraph -

a. The entrance channel will slope to the 47 foot contour (for the 45 foot project depth). No advance maintenance or overdepth will be applied.

b. Advance maintenance dredging is conducted prior to overdepth dredging. Please list advance maintenance before overdepth dredging in the report on pages 15 and 16.

c. Some minor changes in the project include:

(1). The channel approaching the jetties from the ocean is 800 feet in width. Just outside the jetties, the channel will widen to 1000 feet, returning to 800 feet within the jetties and further reducing in width to 600 feet near Sullivan's Island.

(2). There are no further changes in the channel width for the remainder of the project. The channel ranges from 500 to 800 feet in width with two exceptions. The Daniel Island Reach will vary from approximately 600 feet to 875 feet in width for proposed terminal access, and the Horse Reach and Shutes/Folly Reach, where realignment is proposed, will be 900 feet to 1000 feet in width.

14. Page 16, first paragraph - Upland disposal for the dredged material include the Navy Weapons Station Disposal Area and Drum Island Disposal Area.

15. Page 16, third paragraph - It should be noted that the entire channel is not dredged during maintenance dredging. Maintenance dredging is relatively site specific with dredging being conducted in the same locations where shoals reoccur. As a result, benthic organisms throughout the entire channel are not impacted.

16. Page 20, Recommendations - these are addressed at the beginning of this comment letter.

17. As a general comment, project depths considered for the study range from 42 feet mlw to 45 feet mlw at one foot increments. A 42 foot channel and a 45 foot channel are not the only two designs considered, they are the limits of depths being considered for this study.

18. Lastly, the correspondence from your office dated December 20, 1994 was in response to public notice 94-1R-498 for the deepening project. Your correspondence was apparently copied to the South Carolina Department of Health and Environmental Control, Office of Ocean and Coastal Resource Management and to the Office of Water Quality Certification. My office has received telephone calls from both offices requesting our response to your correspondence. A letter response for a federal project is unnecessary when a Fish and Wildlife Coordination Act Report from your office is required by law. The Coordination Act Report provides the required response to the public notice. Furthermore, a draft report should be received by our office with sufficient time to review, comment and receive a final document prior to issuance of information within the document to other agencies. We would appreciate your consideration of this in the future.

19. We appreciate the effort involved in the development of the Coordination Act Report for this project and look forward to receiving the final document. If you have any further questions, please contact Robin Coller-Socha at 803/727-4696.

Respectfully,

GEORGE H. HAZEL
Lieutenant Colonel, U.S. Army
District Engineer

Enclosure

C-SOCHA/4696/K
PREACHER/EN-PR
JACKSON/EN-
KYZER/PM-
HERNDON/D
WATERS/EN
HAZEL/D

February 5, 1996

Planning Branch

Mr. Roger L.Banks
U.S. Fish and Wildlife Service
P.O. Box 12559
Charleston, South Carolina 29422-2559

Dear Mr. Banks:

The U.S. Army Corps of Engineers, Charleston District has reviewed the Fish and Wildlife Coordination Act Report on the Charleston Harbor Deepening Study and offers the following responses to your recommendations on page 21:

1. Review through interagency committee (i.e., Corps, Service, SCDNR, NMFS) the necessity and particulars of a dredging window for the "throat" of the harbor entrance between the jetties. This process should start by utilizing the methodology described in LaSalle (1991) and concentrate on important windows for ingress and egress of key resources such as penaeid shrimp, blue crab, flounder, and red drum.

Response - Dredging in Charleston Harbor is currently restricted to a winter window for hopper dredging which is in accordance with a NMFS Biological Opinion to protect endangered sea turtles. Hydraulic dredging has never been restricted to a window because the impacts are insignificant and short- term. Consequently, the Charleston Harbor channel deepening and turning basin excavation will be conducted in conjunction with standard dredging maintenance protocol. Dredging between the jetties will continue to be accomplished with a hopper dredge, and therefore, would be restricted to a winter window.

2. Establish a dredging window for hopper dredge work based on seasonally restricting work to periods when the water temperature is below 16 degrees Celsius. Coordinate with the National Marine Fisheries Service to implement this and any other necessary measures avoiding hopper dredging impacts to endangered sea turtles.

Response - The Corps South Atlantic Division has recently completed Section 7 coordination with the NMFS to protect endangered sea turtles from the effect of hopper dredging. This coordination included several years of specific studies to determine the most effective method/methods to protect sea turtles. An incidental take limit was established by the NMFS with Reasonable and Prudent Measures to insure that the take is not exceeded. The Reasonable and Prudent Measures include a winter season window (when the water temperature is most often below 16 degrees Celsius), a newly designed drag arm head, and an observer program to monitor the dredge overflow screens.

3. Dispose of suitable materials at the ODMDS in accordance with the signed management plan agreement. Also, in accordance with this plan, coordinate with appropriate agencies to plan for detailed monitoring of disposal operations which track the fate of the material and their ecological effects (especially for large volumes of fine sediments).

Response - All dredged material will be tested to determine suitability for ocean disposal prior to any deepening work. The Charleston District has a monitoring and management plan in place for the Charleston ODMDS that was written through coordination with a resource agency "task force". Intensive monitoring of the site has been conducted for the last two years and is continuing. Monitoring will continue as agreed upon in the management plan but will probably be modified with consideration given to the dredging project scope of work and the recommendations of the task force.

4. Develop, in association with water quality agencies and resource agencies, a water quality management/ monitoring plan. The plan should address potential harbor deepening water quality impacts, control measures, and monitoring both at the dredged sites and at disposal areas.

Response - The 404(b)(1) for this project addresses impacts, minimization measures and discusses the monitoring of upland disposal sites as per agreement with the South Carolina Department of Health and Environmental Control (SCDHEC). Contracts for dredging activities address environmental issues as required by law, and COE Quality Assurance personnel oversee the dredging contracts and inspect/monitor the dredging contracts and inspect/monitor the dredging operations to insure compliance. Monitoring /testing of effluent at the disposal area will continue as per the agreement with SCDHEC.

5. Avoid deepening any area for which modeling indicates a high sedimentation rate.

Response - Channel realignment at Horse Reach and Shutes/Folly Reach were proposed in order to eliminate navigation hazards and to accommodate larger shipping. The turning basin is necessary to allow ships a safe area to turn around. The proposed location of the contraction dike will reduce shoaling in the Daniel Island reach by almost 50%. It is possible that the realignment may cause additional shoaling which cannot be avoided, but unusually high sedimentation rates are not expected in either the realignments or the turning basin.

6. Bulk sediment sampling should be conducted in accordance with the Ocean/ Inland Testing Manuals for all areas with the exception of those which meet the exclusion criteria based on sediment grain size. The results of all sediment testing including the completed elutriate tests should be provided to the Service for review.

Response - Total and dissolved modified elutriate tests have been performed in accordance with the Inland Testing Manual and using the methods developed by The Waterways Experiment Station (the turning basin area is currently being tested). These tests have been or are being performed on material identified for placement in existing upland disposal areas as required by SCDHEC for Section 401 Water Quality Certification. Result from testing is available or will be available to any agency who requests the information.

7. Conduct an alternative analysis for the new contraction dike in the Cooper River. The analysis should, within engineering efficiency constraints, evaluate location, alignment, and construction alternatives consistent with reduction in impact on intertidal habitat, especially those vegetated with emergent marsh.

Response - A model of this project including the location of the contraction dike was prepared by The Waterways Experiment Station (WES). The contraction dike was located by WES with consideration given to navigation safety, location of the proposed turning basin, and location of an existing degaussing pier. However, shoaling reduction was the prime purpose for the location. The proposed location of the contraction dike located as it is will reduce shoaling in the Danial Island reach by almost 50 %. All marsh effected will, upon completion of the dike, be restored to its natural productive state (this is addressed in the Project Environmental Assessment).

I appreciate the effort involved in the development of the Coordination Act Report for this project. If you have any further questions, please contact Mr. Jim Woody of my staff at (803) 727-4759.

Respectfully,

Richard M. Jackson, P.E.
Acting Chief, Engineering and Planning
Division

WOODY/4759/KH

K.HARRIS/EN-P

PREACHER/EN-PR

DENN/EN-PH

CASBEER/EN-PE

JACKSON/A-EN

United States Department of the Interior

FISH AND WILDLIFE SERVICE
P.O. Box 12559
217 Fort Johnson Road
Charleston, South Carolina 29422-2559

February 5, 1996

Lt. Colonel Thomas F. Julich
District Engineer
U.S. Army Corps of Engineers
P.O. Box 919
Charleston, S.C. 29402-0919

Re: Charleston Harbor Deepening Project, FWS Log No. 4-6-96-116

Dear Colonel Julich:

The U.S. Fish and Wildlife Service has reviewed planned modifications to the above-referenced project relative to potential effects on endangered species. The modifications include refurbishment of two existing contraction dikes and construction of a new contraction dike and turning basin all in association with a proposed new Daniel Island ports terminal.

We have reviewed the January 31, 1996 letter from Mr. Richard M. Jackson of your Planning Branch wherein the District's Biological Assessment that none of the listed species potentially occurring in the project area would be effected by the deepening project is expanded to include the above project modifications. Based on our review of the modifications, we will concur with a determination that this action is not likely to adversely affect federally listed endangered and threatened species. In view of this, we believe that the requirements of Section 7 of the Endangered Species Act have been satisfied. However, obligations under Section 7 of the Act must be reconsidered if (1) new information reveals impacts of this identified action that may affect listed species or critical habitat in a manner not previously considered, (2) this action is subsequently modified in a manner which was not considered in this assessment, or (3) a new species is listed or critical habitat determined that may be affected by the identified action.

Your interest in ensuring the protection of endangered and threatened species is appreciated.

Sincerely yours,

Steven S. Gilbert
Acting Field Supervisor

\SG

January 31, 1996

Planning Branch

Mr. Roger L. Banks, Field Supervisor
US Fish and Wildlife Service
PO Box 12559
Charleston, South Carolina 29412

Dear Mr. Banks:

The purpose of this letter is to advise you of modifications being planned for the Charleston Harbor deepening project. The modifications include refurbishment of two existing contraction dikes and construction of a new contraction dike and turning basin. The refurbishment of existing dikes and construction of the new contraction dike are necessary to reducing shoaling in the Daniel Island reach by 50% (See figures 1 and 2).

The existing contraction dikes proposed for refurbishment lie on the west side of the Cooper River, downstream of Shipyard River and upstream of the U.S. Navy degaussing pier. The proposed new contraction dike will be located approximately 150 feet upstream of the U.S. Navy degaussing pier, between the two existing contraction dikes. Marl from the deepening project will be used to provide a foundation base for the proposed dike. Approximately 180,000 cubic yards of marl will be placed as a base with a 12-inch foundation blanket equaling 4000.cubic yards of 6-inch to 12-inch stone . Sheet piling will be sunk into the base marl and foundation stone. The dike will be approximately 1000 feet in length, 300 feet of which is vegetated wetlands on the shoreward end. After excavation and construction of the dike is completed, the effected marsh will be restored on each side of the dike to its original elevation so that marsh grasses will reestablish. The extreme shoreward end of the dike, where it ties into upland will require riprap to prevent scouring. Approximately 800 sq. ft. of emergent wetland will be covered over by this riprap tie-back. Repairs to the two existing dikes will take place within their existing footprint. In addition to the contraction dikes, a turning basin located north of Shipyard River and south of the existing contraction dike (see figure 2) is proposed for construction. The turning basin will be deepened to the same depth as Charleston Harbor which is 49 feet including maintenance and overdepth. Material from the turning basin (3 million cubic yards) will be placed in a diked disposal area. The total area of benthic impact will be approximately 80 acres.

A list of endangered and threatened species which could be impacted by the Charleston Harbor deepening project was received from your office on January 23, 1995. It is assumed that this list has not changed. On January 30, 1995, you concurred with the District's Biological Assessment that none of the listed species would be effected by the deepening project if "standard manatee conditions for use during construction of a project" would be implemented. We believe that the modifications described above also would not affect any of the listed species and further believe that reinitiating consultation under the Endangered Species Act for the modifications is unnecessary, provided all conditions of the original concurrence are met.

We request your concurrence with this letter. Should you have any additional questions regarding the project, please contact Mr. Jim Woody of my staff at (803) 727-4759.

Respectfully,

Richard M. Jackson, P.E.
Chief, Planning Branch

Enclosures

WOODY/4759/KH

K.HARRIS/EN-P

PREACHER/EN-PR

JACKSON/EN-P

February 2, 1996

Planning Branch

Mr. Andreas Mager, Jr.
Assistant Regional Director
National Marine Fisheries Service
9721 Executive Center Drive N.
St. Petersburg, Florida 33702

Dear Mr. Mager:

This is in response to your letters dated 5 December 1995, commenting on the Draft Feasibility Report and Draft Environmental Assessment for the Charleston Harbor Deepening Project, and another dated 18 January 1996, commenting on a District Public Notice (95-1R- 406). The Public Notice was issued as an amendment to the original plan described in the Draft Feasibility Report. These letters identified several areas of concern to the NMFS which I am responding to.

December 5, 1995 Letter

Comment 1. - Atlantic Sturgeon and Shortnose Sturgeon should be added to the final Report.

Response - Agree, these sturgeon will be included in the final report.

Comment 2. - Details are needed concerning the composition of benthic communities to be affected by contraction dike repairs and construction, and construction of the Danial Island turning basin. If sampling of these communities is not planned, then relevant data and conclusions used in your analysis should be provided.

Response - The most recent study conducted on Charleston Harbor benthos was conducted in 1990 by the Marine Resources Division of the South Carolina Department of Natural Resources (A Physical and Ecological Characterization of the Charleston Harbor Estuarine System). This study included benthic sampling at several stations near the proposed turning basin and contraction dike and indicates that water quality and toxic sediments have a greater effect on benthic organisms than dredging. Additional studies conducted over the years by the Army Corps of Engineers, Charleston District and Waterway Experiment Station have specifically shown that the most significant impacts of hydraulic dredging is the distruction of benthic invertebrates in the path of the dredge cutterhead. These studies have also shown that channel dredging has very little long term effects on the health, number and diversity of Harbor benthic resources.

The greatest concentration of benthic invertebrates in the Charleston Harbor estuary occur in and around salt marshes in lieu of the deeper channel. The specific areas identified for the new contraction dike and turning basin, however, contain no shellfish beds or communities. Common invertebrates in the vicinity of the proposed contraction dike include fiddler crabs and the common marsh periwinkle snails. Construction of the turning basin will cause destruction of benthos in the immediate vicinity of the cutterhead. Benthos not trapped by the cutterhead will be displaced to shallow bottoms. Deepening in the present navigation channel, where maintenance of recurring shoals are dredged on a 12 to 18 month rotation, is not expected to significantly effect Harbor benthic resources. Scientific studies have repeatedly shown a short-term rate for recovery of benthos following dredging operations, provided water quality and bottom sediment are free of pollutants.

Comment 3. - " details regarding proposed creation of regularly flooded wetlands, as needed to offset areas affected by the proposed contraction dike are needed. For example, the approximate size, location, and work completion date for the mitigation".

Response - The new contraction dike which was originally designed with a causeway filling approximately 2 acres of salt marsh has been redesigned. The new design does not include a causeway or subsequent wetland fill, but will allow the effected salt marsh to be restored to its original elevation and productivity. This new design will be clarified in the final report and EA.

Comment 4. - Coordinate the present plan with NMFS Protected Species Branch.

Response - Coordination of the final report with NMFS Protected Species Branch was initiated on January 31, 1996.

January 18, 1996 Letter

Comment 1. - Restriction of all work involving excavation and filling of aquatic habitats to periods of low biological activity. This would limit such work to December 1 through March 15 of any year.

Response - Dredging in Charleston Harbor is currently restricted to a winter window for hopper dredging which is in accordance with a NMFS Biological Opinion to protect endangered sea turtles. Hydraulic dredging has never been restricted to a window because the impacts are insignificant and short-term. Consequently, the Charleston Harbor channel deepening and turning basin excavation will be conducted in conjunction with maintenance contracts. The U.S. Fish And Wildlife Service Coordination Act report recommended "a review through interagency committee the necessity and particulars of a dredging window for the "throat" of the harbor entrance between the jetties". Dredging between the jetties would be accomplished with a hopper dredge and, therefore, restricted to a winter window.

Comment 2. - Assessment of the location and size of shellfish beds (if any) in the vicinity of all proposed excavation and fill activities.

Response - There are no identified shellfish beds in areas of the harbor proposed for this project.

Comment 3. - Avoidance to the extent practicable, of the loss and degradation of productive shellfish (hard clam) beds, intertidal habitats, and emergent wetlands.

Response - This project will be designed in its final phase to employ "avoidance techniques" where practicable.

Comment 4. - Development of remedial measures needed to off set unavoidable wetland and aquatic resource impacts.

Response - See comment 3 and response under the December 5 letter above.

Thank you for your willingness to cooperate with the Charleston District in the design of this project to insure that project purposes are met and South Carolina's natural resources are sufficiently protected. If you should have questions, please contact Mr. Jim Woody of my staff at (803) 727-4759.

Respectfully,

Richard M. Jackson, P.E.
Chief, Planning Branch

WOODY/4759/KH

K.HARRIS/EN-P

DENN/EN-PH

PREACHER/EN-PR

CASBEER/EN-PE

JACKSON/EN-P

EN

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9721 Executive Center Drive N.
St. Petersburg, Florida 33702

December 5, 1995

Lt. Colonel Thomas F. Julich
District Engineer, Charleston District
U.S. Army Corps of Engineers
P.O. Box 919
Charleston, South Carolina 29402-0919

Dear Colonel Julich:

The National Marine Fisheries Service has reviewed the Draft Feasibility Report and Draft Environmental Assessment (DEA) for the Charleston Harbor Deepening Project, Charleston County, South Carolina. Based on the information contained in these documents, we generally concur with your determination that long-term adverse impacts to living marine resources are unlikely. In making this determination, we note that planned improvement of existing contraction dikes; construction of a third contraction dike; and excavation of the Daniel Island turning basin have been recently proposed and are only briefly addressed in the DEA. Since details regarding the environmental consequences of these additional features will be provided in the final environmental document, additional comments may be forthcoming.

Specific comments

Draft Feasibility Report

Page 15, Paragraph 1. Atlantic sturgeon (*Acipenser oxyrhynchus*) and shortnose sturgeon (*Acipenser brevirostrum*) have been reported from the Cooper and Ashley Rivers and should be included in the list of anadromous fish provided in this section.

Draft Environmental Assessment

Page 6, first paragraph. Details are needed concerning the composition of benthic communities to be affected by constriction dike repairs and construction, and construction of the Daniel Island turning basin. If sampling of these communities is not planned, then relevant data and conclusions used in your analysis should be provided.

Page 7, last paragraph. Details regarding proposed creation of regularly flooded wetlands, as needed to offset areas affected by the proposed constriction dike, are needed. For example, the approximate size, location, and work completion date for the mitigation should be provided.

Finally, we note that while coordination with our Protected Species Branch has been performed, it preceded the present plan of action. As appropriate, you should inform the Branch of changes that may affect endangered or threatened species or their habitat.

We appreciate the opportunity to provide these comments.

Sincerely,

Andreas Mager, Jr.
Assistant Regional Director
Habitat Conservation Division

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9721 Executive Center Drive North
St. Petersburg, Florida 33702-2432

January 18, 1996

Lt. Colonel Thomas F. Julich
District Engineer, Charleston District
Department of the Army, Corps of Engineers
P.O. Box 919
Charleston, South Carolina 29402-0919

Dear Colonel Julich:

The National Marine Fisheries Service (NMFS) has reviewed Public Notice 95-1R-406 which announces addition of components to the Corps of Engineers' Charleston Harbor Deepening Project, Charleston County, South Carolina. The NMFS provided comments on the overall project and the Draft Environmental Assessment in our letter dated December 5, 1995. Planned additional work includes refurbishing of two existing contraction dikes; construction of a third contraction dike; and excavation of a ship turning basin. Planned activities would occur in waters of the Cooper River (Charleston Harbor) and involve:

- Construction of a 300-foot-long solid-fill marl causeway and 700-foot-long sheet-pile dike covering approximately 2 acres of regularly flooded wetlands and 4 acres of intertidal and subtidal unconsolidated estuarine bottom.
- Construction of an 80-acre (approximate) by 49-foot-deep ship turning basin in submerged bottom.
- Placement of 3 million cubic yards of dredged material in the Clouter Island diked disposal site.

Three distinct aquatic zones -- unconsolidated deepwater bottom, intertidal flats, and emergent wetlands would be affected by the additional work. Unconsolidated deep-water bottoms in the vicinity of Charleston Harbor generally do not support large populations of commercially or ecologically important benthic organisms. Possible exceptions include bivalves such as hard clams (Mercenaria mercenaria); transitory invertebrates such as blue crabs (Callinectes sapidus) and shrimp (Penaeus spp.); and demersal fish such as summer flounder (Paralichthys dentatus).

Intertidal sand and mud flats generally provide more suitable habitat for living marine resources. Conditions such as shallow water depth and exposure to sunlight favor fish nursery functions and increased food production. The intertidal flats of the Cooper

River are recognized as important sites for the growth and maturation of a large and diverse group of fish and invertebrates that are of ecological and economic importance.

The regularly flooded smooth cordgrass (*Spartina alterniflora*) marsh is a highly productive resource. Its use as forage, cover, and reproductive sites for a variety of living marine resources is also well established. The tidal marsh also has considerable value with regard to estuarine food production and water quality enhancement as provided through erosion abatement, sediment retention, and assimilation of excess nutrients and pollutants.

Based on the ecological and economic value of the aquatic areas that will be affected by the proposed action, impact avoidance, minimization, and mitigation are needed to preclude significant degradation of living marine resources. Needed measures, which are hereby provided in accordance with provisions specified the Fish and Wildlife Coordination Act, include:

1. Restriction of all work involving excavation and filling of aquatic habitats to periods of low biological activity. This would limit such work to December 1 through March 15 of any year;

2. Assessment of the location and size of shellfish beds (if any) in the vicinity of all proposed excavation and fill activities;

3. Avoidance, to the extent practicable, of the loss and degradation of productive shellfish (hard clam) beds, intertidal habitats, and emergent wetlands; and

4. Development of remedial measures needed to offset unavoidable wetland and aquatic resource impacts.

In the absence of these measures we conclude that a significant and unacceptable loss of high quality public trust resources will occur and these elements of the overall Charleston Harbor Deepening Project should not be implemented. The NMFS is willing to cooperate with the Charleston District in the design of project features needed to ensure that project purposes are met and South Carolina's aquatic resources are sufficiently protected. Mr. David Rackley of my staff is available to assist you in this regard. He may be reached at P.O. Box 12607, Charleston, South Carolina 29412, or at (803) 762-8574.

Sincerely,

David H. Rackley

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

JAN 0 5 1995

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9721 Executive Center Drive North
St. Petersburg, Florida 33702-2432

December 29, 1994

Lt. Colonel George H. Hazel
District Engineer, Charleston District
Department of the Army, Corps of Engineers
P.O. Box 919
Charleston, South Carolina 29402-0919

Dear Colonel Hazel:

The National Marine Fisheries Service (NMFS) has reviewed Public Notice 94-1R-498 which advertises new work by the Charleston District, Corps of Engineers, in association with the Charleston Harbor Deepening and Widening Project in Charleston and vicinity, South Carolina.

Comments provided in the U.S. Fish and Wildlife Service's December 20, 1994, response to the Public Notice and in their detailed Fish and Wildlife Coordination Act report were prepared in close coordination with the NMFS. A copy of their December 20, 1994, report is enclosed. We fully concur with the enclosed comments and recommendations and we request that they also be considered as the views and recommendations of the NMFS.

We appreciate the opportunity to provide these comments. Related questions should be directed to the attention of David Rackley at (803) 762-8574.

Sincerely,

David D. Rackley

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

EN-PR

C'1 DEC 27 1994

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9721 Executive Center Drive North
St. Petersburg, Florida 33702-2432

December 20, 1994

Mr. Roger Banks
Supervisor
Charleston Field Office
U.S. Fish and Wildlife Service
P.O. Box 12559
Charleston, South Carolina 29412

Dear Mr. Banks:

The National Marine Fisheries Service has reviewed the Draft Fish and Wildlife Coordination Act Report on the Charleston Harbor Deepening Study. The report describes fish and wildlife resources in the study area, identifies potential effects on those resources, and provides recommendations for reducing possible impacts.

We concur with the findings made in your agency's report and we endorse implementation of the recommendations provided. By copy of this correspondence we hereby notify the Charleston District of their need to coordinate with our Protected Species Branch personnel concerning possible impacts to shortnose sturgeon and sea turtles. Related correspondence should be addressed to Mr. Charles Oravetz at the letterhead address.

We appreciate the opportunity to review the subject document and we request that our comments be compiled into your final report to the Charleston District. Related questions should be directed to the attention of David Rackley at (803) 762-8574.

Sincerely,

David D. Rackley

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

January 31, 1996

Planning Branch

Mr. Charles A. Oravetz
Chief, Protected Species Management Branch
National Marine Fisheries Service
9450 Koger Boulevard
St. Petersburg, Florida 33702

Dear Mr. Oravetz:

The purpose of this letter is to advise you of modifications being planned for the Charleston Harbor deepening project. The modifications include refurbishment of two existing contraction dikes and construction of a new contraction dike and turning basin. The refurbishment of existing dikes and construction of the new contraction dike are necessary to reducing shoaling in the Daniel Island reach by 50% (See figures 1 and 2).

The existing contraction dikes proposed for refurbishment lie on the west side of the Cooper River, downstream of Shipyard River and upstream of the U.S. Navy degaussing pier. The proposed new contraction dike will be located approximately 150 feet upstream of the U.S. Navy degaussing pier, between the two existing contraction dikes. Marl from the deepening project will be used to provide a foundation base for the proposed dike. Approximately 180,000 cubic yards of marl will be placed as a base with a 12-inch foundation blanket equaling 4000 cubic yards of 6-inch to 12-inch stone . Sheet piling will be sunk into the base marl and foundation stone. The dike will be approximately 1000 feet in length, 300 feet of which is vegetated wetlands on the shoreward end. After excavation and construction of the dike is completed, the effected marsh will be restored on each side of the dike to its original elevation so that marsh grasses will reestablish. The extreme shoreward end of the dike, where it ties into upland will require riprap to prevent scouring. Approximately 800 sq. ft. of emergent wetland will be covered over by this riprap tie-back. Repairs to the two existing dikes will take place within their existing footprint. In addition to the contraction dikes, a turning basin located north of Shipyard River and south of the existing contraction dike (see figure 2) is proposed for construction. The turning basin will be deepened to the same depth as Charleston Harbor which is 49 feet including maintenance and overdepth. Material from the turning basin (3 million cubic yards) will be placed in a diked disposal area. The total area of benthic impact will be approximately 80 acres.

A list of endangered and threatened species which could be impacted by the Charleston Harbor deepening project was received from your office on January 11, 1995. It is assumed that this list has not changed. On March 6,1995, you concurred with the District's Biological Assessment that none of the listed species would be effected by the deepening project if it was constructed in accordance with a previously coordinated Biological Opinion prepared by your office for hopper dredging. We believe that the modifications described above also would not affect any of the listed species and further believe that reinitiating consultation under the Endangered Species Act for the modifications is unnecessary.

We request your concurrence with this letter. Should you have any additional questions regarding this project, please contact Mr. Jim Woody of my staff at (803) 727-4759.

Respectfully,

Richard M. Jackson, P.E.
Chief, Planning Branch

Enclosures

WOODY/4759/KH

K.HARRIS/EN-P

PREACHER/EN-PR

JACKSON/EN-P

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

Southeast Regional Office
9721 Executive Center Drive N.
St. Petersburg, FL 33702

F/SEO13:JEB

FEB 7 1996

Mr. Richard M. Jackson
Chief, Planning Branch
Charleston District
U.S. Army Corps of Engineers
P.O. Box 919
Charleston, SC 29402-0919

Dear Mr. Jackson:

This responds to your letter dated January 31, 1996, regarding a modification to the deepening project for the Charleston Harbor channel and the Shipyard River entrance channel. The original project was determined to not adversely affect threatened or endangered species, if carried out in accordance with the generic opinion with the Corps of Engineers on dredging in the Southeast United States. The modifications to the project include refurbishment of two existing contraction dikes and construction of a new contraction dike and turning basin. A biological assessment was submitted pursuant to Section 7 of the Endangered Species Act of 1973 (ESA).

We have reviewed the modifications to this project and concur with your determination that populations of threatened or endangered species under our purview would not be adversely affected by the proposed action or the modifications provided that all dredging is carried out in accordance with the August 25, 1995 generic biological opinion on dredging in the Southeast U.S. along the Atlantic coast.

This concludes consultation responsibilities under Section 7 of the ESA. However, consultation should be reinitiated if new information reveals impacts of the identified activity that may affect listed species or their critical habitat, a new species is listed, the identified activity is subsequently modified, or critical habitat is determined that may be affected by the proposed activity.

If you have any questions please contact Jeffrey Brown, Fishery Biologist, at (813) 570-5312.

Sincerely,

Andrew J. Kemmerer
Regional Director

cc: F/PR2
F/SEO2

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9721 Executive Center Drive N.
St. Petersburg, FL 33702

March 6, 1995 F/SEO13:JEB

Thomas W. Waters
Chief
Engineering and Planning Division
U.S. Army Corps of Engineers
P.O. Box 919
Charleston, SC 29402-0919

Dear Mr. Waters:

This responds to your letter dated January 25, 1995, regarding deepening the Charleston Harbor channel and Shipyard River entrance channel, from 40 and 38 feet respectively, to 42 feet below mean low water with 2 feet of allowable depth and 2 feet of advance maintenance. A biological assessment was submitted pursuant to Section 7 of the Endangered Species Act of 1973 (ESA) in [illegible]1 prior to the issuance of a generic biological opinion on channel dredging along the Atlantic coast of the Southeast United States.

We have reviewed this project and concur with your determination that populations of threatened or endangered species under our purview would not be adversely affected by the proposed action provided that all dredging is carried out in accordance with the November 1991 biological opinion.

This concludes consultation responsibilities under Section 7 of the ESA. However, consultation should be reinitiated if new information reveals impacts of the identified activity that may affect listed species or their critical habitat, a new species is listed, the identified activity is subsequently modified, or critical habitat is determined that may be affected by the proposed activity.

If you have any questions please contact Jeffrey Brown, Fishery Biologist, at (813) 570-5312.

Sincerely,

Andrew J. Kemmerer
Regional Director

cc: F/PR2
F/SEO2

Endangered and Threatened Species and Critical Habitats Under NMFS Jurisdiction

South Carolina

Listed Species	Scientific Name	Status	Date Listed
finback whale	*Balaenoptera physalus*	E	12/02/70
humpback whale	*Megaptera novaeangliae*	E	12/02/70
right whale	*Eubaleana glacialis*	E	12/02/70
sei whale	*Balaenoptera borealis*	E	12/02/70
sperm whale	*Physeter catodon*	E	12/02/70
green sea turtle	*Chelonia mydas*	Th	07/28/78
hawksbill sea turtle	*Eretmochelys imbricata*	E	06/02/70
Kemp's (Atlantic) ridley sea turtle	*Lepidochelys kempi*	E	12/02/70
leatherback sea turtle	*Dermochelys coriacea*	E	06/02/70
loggerhead sea turtle	*Caretta caretta*	Th	07/27/78
shortnose sturgeon	*Acipenser brevirostrum*	E	03/11/67

SP[illegible] PROPOSED FOR LISTING
[illegible]

LISTED CRITICAL HABITAT
None

PROPOSED CRITICAL HABITAT
None

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
345 COURTLAND STREET, N.E.
ATLANTA, GEORGIA 30365

NOV 14 1995

Mr. Richard M. Jackson, P.E.
Chief, Planning Branch
Charleston District, Corps of Engineers
PO Box 919
Charleston, South Carolina 29402-0919

Dear Mr. Jackson:

This letter is in response to your request of October 20, 1995 to Mr. Gary Collins concerning a 103 Evaluation of sediments from the Charleston Harbor Deepening Project. We are giving concurrence for the ocean disposal of dredged material from those portions of the project associated with the following test stations: CH-4, CH-5, CH-6, CH-7, CH-9, CH-11, CH-12 and CH-13.

We appreciate the efforts in coordination throughout this evaluation process. Should .you have any questions concerning this letter or wish to discuss any of the data, please contact Mr. Gary Collins at 706/546-2294 or Mr. Doug Johnson at 404/347-1740 ext. 4286.

Sincerely,

Wesley B. Crum

Wesley B. Crum
Chief, Coastal Programs Section

OPTIONAL FORM 99 (7-90)
FAX TRANSMITTAL # of pages ▶ 1

To Robin Socha	From Doug Johnson
Dept./Agency USCOE · Charleston	Phone # 404-347-1740 X4286
Fax # 803-727-4260	Fax # 404-347-1797

NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

October 20, 1995

Planning Branch

Mr. Gary Collins
United States Environmental
Protection Agency
Coastal Programs
345 Courtland Stree, N.E.
Atlanta, Georgia 30365

Dear Mr. Collins:

This letter is in reference to the sediment testing results for the Charleston Harbor Deepening Project. Initial results were submitted to your office in late April 1995. Following your review of the data, bioaccumulation testing for PAH's at two sites, CH-3, located in Shipyard River and CH-4, located adjacent to the proposed Terminal X was required prior to a final 103 Evaluation being conducted by your agency. The bioaccumulation data has been received by this office and is enclosed as requested.

Our review of the bioaccumulation data indicates that the material from site CH-3 is not suitable for ocean disposal and should be disposed of at an upland location.

By copy of this letter, the Charleston District is requesting that your office complete the 103 Evaluation of all the testing results, and provide concurrence that all other sites are suitable for ocean disposal. Please provide a response to the Charleston District by November 15, 1995.

We appreciate your review and assistance. If you have questions, please call Robin Coller-Socha at 803/727-4696.

Respectfully,

RICHARD M. JACKSON, P.E.
Chief, Planning Branch

HARRIS/EN-P

C-SOCHA/EN-PR/4696
PREACHER/EN-PR
JACKSON/EN-P

Enclosure

Exhibits

Prior Studies and Reports

The River and Harbor Act of August 30, 1852 initially authorized $50,000 for permanent improvements to Charleston Harbor. However, passage of the River and Harbor Act of June 18, 1878 authorized the initial deepening of a navigational channel through the ocean bar to a depth of 21 feet mean low water and construction of two jetties for stabilization of the new channel. Since the passage of these two Acts, numerous studies and reports pertaining to Charleston Harbor have been completed. Information regarding reports written prior to 1974 on Charleston Harbor and Shipyard River are listed at the end of this exhibit.

The October 1974 Interim Feasibility Report recommended that Charleston Harbor be modified to provide for construction and maintenance of a 40-foot and 38-foot Federal navigation project in Charleston Harbor (Cooper River) and Shipyard River, respectively, conditional to implementation of the Cooper River Rediversion Project. The report further stated that if the Cooper River Rediversion Project was delayed, the recommended improved channel depths of 40 and 38 feet for Charleston Harbor and Shipyard River should be reduced to 38 and 35 feet, respectively, during the interim period until rediversion was implemented. This interim feasibility report was printed on April 2, 1976 as part of House Document 94-436, 94th Congress, 2nd Session.

A Phase I AE&D Study of Charleston Harbor, completed in April 1980, was authorized by the 94th Congress in Section 101 of the Water Resource Act of 1976. The purpose of this study was to determine if the recommendations presented in the 1974 Interim Review of Reports on Charleston Harbor were still justified under the Water Resources Council's Principles and Standards. In addition to the channel deepening recommended in the 1974 report, this report recommended realignment of the channel centerline to provide 125 feet between existing docks, piers, etc. and the edge of the channel; easing of the bend at the northern approach to the Cooper River Bridge; widening of Filbin Creek and North Charleston Reaches and Shipyard River Connecting Channel; enlargement of the turning basins at Columbus Street Terminal, North Charleston Terminal, Shipyard River; and enlargement of the anchorage basin.

The final report on Charleston Harbor (Wando River Extension) was completed in January 1984 in compliance to seven congressional resolutions. This report recommended Federal maintenance and deepening of the Wando River deep draft navigational channel which was dredged in the summer of 1981 by the South Carolina State Ports Authority to connect their newly constructed terminal facilities adjacent to Hobcaw Creek with the existing Charleston Harbor project. This report was later published as House Document Number 100-27, 100th Congress, 1st Session dated February 2, 1987.

The Charleston Harbor General Design Memorandum (GDM) was completed in July 1987 in response to passage of the Water Resources Development Act of 1986 (PL 99-662) which authorized deepening of Charleston Harbor generally in accordance with the Phase I AE&D dated April 1980.

Three supplements to the Charleston Harbor GDM were prepared in January 1988, February 1989 and September 1989 recommending enlargement of North Charleston Turning Basin, Columbus Street Turning Basin, and realignment of Lower Town Creek Channel, respectively. Supplements 1 and 2 recommended enlarging the turning basins from the authorized 1200 feet to 1400 feet in order to accommodate larger vessels currently porting at Charleston. Supplement 3 recommended removal of the ends of two piers and realigning Lower Town Creek Channel so that is would parallel the South Carolina State Ports Authority dock and eliminate a hazard to the turning of vessels in the Columbus Street Turning Basin.

The Wando River Extension GDM, date June 1988, recommended construction and maintenance of a 40-foot deep by 400-foot wide channel from the Cooper River to a 1400-foot by 1400-foot turning basin in the Wando River opposite the South Carolina State Ports Authority's (SCSPA) Wando Terminal at Hobcaw Creek.

A reconnaissance report was prepared in July 1990 under authority of Section 107 of the 1960 River and Harbors Act, as amended, to determine whether there was Federal interest and justification in deepening Shipyard River from 38 feet to 40 feet. The report found that deepening the lower portion of Shipyard River to 40 feet was justified and recommended further detailed studies. This project was terminated during the feasibility study on 1 April 1991 as the project sponsor was unable to obtain the needed financial support from the project users.

Supplement 1 to the Wando River Extension GDM completed in May 1991. The GDM supplement recommended extending the channel 1500 feet so that the additional wharf under construction by SCSPA could be accessible to shipping interests.

The SCSPA has been conducting studies to determine the location of a new containership terminal to accommodate future increases in containerized cargo. In November 1990, SCSPA contracted with Marine Safety International and the Computer Aided Operations Research Facility (CAORF) at the National Maritime Research Center to conduct ship simulation studies on three sites. These three sites were: Site 1, east side of the Cooper River adjacent to Filbin Creek Reach; Site 2, east side of the Cooper River adjacent to Daniel Island Reach; and Site 2A, west side of the Wando River across from the existing Wando Terminal. Both a C-10 and Econ class containership were used in the study due to their size and maneuverability. Results of this study, completed in June 1991, show that the current channel widths to the North Charleston Terminal are insufficient for two-way traffic for larger vessels and that Site 2 was preferable over Site 1 based on ease of

navigability and maintenance requirements. Since Site 2A was more straightforward than the other two sites, access was not tested.

In 1993 the Daniel Island Alternatives Study was completed. This study was conducted to identify alternate dredged material disposal sites when the Daniel Island Disposal Site became unavailable. Dredged material from Mile 5 to Mile 10 of the federal navigation channel is placed in the 676 acre Daniel Island Disposal Site located on the southern tip of Daniel Island. The analysis considered environmental, costs, and regional social factors of all options. Results of this analysis determined that the least cost plan for disposal of dredged material from Mile 5 to Mile 10 of the navigation channel is the continued use of the Daniel Island Disposal Area in conjunction with the Ocean Dredged Material Disposal Site (ODMDS) and the Drum Island Disposal Site. This conclusion is not favorable to the City of Charleston or the Guggenheim Foundation who have extensive commercial development plans for a large portion of the area. The State Ports Authority owns the western side of the disposal site where the proposed new container terminal is to be located. The loss of the Daniel Island Disposal Site will increase the cost of maintenance dredging by as much $2,000,000 annually.

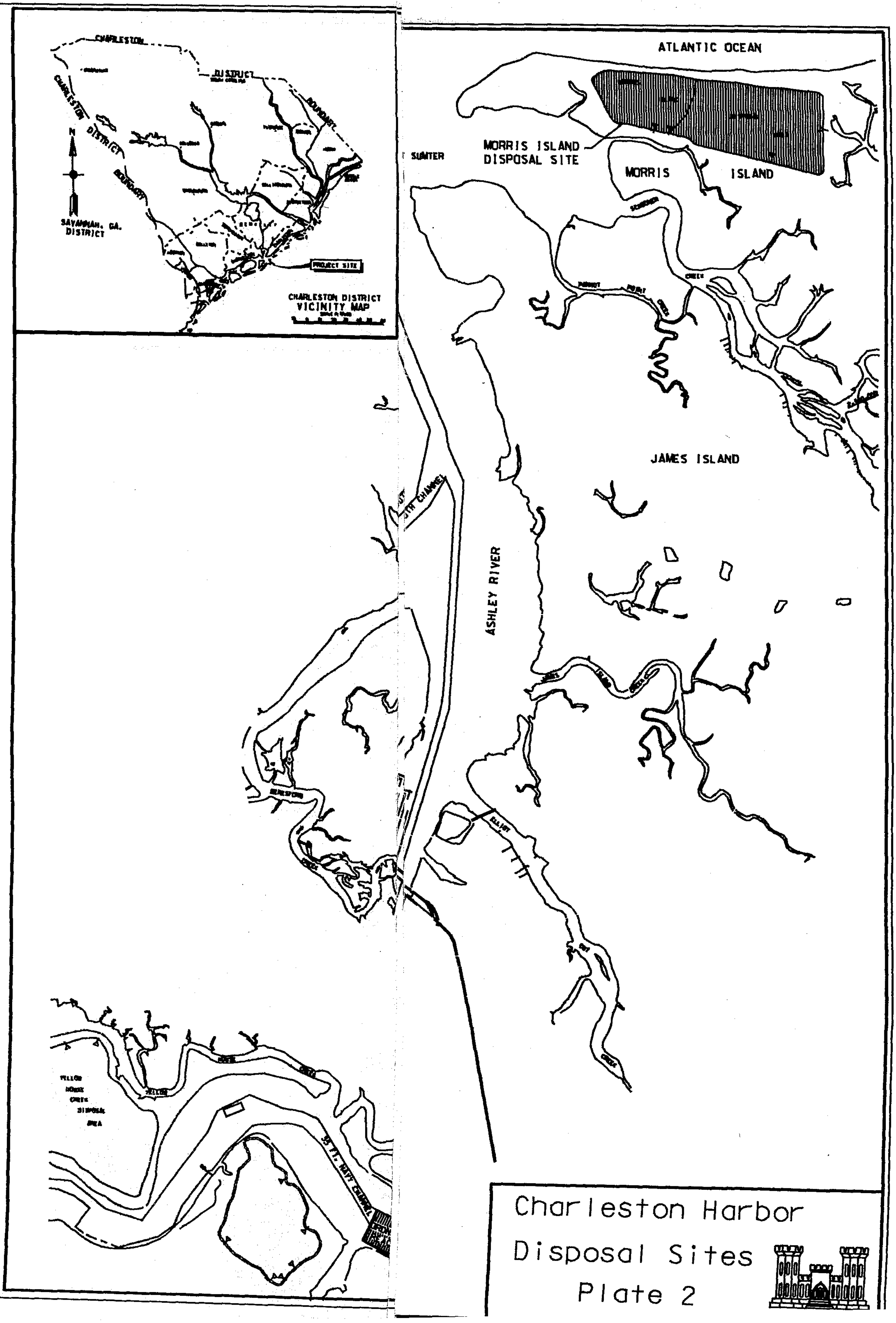
Reports on Charleston Harbor Written Prior to 1974

Date	Recommendation	Reference
16 Dec 1958	Maintenance and extension of Shem Creek	HD 86-35
10 Jul 1954	Deepen Drum Island Channel from 30 to 35 ft.	SD 83-136
25 Mar 1941	Deepen Anchorage Basin to 30 ft	HD 77-156
19 Apr 1939	Deepen channel to 35 ft from sea to head of project via Cooper River and Town Creek also a channel in Shem Creek to Mt. Pleasant 110 ft wide and 10 ft deep including turning basin at upper end.	HD 76-259
19 Nov 1936	Navigational channel to Columbia not recommended	Annual Report 1937 p 541
8 Feb 1926	Entrance channel 32 ft deep & 1000 ft wide to inner end of jetties, 30 ft deep & 600 ft wide to Navy yard & improve Town Creek to a depth of 35 ft & width of 500 ft & that from the Navy yard to the upstream limit of the terminal be improved to a depth of 30 ft & width of 400 ft with a turning basin 700 ft wide opposite port terminal.	HD 69-249
2 Dec 1924	Modify existing project to provide for dredging to a depth of 30 feet an irregular area in Cooper River where a shoal	HD 68-480

	had formed about 2 sunken wrecks.	
22 May 1914	Dredge a channel to the Naval Reservation 26 ft deep & 300 ft wide.	HD-63-19
25 Oct 1911	Dredging to secure a depth of 30 ft provided local authorities show that they would provide adequate terminal facilities.	HD 62-288
27 Jan 1904	Dredge to secure a channel 28 ft deep, 500 ft wide between the jetties & 1000 ft seaward to the 28-ft depth.	HD-58-499
15 Dec 1898	Dredging to secure a channel 26 ft deep at low water & 600 ft wide by constructing a large sea-going dredge & operating it in connection with the dredge then owned by the project.	HD 55-83
-	Recommended modification of the height & length of the jetties but no change in their position or distance apart.	Annual Report 1915 p 554
-	Provisions for establishing & maintaining by means of two jetties & auxiliary dredging a channel of not less than 21 ft deep across the bar.	Annual Report 1878 p 554

Reports on Shipyard River Written Prior to 1974

Aug 1959	Recommended widening the access reach from 200 ft to 300 ft in the interest of safety.	District Rpt
15 Feb 1950	Recommended no improvements at that time	District Rpt
11 Apr 1942	Extension of the existing 30-ft channel to vicinity of Pittsburgh Metallurgical Co. plant with a turning basin at the upper end.	HD 79-93
16 Jun 1931	Enlargement of the channel to a depth of 30 ft & a width of 200 ft up to the Gulf Oil Terminal with a turning basin 30 ft deep at the latter point.	R&H Comm Doc 38 75 Cong
8 May 1934	28-ft channel from Cooper River to the Gulf Oil Terminal & deepening of the channel above that point to 20 ft from the depth of 12 ft previously authorized without local cooperation.	R&H Comm Doc 43 73 Cong
6 Dec 1929	Channel depths of 10 & 20 ft.	R&H Comm Doc 13 71 Cong



Charleston Harbor
Disposal Sites
Plate 2

APPENDIX A

Hydraulics

ENGINEERING APPENDIX

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APPENDIX A

Hydraulics

The increase in vessel dimensions and the environmental limitations that incur at Charleston Harbor initiated this study. A deeper channel will allow more efficient use of the large vessels that call on the harbor. In addition, the increased traffic to the harbor has created a situation where harbor pilots are being forced to pass vessels in reaches they normally would choose not to. Thus, more two-way traffic reaches are needed in the harbor. To accomplish these design tasks the Corps' hydraulic research facility at Waterways Experiment Station (WES) in Vicksburg, Mississippi was consulted for numerical modeling activities.

NUMERICAL MODELING -

An extensive numerical modeling effort was conducted for this study at WES. The primary areas of investigation were: Hydrodynamic, Salinity Intrusion, Sedimentation, and Ship Simulation. All the numerical models were compared with the existing or base condition (40 foot project depth) to a proposed 45 foot project depth. The purpose of the Salinity Intrusion investigation was to predict the impact of the channel deepening on the existing salinity regime. Of particular concern was the Bushy Park Industrial area (Figure 1) dependent on freshwater from the 850 acre Bushy Park Reservoir located approximately 17 miles north of Charleston along the Cooper River. South Carolina Electric and Gas (SCE&G), Amoco, DuPont and Mobay Chemical Companies are among some of the industrial users dependent on freshwater from the reservoir. The primary use of freshwater by the industrial community is for cooling machinery, SCE&G uses 550 million gallons of water from the reservoir on a daily basis. The City of Charleston depends on the reservoir to provide 10-35% of the water supply for municipal use. Introduction of saltwater to the freshwater supply would damage industrial machinery causing prolonged periods of non-productivity resulting in increased operation costs. The Sedimentation Study was conducted to predict the pattern of sedimentation resulting from the deepened and realigned navigation channel. The Ship Simulation model was developed to test navigation by commercial vessels in various channel alignments. These results were utilized in the final channel design.

Hydrodynamic Model -

The numerical models used to develop the channel velocities and water levels for the base condition and the proposed conditions in support of the Ship Simulation and the sedimentation study were the TABS-MD collection. This set of computer programs includes: the two-dimensional, depth-averaged, hydrodynamic model,

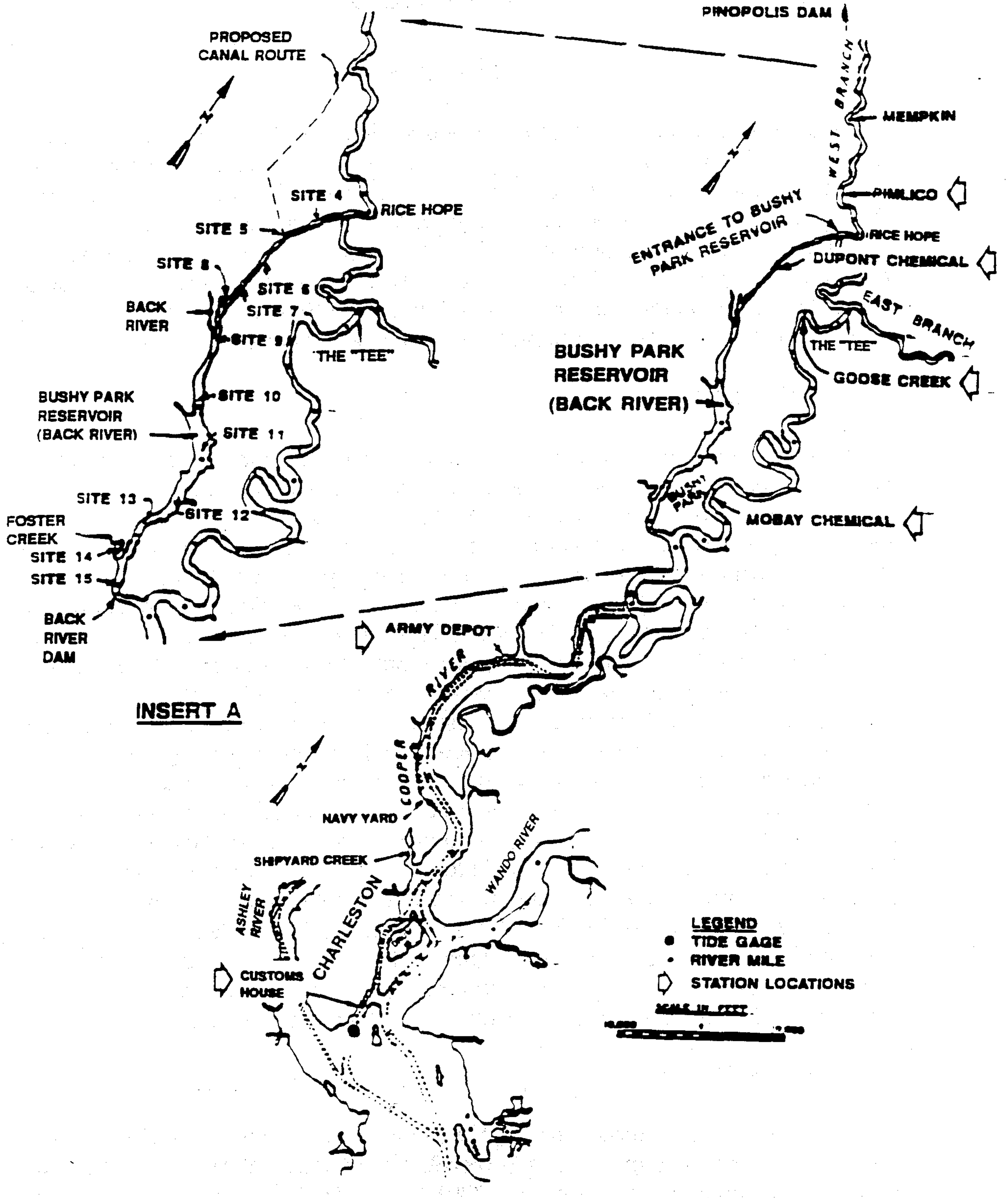

Figure A-1: Vicinity Map for Numerical Modeling

RMA-2V; the two-dimensional, dissolved constituent transport model, RMA-4; and STUDH, the two-dimensional sediment transport model.

Salinity Intrusion Model -

The verified hydrodynamic model was used to generate a seven-day sequence for use in the salinity model. A period in December 1987 was simulated as it included upstream salinity intrusion events into the Bushy Park Reservoir. Data from the USGS conductivity monitoring network was used for model adjustments and verification. The verification condition was for the 35-foot MLW deep navigation channel. A desk study was performed to identify the effects of the 40-foot deep navigation channel on salinity conditions. Monthly periods of 4,500 cfs weekly average flow were used.

After the salinity model was verified to the 35-foot channel, the model was deepened to the 40-foot channel condition (Base) and comparisons were made at selected locations along the channel. The salinity intrusion was found to be within the statistical limits of the prototype measurements for the existing 40-foot channel.

The model was deepened to the 45-foot channel for Plan 2-5 and 2-6. Comparisons of the two plans with the 40-foot channel (Base) were then made.

Much of the testing program was devoted to calibrating the salinity transport models. The 35-foot channel was used as the calibration yardstick. Comparison were then made for the existing 40-foot channel and the proposed 45-foot channel. Intrusion lengths were found to be within the statistical noise limits of the model. No significant difference can be found between the existing 40-foot channel (Base) and the proposed 45-foot channel (Plan 2-5).

Sedimentation Model -

The STUDH sedimentation numerical model was used to effectively schematize and model the complex geometries and processes involved. STUDH is a component in the TABS-MD system and is a companion model to RMA-2V.

The first phase of a thorough sedimentation study generally requires historical hydrographic surveys for existing conditions to develop long-term shoaling/scouring rates for model verification. Since about 70 percent of the Cooper River freshwater inflow was rediverted in 1985 and the Federal channels have just recently been deepened to 40 feet MLW, the system is presently undergoing substantial change to adjust to these new conditions. Thus, no suitable field data sets are available for the purpose of a shoaling verification. The FIBS model can predict general shoaling but potential problem areas could not be adequately defined with this model. The verified hydrodynamic model was used to generate a six-day sequence for use in the sediment model. A period of tidal record in August 1992 was used as the tidal forcing boundary. The sediment model was adjusted to reproduce general shoaling patterns. The Base or existing 40-foot below MLW channel and three Plan configurations were simulated. Plan 2-5 is the deepened channel (45 feet below MLW) with the Daniel Island Terminal and across channel turning basin. Plan 2-6 is the deepened channel with just a width increase within the Daniel Island Reach. Plan 2-5T is the same as Plan 2-5 with both Daniel Island Reach west bank training structures completely repaired and the addition of a 700 foot long training structure adjacent to the Navy degaussing facility.

After the sediment model had been calibrated for the Base or existing conditions, the three Plan configurations were then simulated. Plan 2-5 shows that the deepened channel will generally become a more effective sediment trap. The most significant change was within the Daniel Island Reach and new turning basin. The Base channel had been near equilibrium or even slightly erosional, but the Plan 2-5 increased cross-sectional area has become a very effective sediment trap.

Additional shoaling tests were conducted in the Wando River Turning Basin area. These tests were quick look scenario tests without field data verification to see if the addition of a pilot channel at the upriver end of the Wando Turning Basin would reduce the shoaling within the Basin. Additionally two training structures were located upstream and downstream of the Turning Basin on the right descending bank to increase the current velocities within the Turning Basin as a means of decreasing the sediment deposition within the Basin. Little sedimentation change was evident with only the pilot channel. Significant change was evident in the distribution of sediment within the Turning Basin with the training structures in place, however, the overall sedimentation occurring in the Turning Basin was relatively unchanged. No ship simulator scenarios were conducted for these hydrodynamic and sedimentation tests for the Wando Turning Basin.

Ship Simulation Model -

In order to evaluate the proposed plans for channel improvements, a real-time (model operates at actual time) ship simulation investigation was conducted by WES. The purpose of the study was to determine the effects of the proposed improvements on navigation and to optimize the required channel width and alignment required to safely and efficiently navigate the study area. A vertical motion study was undertaken to determine the necessary depths in the entrance channel to allow for the ship's vertical motion due to wave action.

The WES Ship/Tow Simulator is a marine simulator which can function as either a deep-draft or a shallow-draft simulator. Simulation of Charleston Harbor was accomplished by having experienced mariners from the project area navigate a simulated vessel through the simulation models of the waterway. The pilots initially tested the model for the existing project conditions to validate the models data. The intent is to generate all conditions as realistically as possible. This includes environmental as well as synthetic (vessels, etc.). Once the model has been deemed realistic in the validation phase the proposed conditions are tested. For this project deepening (45-foot project depth) and channel realignments are modeled.

The simulator generates a visual display of the project area (Figures A-2 and A-3) which the mariners use in conjunction with the radar displays; and a precision navigation display which includes vessel speed (both absolute and relative to the water), lateral velocities, heading, rudder angle, engine speed, wind, and a rate-of-turn indicator.

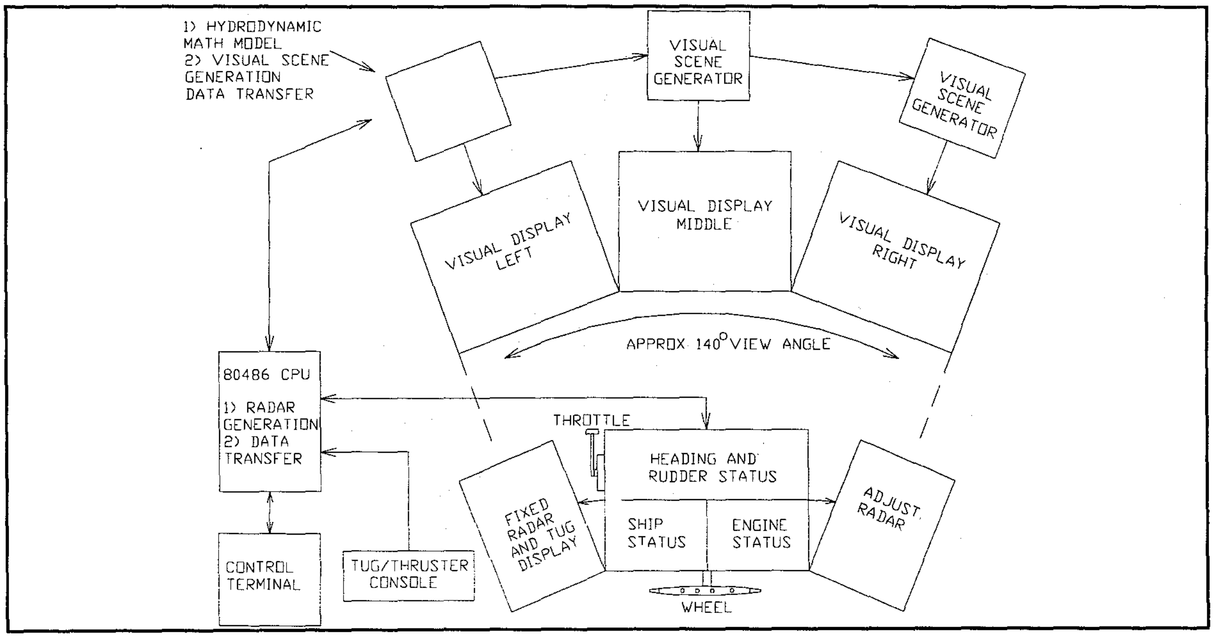

Figure A-2: Schematic diagram of WES Ship/Tow Simulator

Mariners operate the simulator by issuing engine, rudder, or tug/thruster commands. The engine and rudder commands are input to the hydrodynamic program at the ship's console by either the mariner or a helmsman. Tug or thruster commands are input by an operator stationed at the tug controls. The hydrodynamic program calculates the resultant vessel movement based on these inputs and environmental conditions. The ship's motion is then shown on the visual and radar displays.

The visual scene is generated in three dimensions: north-south, east-west, and vertical elevation. As the ship progresses through the channel, the three-dimensional picture is constantly transformed into a two-dimensional perspective graphic image representing the relative size of the objects in the scene as a function of the vessel's position and orientation and the relative direction and position on the ship's bridge for viewing. The computer model updates parameters constantly to provide instant viewing information for the mariners. This information includes; vessel heading, rate of turn, forward and lateral velocity, and position. Two radar displays are provided for the mariner's use during a simulator run. The radar image is a continuously updated plan view of the vessel's position relative to the surrounding area.

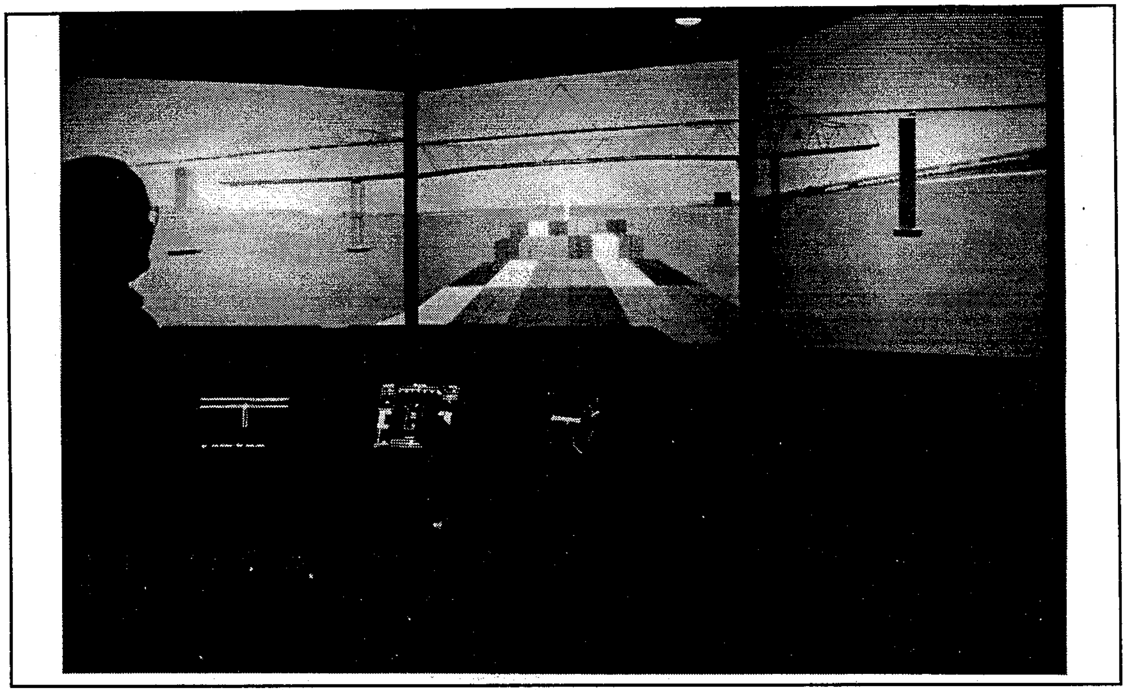

Figure A-3. WES Ship/Tow Simulator, Charleston Harbor scenario

In order to simulate the study area, certain data was required for input:

1. The channel database contains dimensions for the existing channel and the proposed channel modifications. It includes the channel cross sections, bank slope angle, overbank depth, waves, initial conditions, and autopilot track line definition.

2. The visual scene database is composed of three-dimensional images of principal features of the simulated area, including the aids to navigation, docks, and buildings.

3. The radar database contains the features for the plan view of the study area.

4. The current pattern data in the channel include the magnitude and direction of the current and the water depth for each cross section defined in the channel database.

5. The ship data file contains characteristics and hydrodynamic coefficients for the test vessels.

Ship Simulation Conditions -

The test scenarios, design vessels, and environmental conditions were selected in order to test the existing and proposed channels in the "maximum credible adverse situation," or, the worst conditions under which the harbor would maintain normal operations. This approach provides a built-in safety factor when analyzing the results. The existing channels were tested in order to provide a base with which to compare tests conducted in the proposed channels, and to provide a basis for comparison of conditions by the mariners involved in the testing.

For the existing channel runs, the entrance channel was defined as a minimum of 42 feet deep and the interior reaches were defined as a minimum of 40 feet. For all plan channels, the entrance channel was defined as a minimum of 47 feet deep and the interior reaches as 45 feet. The maximum proposed increase in channel depth is 5 feet, for simulation purposes.

The tidal cycle plays a significant factor in the operation of Charleston Harbor. Some deeper draft vessels must utilize the high tide in order to keep sufficient underkeel clearance. As a result of the strong tides experienced throughout the project area, currents dictate much of the maneuverability of vessels. Channel currents were derived from a TABS-2 model study conducted at WES. All currents tested in the simulation study were tidal driven. There are no areas of fresh water inflow in the harbor area. Most reaches were tested using currents which were used for the maximum spring ebb and flood tides. Fort Sumter Range was tested with ebb tide only, because flood tide is not a significant problem in the entrance channel.

Testing of the turn between Hog Island Reach and Drum Island Reach was done for maximum spring flood and two hours before maximum spring ebb. Ebb currents were chosen prior to the time of maximum magnitude because the stronger Cooper River currents dampened the Wando River currents. The Wando River currents act perpendicularly on a vessel making the turn between Hog Island Reach and Drum

Island Reach. The pilots regard these crosscurrents as significantly more difficult to navigate than the stronger currents that occur at maximum ebb tide, because the maximum ebb currents are aligned with the channel. Phasing of the tidal currents does not occur during flood tide.

During testing of meeting and passing in the Daniel Island Reach with the proposed terminal in place, some additional tests were conducted with three-quarter strength and half strength tidal currents.

Waves used in the navigation study were modeled by the Coastal Engineering Research Center (CERC) at WES. Twenty years of hindcast wind and wave information (1956-1975) was used to characterize the wind and wave climate offshore of the harbor entrance. Selected combinations of wave height, period, and direction from the offshore conditions were transformed through the harbor entrance using a numerical model. These combinations were transformed for both the existing and the proposed channel conditions. During validation of the currents, the pilots selected the wave condition that they deemed most typical for the entrance channel and this condition was used for the existing and plan channels for testing.

A northeast wind was imposed on all simulation tests in Charleston Harbor. The wind module gusts randomly plus or minus 50 percent of the average wind speed and also varies the direction about the average direction by plus or minus 15 degrees. A wind speed of 37 knots was used in the entrance channel test and 25 knots was used in the interior reaches. During validation, the pilots requested that the random direction and magnitude of the wind be changed to a fixed direction and magnitude. There is no sheltering from wind effects anywhere in the study area.

The test vessels were selected based on the economic analysis of future shipping business and operations. Table A-1 Lists the particulars of the ships used in the simulations. The bulk carrier represents a coal ship leaving Shipyard River. The current practice is to overload these vessels and wait on high tide to leave the harbor. With a deeper channel this practice will be avoided.

Table A-1

Test Ship Characteristics				
Ship Type	LOA ft	Beam ft	Draft[1] ft	Test Channel
Container Ship	860	106	40	Existing
Container Ship	950	130	45	Proposed
Bulk Carrier	875	144	40	Existing
Bulk Carrier	875	144	45	Proposed
[1] Tidal range in Charleston Harbor in nearly five ft. Approximately 3 ft of underkeel clearance was available for the tidal currents tested.				

Validation -

The ship simulation was validated with the assistance of two pilots licensed for Charleston Harbor. The following information was verified and fine tuned during validation:

a. Wind effects
b. Bank conditions
c. Waves and currents
d. Ship engine and rudder response
e. Ship to ship interaction
f. The visual scene and radar image of the study area.
    1. Location of all aids to navigation.
    2. Location and orientation of the docks.
    3. Location of buildings visible from the vessel.

Validation consisted of the pilots testing the integrity of the ship simulation model for existing project conditions (i.e. 40 foot project). This was done by maneuvering the

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vessel through the channel using the fast-time simulation to visually check the building and buoy locations throughout the study area. The next step was to test the vessel response due to external forces in the real-time simulation. The model was adjusted and further simulated until the pilots were satisfied that the simulated vessel response was similar to that of an actual vessel in the prototype.

Preliminary Testing -

The preliminary test program was undertaken to determine the channel width to be tested in the entrance channel to Charleston Harbor, the effectiveness of the channel realignments for the Mt. Pleasant through Horse Reaches (Figure A-4) and the design for the proposed Daniel Island Terminal (Figure A-5).

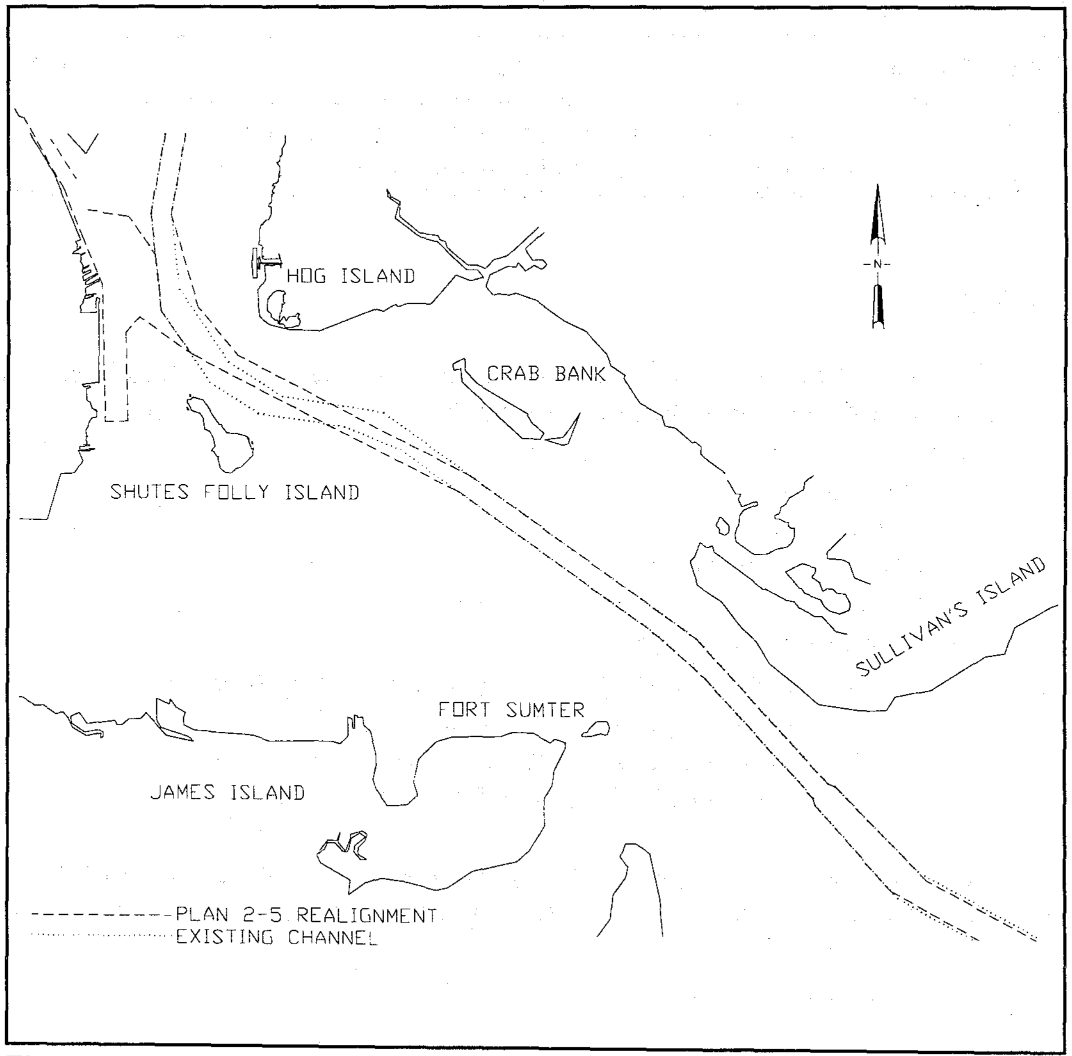


Figure A-4: Plan 2-5 alignment from Mt. Pleasant Range to Horse Reach

The pre-testing phase of the ship simulation modeling was performed to provide results for the areas of the project which were under consideration for realignment or channel width adjustments. The first pre-tests were in the entrance channel where the existing 1000-foot channel was compared with the deepened channels with 1000-, 800-, and 600-foot widths using wave conditions obtained from the wave modeling. The results from these tests indicated that the 800-foot wide channel warranted more extensive testing.

The second area under consideration for pre-testing was the proposed realignment of Mt. Pleasant Range to Horse Reach. This plan would allow for a longer reach for two-way traffic in the lower harbor area. During the pre-testing phase in this portion of the harbor, the pilots felt that the new alignment for Mt. Pleasant Range caused the ships to be more influenced by cross-currents in the harbor.

During the preliminary design program, a new realignment was developed, which used the existing Mt. Pleasant Range alignment. This alignment (Plan 2-5) avoided both the cross-currents and an area of historical significance. Since two-way traffic existed in the Mt. Pleasant Range already, no compromise was made on the efficiency of the traffic either.

The final region studied in the preliminary test program was the Daniel Island Terminal portion. Two plans were developed for the proposed Daniel Island Terminal. These plans (Plan 2-5 and Plan 2-7) differ only in that Plan 2-7 includes a short training dike just south of the turning basin.

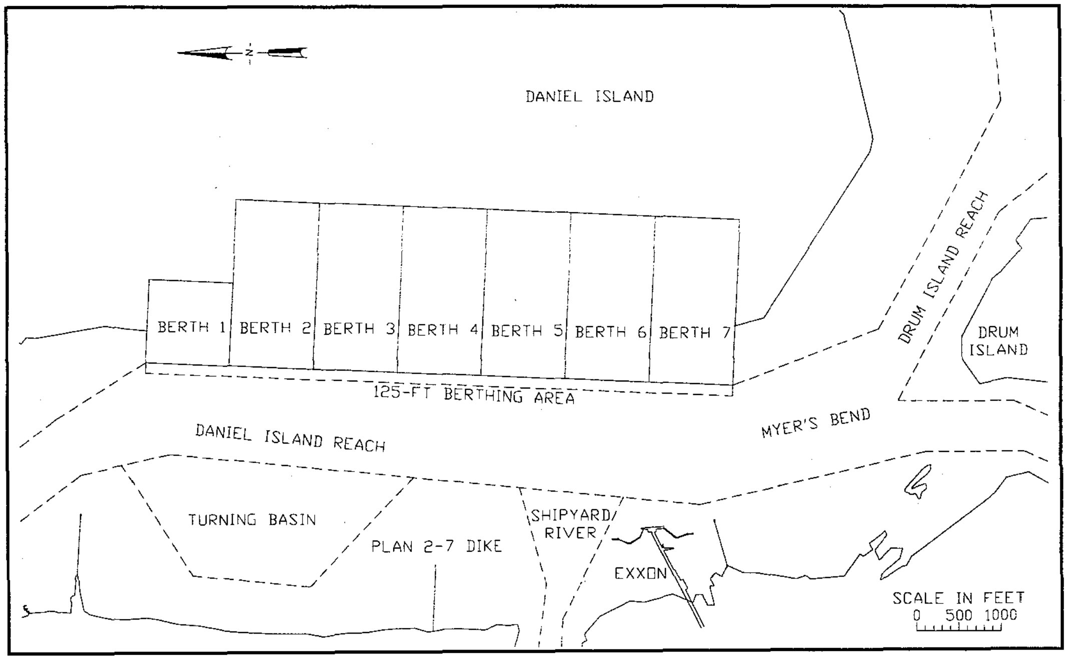


Figure A-5: Daniel Island Terminal location, Plans 2-5 and 2-7

Test Scenarios -

Tests were conducted in a random order. This was done to prevent prejudicing the results as would happen if, for example, all existing conditions were run prior to running the plans. The skill gained at operating the simulator could show the plans to be easier than they might really be.

During each run, the characteristic parameters of the ship were automatically recorded every 5 seconds. For runs made in the entrance channel with waves, the parameters were recorded every second. These parameters included the position of the ship's center of gravity, speed, rpm of the engine, heading, drift angle, rate of turn, rudder angle, and port and starboard clearances.

To test the ability of the docking pilots to turn the design vessel in the deepened turning basins at North Charleston, Columbus Street, Wando and the proposed turning basin opposite the proposed Daniel Island Terminal, a series of real-time simulations were performed. During these runs, the vessel was started approximately one-half mile outside the turning basin and the docking pilots were provided up to four 3000 HP tugs to assist in the turn. The runs were performed with both maximum ebb and maximum flood tides for both the existing turning basins and the proposed deepened basins.

To test all channels with a variety of meeting and passing scenarios, the study area was divided into nine test reaches, A through I (Figures A-6 through A-9). Testing of two way traffic was accomplished with two real-time piloted simulations conducted simultaneously. The pilots were in verbal contact with each other and could see the other vessel on their visual scene and radar display.

The test reaches were divided as follows:

a. Reach A, inbound from outer entrance channel/outbound from outer entrance channel. This test was designed to test the meeting and passing of two loaded containerships in the outer entrance channel where full wave effect would be present. This was a short test run that ended once the meeting and passing was successfully completed. This was tested with wave conditions, 37 knots of wind, and ebb tide current.

b. Reach B, inbound from outer entrance channel/outbound from between entrance channel jetties. This test was designed to test meeting and passing of two loaded containerships near the outer end of the entrance channel jetties where the wave effect is diminishing for the inbound vessel and increasing for the outbound vessel. This was a short test run that ended once the meeting and passing was successfully completed. This was tested with wave conditions, 37 knot winds, and ebb tide current.

c. Reach C, inbound from outer entrance channel to jetties/outbound from inner entrance channel to jetties. This test was designed to test meeting and passing of two loaded containerships inside the jetties where the wave effect was minimal. This was a short test run that ended once the meeting and passing was successfully completed. This was tested with wave conditions, 37 knot winds, and ebb tide current.

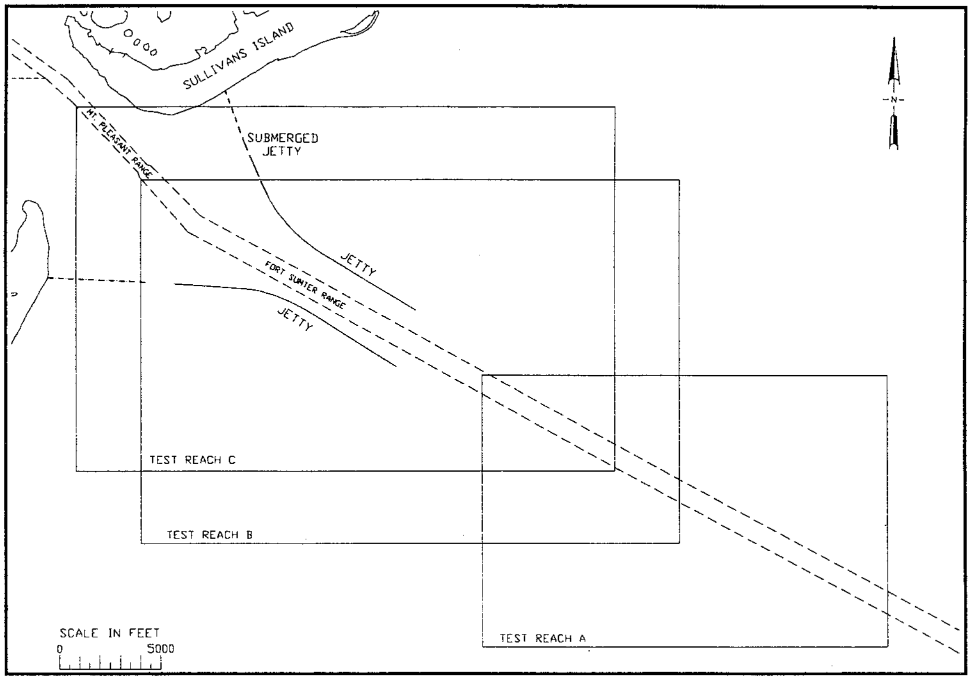


Figure A-6: Test Reaches A, B, and C

d. Reach D, inbound from Mt. Pleasant Range/outbound from Rebellion Range. This test was designed to test meeting and passing of two loaded containerships near the intersection of the Mt. Pleasant and Rebellion Reaches. This was a short test run that ended once the meeting and passing was successfully completed. This reach was tested with both the maximum ebb and maximum flood tides and with 25 knots of wind.

e. Reach E, inbound from the Rebellion Reach/outbound from the Hog Island Reach. This test was designed to test meeting and passing of two loaded containerships in the existing Horse, Shutes, and Folly Reaches and the proposed realigned channel that would replace the existing reaches. This was a short test run that ended once the meeting and passing was successfully completed. This reach

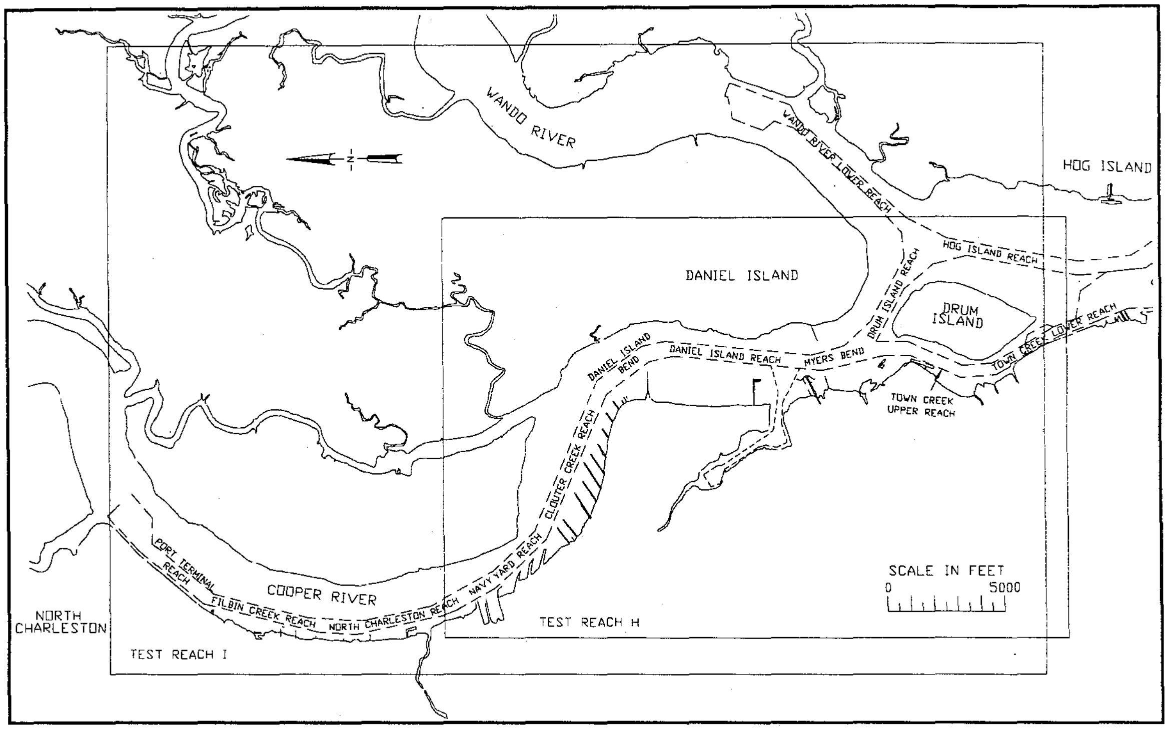


Figure A-9: Test Reaches H and I

Ship Simulator Results -

Track plots were generated for each test run on the simulator. Selected plots are located at the end of this appendix which show the position and orientation of the ships recorded every 10 seconds during the tests. By superimposing the track plots on the plan view the path the ships followed throughout a test run is recorded. Navigation parameters included in this report are: rudder angle, engine speed, ship speed, and rate of turn. Summary tables are listed for each test reach which contain the outcome and important clearances during each test condition.

Test Reach A -

A total of twelve runs were made, six in the existing channel and six in the proposed channel. All runs were conducted with ebb tide. Table A-2 shows the summary of results of the simulation runs.

Existing Conditions -

There were three instances of the ships leaving the channel. Only the run that left the channel by 195 feet would have been in danger of grounding. Detailed bathymetric data is unavailable for the area. However, given the naturally deep water and the approximately four feet of tide, it is unlikely that this vessel would have grounded. The clearance values at the time of meeting were fairly large.

Parameter Plots for the existing condition runs show that most pilots kept the vessel on "full ahead" (i.e. maximum engine speed) for the entire run. Even though the Entrance Channel is a straight reach, both the inbound and outbound vessel required rudder changes to stay on course. This is in response to ship motion caused by waves. At no point in any of the runs was the rudder "hard over" (i.e. maximum rudder angle) for more than a few moments.

Proposed Conditions -

There were two instances of the ships leaving the channel. Neither of the instances would have resulted in grounding. The clearance values at the time of meeting, while not as large as those in the existing channel, were adequate.

Parameter Plots for the proposed condition runs show that for several of the runs one or both of the ships reduced the engine speed from full ahead. This was done to slow the ship's speed for the meeting to reduce the ship-to-ship interaction. This interaction was undetected in all but one of the track plots and parameter plots. The interaction is most noticeable in the inbound ship's increased rate of turn, just after meeting.

Table A-2

Clearances, Test Reach A, Ebb Tide

Inbound Pilot	Outbound Pilot	Clearance at Time of Meeting, ft			Notes
		Between Ships	Inbound Ship to Channel	Outbound Ship to Channel	
			Existing Conditions		
1	2	527	96	81	
2	1	505	93	69	Outbound ship left channel by 44 ft.
3	4	527	110	138	
4	3	419	202	162	Inbound ship left channel by 13 ft.
5	6	552	92	97	Inbound ship left channel by 195 ft.
6	5	450	180	85	
			Proposed Conditions		
1	2	420	3	11	Outbound ship left channel by 12 ft.
2	1	270	137	50	
3	4	345	74	97	Inbound ship left channel by 7 ft.
4	3	341	87	73	
5	6	341	92	70	
6	5	269	141	71	

Test Reach B -

A total of twelve runs were made, six in the existing channel and six in the proposed channel. All runs were conducted with ebb tide. Currents are strong in this reach, with the larger magnitudes occurring near the western end of the channel. Results of the simulation runs are summarized in Table A-3.

Existing Conditions -

There were no instances of the ships leaving the channel. Parameter plots for the existing condition runs show several different techniques used by the pilots. The pilots adjusted the ship's speed by reducing the engine power and/or taking advantage of the tidal currents to manipulate the position of passing. Plots of the rudder angle show that while there was a lot of rudder movement throughout the runs, there were no instances of hard over rudder being applied.

Proposed Conditions -

There were three instances of inbound ships leaving the starboard side of the channel. The clearance values at the time of meeting, while not as large as those for the existing channel, seem adequate.

Parameter plots for the proposed condition runs show that the different pilot pairs used different strategies in this reach. Pilots 1 and 2 significantly reduced engine speed in preparation for the meeting. Pilots 3 and 4 ran full ahead for the entire run. Pilots 5 and 6 reduced engine speed at the start of the run for the outbound ship and shortly before the meeting for the inbound ship. Examination of the rate of turn for all runs reveals that Pilots 1 and 2 had significantly less ship interaction than the other runs. Plots of the rudder angle for all runs show that while there was a lot of rudder action throughout the runs, there was no instance of hard over rudder being applied.

Table A-3

Clearances, Test Reach B, Ebb Tide

Inbound Pilot	Outbound Pilot	Clearance at Time of Meeting, ft Between Ships	Inbound Ship to Channel	Outbound Ship to Channel	Notes
Existing Conditions					
1	2	449	186	89	
2	1	412	155	189	
3	4	385	114	278	
4	3	468	78	222	
5	6	234	273	253	
6	5	408	176	152	
Proposed Conditions					
1	2	349	118	49	
2	1	382	7	114	Inbound ship left channel by 11 ft.
3	4	283	46	148	Inbound ship left channel by 31 ft.
4	3	430	39	36	Inbound ship left channel by 74 ft.
5	6	182	92	157	Inbound ship, 12 ft. clearance to channel edge
6	5	242	115	120	Inbound ship, 18 ft. clearance to channel edge

Test Reach C -

A total of twelve runs were made, six in the existing channel and six in the proposed channel. All runs were conducted with ebb tide. Summary of ship simulations for this reach are contained in Table A-4.

Existing Conditions -

There were no instances of the ships leaving the channel. Parameter plots for the existing condition runs show that one set of pilots kept their vessels on full ahead for the entire run, while the other pilots reduced engine speed. Only one run experienced the high rate of turn associated with ship-to-ship interaction. Plots of the rudder angle for all runs show that although there were several instances of hard over rudder being applied, hard rudder was not maintained for more that a short period of time.

Proposed Conditions -

There were three instances of the ships leaving the channel. The parameter plots for the proposed condition runs show only one run where both of the ships remained full ahead. The pilots on the remainder of the runs reduced speed in order to avoid vessel interaction. Plots of the rudder angle show none of the pilots used hard rudder for a sustained period of time.

Table A-4

Clearances, Test Reach C, Ebb Tide

Inbound Pilot	Outbound Pilot	Clearance at Time of Meeting, ft.			Notes
		Between Ships	Inbound Ship to Channel	Outbound Ship to Channel	
Existing Conditions					
1	2	351	144	263	
2	1	361	64	332	
3	4	366	136	276	
4	3	467	172	145	
5	6	209	260	289	
6	5	364	241	170	
Proposed Conditions					
1	2	230	86	191	
2	1	219	90	204	
3	4	338	58	137	Inbound ship had minimum clearance of 15 ft.
4	3	300	54	143	Inbound ship left channel twice by 40 ft. and 63 ft.
5	6	286	-1	215	Inbound ship left channel by 76 ft.
6	5	235	105	185	

Test Reach D -

The proposed channel for this reach is on a different alignment than the existing channel. Runs for this test reach were conducted with both ebb and flood tides. The natural bathymetry of the harbor must be considered when evaluating the simulation results in this area. The area with water of navigable depth is significantly greater than that defined by the authorized federal navigation channel, particularly the Mt. Pleasant Range. The pilots use this naturally deep water on both sides of the channel, particularly when meeting another ship. This is verified by the fact that buoys on the western side of the Mt. Pleasant Range mark areas far from the authorized channel. The northern and southern buoys are positioned approximately 600 and 900 feet, respectively, from the authorized channel. If the channel is deepened to 45 feet, the adjacent area to the channel that is as deep or deeper will decrease. Results of ship simulation runs for Test Reach D are summarized in Tables A-5 and A-6 for ebb and flood tide conditions, respectively.

Existing Conditions - Ebb Tide -

Both ships left the authorized channel during each run. The inbound ships used the deep water near the west side of Sullivan's Island to increase the distance to the outbound ship. The outbound vessels cut the corner while turning from Rebellion Reach to Mt. Pleasant Range. All of the outbound ships and two of the inbound ships crossed the 40 foot contour. The cause of this incident was the inbound pilot reduced the ship's engine speed and was unable to maintain headway against the strong ebb currents.

Proposed Conditions - Ebb Tide -

All of these runs show one or both of the ships leaving the authorized channel. The inbound ship in the most successful meeting left the authorized channel, but did not cross the 45 foot contour.

Table A-5

Clearances, Test Reach D, Ebb Tide					
		Clearance at Time of Meeting, ft.			
Inbound Pilot	Outbound Pilot	Between Ships	Inbound Ship to Channel	Outbound Ship to Channel	Notes
Existing Conditions					
1	2	777	484	13	Both ships crossed 40-ft contour
2	1	615	485	405	Outbound ship crossed 40-ft contour
3	4	435	681	373	Outbound ship crossed 40-ft contour
4	3	709	596	62	Outbound ship crossed 40-ft contour
5	6	582	-190	289	Both ships crossed 40-ft contour
6	5	340	793	324	Outbound ship crossed 40-ft contour
Proposed Conditions					
1	2	250	623	147	Inbound ship hit buoy
2	1	405	457	188	Inbound ship hit buoy
4	3	242	674	86	Inbound ship hit buoy
5	6	315	576	111	Inbound ship hit buoy
6	5	187	722	97	Inbound ship hit buoy
7	8	83	110	583	Inbound ship hit buoy and left channel by 103 ft.; Outbound ship left Reb. Reach by 95 ft.
8	7	136	253	444	Outbound ship left Rebellion Reach by 38 ft.
9	10	67	316	527	Outbound ship hit buoy
10	9	213	263	571	Inbound ship hit buoy; Outbound ship left channel by 229 ft.

Existing Conditions - Flood Tide -

The outbound ships left the authorized channel during each run, crossing the 40-foot contour each time. The inbound ships left the authorized channel in all runs but one. Only one of the inbound ships crossed the 40-foot contour.

Proposed Conditions - Flood Tide -

Two of the runs were completed without either ship leaving the channel. The remainder of the runs show one or both of the ships leaving the authorized channel and crossing the 45-foot contour. Two of the runs show a ship hitting a buoy.

Table A-6

Clearances, Test Reach D, Flood Tide

		Clearance at Time of Meeting, ft			
Inbound Pilot	Outbound Pilot	Between Ships	Inbound Ship to Channel	Outbound Ship to Channel	Notes
Existing Conditions					
1	2	391	97	-117	Outbound ship crossed 40-ft contour
2	1	507	1054	-294	Outbound ship crossed 40-ft contour
4	3	819	-67	-358	Both ships crossed 40-ft contour
5	6	427	104	-178	Outbound ship crossed 40-ft contour
6	5	502	273	-269	Outbound ship crossed 40-ft contour
Proposed Conditions					
1	2	262	14	43	
2	1	270	-161	132	Inbound ship left channel by 150 ft.
3	4	219	103	-41	Outbound ship left channel into 40-ft anchorage
4	3	394	-68	-25	Inbound ship left channel by 70 ft; Outbound ship left channel by 26 ft.
5	6	305	-158	127	Inbound ship left channel by 158 ft.
6	5	211	44	88	
7	8	219	817	84	Outbound ship left Rebellion Reach by 51 ft and Mt. Pleasant Range by 37 ft.
8	7	92	701	145	Outbound ship left channel by 57 ft.
9	10	253	875	6	Outbound ship hit buoy
10	9	278	778	73	Inbound ship hit buoy

Test Reach E -

The proposed channel for Test Reach E is on a different alignment than that of the existing channel. Runs were conducted with both ebb and flood tide. As with Test Reach D, the bathymetry of this area must be considered when evaluating the simulation results, especially with the runs in the existing condition. The natural channel through the Rebellion, Horse, Shutes, and Folly Reaches is 40 feet or better beyond the authorized channel. For purposes of distance to channel edge, the 40-foot contour will be used when it is beyond the authorized channel for the existing condition. For the proposed channel, the authorized channel also defines the limits of available 45-foot draft. Summary results of the simulation runs are shown in Tables A-7 and A-8.

Existing Conditions - Ebb Tide

None of the outbound ships were within the navigation channel as they met and passed the inbound vessels. This was caused by a strong ebb tide set to starboard for the outbound vessels. Six of the seven inbound runs went out of the channel to starboard at the turn from Rebellion to Folly Reach. The run with no clearance (see Table A-7) indicates that the vessels may have touched but since the inbound and outbound tracks (see plots at end of appendix) do not overlap the incident was not considered as a collision.

The parameter plots of engine rpm show the pilots varied the amount of engine for the outbound runs used from approximately half ahead to full ahead, but with little difference in the outcome. There are extended applications of maximum rudder for the outbound vessels as they turn from Hog Island Reach onto Horse Reach and inbound vessels as they turn from the Rebellion Reach to Folly Reach, indicating control difficulties.

Proposed Conditions - Ebb Tide -

The outbound vessels still tended to set to starboard and outside of the channel, but most of the runs went far less outside the channel as with the existing condition channel. The inbound vessels still experienced a strong set to starboard at the turn from Rebellion to Folly Reach, but with the exception of one run, the distance out of the channel was smaller with the proposed channel versus the existing channel.

The Parameter plots for the inbound vessels show that there is still a lot of rudder activity but fewer large sustained values of rudder as compared with the existing condition. The outbound pilots must use an extensive large value of port rudder to turn out of Drum Island Reach into the realigned Horse-Shutes-Folly Reaches due to the strong starboard set of the ebb current. After making this turn, there was normally not any extended use of large rudder values, indicating better control in the proposed channel design.

Table A-7

Clearances, Test Reach E, Ebb Tide

		Clearance at Time of Meeting, ft			
Inbound Pilot	Outbound Pilot	Between Ships	Inbound Ship to Channel	Outbound Ship to Channel	Notes
1	2	307	147	-104	Inbound ship left Rebellion Reach by 12 ft. Outbound ship left Horse Reach by 250 ft and grounded in Folly Reach.
1, run 2	2, run 2	201	116	-143	Inbound ship left Rebellion Reach by 64 ft. Outbound ship grounded in Folly Reach.
2	1	479	138	-262	Inbound ship left Rebellion Reach by 191 ft. Outbound ship left Horse Reach by 250 ft, Shutes Reach by 115 ft. and grounded in Folly Reach.
3	4	174	268	-233	Inbound ship left Rebellion Reach by 146 ft. Outbound ship left Horse Reach by 142 ft, Folly Reach by 295 ft and grounded in Rebellion Reach.
4	3	65	231	-170	Outbound ship left Horse Reach by 195 ft, Shutes Reach by 10 ft, Folly Reach by 450 ft and grounded in Rebellion Reach.
5	6	0	383	-375	Inbound ship left Rebellion Reach by 121 ft. Outbound ship left Horse Reach by 124 ft and grounded in Folly Reach.
6	5	59	481	-205	Inbound ship left Rebellion Reach by 70 ft. Outbound ship left Horse Reach by 67 ft and grounded in Folly Reach.
Proposed Conditions					
1	2	143	70	57	Outbound ship left channel by 43 ft.
2	1	181	-88	84	Inbound ship left channel by 338 ft.
3	4	107	-33	110	Inbound ship left channel by 189 ft; Outbound ship left channel by 21 ft.
4	3	276	73	-130	Outbound ship left channel by 227 ft.
5	6	255	-36	48	Inbound ship left channel by 50 ft; Outbound ship left channel by 18 ft.
6	5	142	3	116	Inbound ship left channel by 16ft.

Existing Conditions - Flood Tide -

One inbound ship went out of the channel by 42 feet. Four of the meetings and passings had less than 100 feet clearance between the vessels. There were three of the outbound transits that went out of the channel and two others that came very close to going out during the runs. The parameter plots indicate that most pilots chose to use 40 to 60 percent of maximum engine rpm for most of the runs, both inbound and outbound, to reduce the vessel speed and interaction forces between the vessels when they met. Most runs have a lot of rudder activity, but no extended use of large rudder values.

Proposed Conditions - Flood Tide -

The parameter plots for the proposed condition do not indicate any significant differences as compared to the existing condition plots. A number of the vessels still went out of the channel, but had no impact on the runs.

Table A-8

Clearances, Test Reach E, Flood Tide					
		Clearance at Time of Meeting, ft			
Inbound Pilot	Outbound Pilot	Between Ships	Inbound Ship to Channel	Outbound Ship to Channel	Notes
Existing Conditions					
1	2	396	77	-185	Outbound ship left Horse Reach by 23 ft and Folly Reach by 211 ft.
2	1	67	333	12	Outbound ship left Shutes Reach by 87 ft.
3	4	329	33	-35	Outbound ship left Hog Island Reach by 40 ft and Shutes Reach by 157 ft.
4	3	78	385	-7	Inbound ship left Folly Reach by ?? ft. Outbound ship left Hog Island Reach by 168 ft and Horse Reach by 8 ft.
5	6	65	219	187	
6	5	20	127	426	
Proposed Conditions					
1	2	136	21	104	Outbound ship left channel by 38 ft.
2	1	219	66	12	
3	4	44	30	58	
4	3	170	-22	115	Inbound ship left channel by 59 ft.
5	6	210	8	84	
6	5	143	75	96	

Test Reach F -

The proposed channel for Test Reach F is on a different alignment than that of the existing channel. Runs were conducted for both flood and ebb tides in this reach. As with Test Reach E, the bathymetry of this area must be considered when evaluating the simulation results, especially with the existing condition runs. The natural channel through the Rebellion, Horse, Shutes, and Folly Reaches is 40 feet or better beyond the authorized channel. For purposes of distance to channel edge, the 40-foot contour will be used when it is beyond the authorized channel for the existing condition. For the proposed channel, the authorized channel also defines the limits of available 45-foot draft. Results of the simulation are summarized in Table A-9 and A-10.

Existing Conditions - Ebb Tide -

The inbound pilots had difficulty with the strong ebb tide sets in the Folly, Shutes, and Horse Reaches. Outbound runs generally had little problem until they approached the Customhouse and Horse Reaches which is where the two ships usually met and passed. From this point onward, the outbound pilots experienced the strong ebb tide sets and four of the runs left the channel by large distances.

The parameter plots show that the inbound pilots were almost constantly changing the position of the rudder to maintain control. There is considerable use of maximum rudder values for extended periods. This, along with the amount of activity of rudder movement indicate control difficulties. The outbound pilots had much less rudder activity for most of their transits until they got into the Horse and Customhouse Reaches and were meeting and passing the inbound vessels.

Proposed Conditions - Ebb Tide -

The test results from this phase of runs were rather favorable. The inbound ships made the transit through the straightened channel section between the Crab Bank shoal and Shutes/Folly Reach within the channel limits with only one exception (which left the channel by only 16 feet). The turn from the realigned channel onto the Hog Island Reach was completed with some difficulty. The ships generally tended to stay near the starboard side of the channel limits. The outbound vessels experienced few problems until approaching the inbound vessel and making the turn from the Hog Island Reach onto the realigned channel near Shutes/Folly Reach.

The parameter plots still show heavy rudder activity for the inbound vessels. The amount of maximum rudder appears to be slightly less than with the existing condition. This still indicates control difficulty, but since the distances the inbound vessels went out of the channel are usually smaller than with the existing channel, the proposed channel would appear to be less difficult. Use of rudder by outbound vessels is almost the same as the existing conditions, but improvement in distances that the outbound vessels went out of the channel would indicate better control.

Table A-9

Clearances, Test Reach F, Ebb Tide

Inbound Pilot	Outbound Pilot	Clearances at Time of Meeting, ft			Notes
		Between Ships	Inbound Ship to Channel	Outbound Ship to Channel	
			Existing Conditions		
1	2				Inbound ship left Folly Reach by 113 ft. Equipment malfunctioned prior to meeting.
2	1	78	329		Inbound ship Left Folly Reach by 281 ft. Outbound Ship left channel by Hog Island Reach by 30 ft. Meeting not completed due to equipment malfunction.
4	3	183	113	182	Inbound ship left Folly Reach by 162 ft. Outbound ship left Horse Reach by 400 ft and Folly Reach by 215 ft.
5	6	361	381	83	Inbound ship left Rebellion Reach by 99 ft and Folly Reach by 265 ft. Outbound ship left Horse Reach by 691 ft.
6	5	333	289	97	Inbound ship left Folly Reach by 60 ft. Outbound ship left Horse Reach by 691 ft.
10	9	48	-44	-247	Inbound ship left Custom House Reach by 105 ft and Hog Island Reach by 12 ft. Outbound ship grounded in Custom HR
			Proposed Conditions		
1	2	98	-89	105	Inbound ship left channel by 200 ft while turning into Wando R.
2	1	174	54	68	Outbound ship left channel by 40 ft while turning into Hog Island Reach and 110 ft while turning into Rebellion Reach.
4	3	128	70	77	Inbound ship left channel by 40 ft at southern end of Hog Island Reach and by 105 ft while turning into Wando River.
5	6	335	222	-111	Inbound ship left channel by 18 ft while turning into Wando Riv.
6	5	343	153	-81	
10	9	245	-13	341	Inbound ship left Rebellion Reach by 15 ft, the southern end of Hog Island Reach by 31 ft, and the turn into Wando River by 159 ft.

Existing Conditions - Flood Tide -

The inbound ships tended to go toward the starboard side of the Folly Reach with two of them going slightly outside the channel. From that point the runs were made with little difficulty. The outbound vessels made most of the transits with no difficulty, except for the point at which they met and passed the inbound vessel, usually near the Customhouse Reach. The parameter plots show considerable rudder activity for both the inbound and outbound runs. There were few occasions that maximum rudder was used for an extended time. These occasions only occurred with the inbound vessel in the bend of the Horse-Shutes-Folly Reaches and turning into the Wando River.

Proposed Conditions - Flood Tide -

Most of the inbound runs were made with little difficulty. There were two incidences where the vessels went outside the channel. The outbound vessels generally had little difficulty except when meeting and passing the inbound vessel. As the vessels met and passed, the outbound vessel usually tended to be very near or slightly outside of the channel. The parameter plots show considerable rudder activity and some extended use of maximum rudder, but nothing significantly different from that of the existing condition runs.

Table A-10

Clearances, Test Reach F, Flood Tide

Inbound Pilot	Outbound Pilot	Clearance at Time of Meeting, ft Between Ships	Inbound Ship to Channel	Outbound Ship to Channel	Notes
Existing Conditions					
1	2	246	197	-88	
2	1	136	78	124	Inbound ship left western side of channel by 30 ft while turning into Wando River.
3	4	62	183	64	Inbound ship left Folly River by 65 ft.
4	3	82	109	103	
5	6	261	260	208	
6	5	189	142	164	
Proposed Conditions					
1	2	163	105	15	Outbound ship came within 2 ft of channel edge while turning onto Hog Island Reach.
2	1				Simulator malfunctioned prior to meeting, run aborted.
2, run 2	1, run 2	99	137	91	
3	4	314	25	10	Outbound ship left Wando River Lower Reach by 30 ft and the southern end of Hog Island Reach by 30 ft.
4	3	168	72	82	
5	6	217	51	221	Inbound ship left Rebellion Reach by 150 ft.
6	5	89	85	49	

Test Reach G -

Existing Conditions -

Runs were conducted with only flood tide and outbound from Shipyard River. The method of the transits varied for each pilot. The parameter plots show that extended use of maximum rudder was required to make the turn from Shipyard River to Daniel Island Reach, Daniel Island Reach to Drum Island Reach and Drum Island Reach to Hog Island Reach.

Table A-11 lists the distance upstream of the Cooper River Bridges that the pilots completed their starboard turns onto the Hog Island Reach. This distance was obtained by determining the point at which the pilot went from starboard rudder to port rudder after completing the turn.

Table A-11

Distance to Cooper River Bridges, Test Reach G
Existing Conditions

	Distance from bridges at turn completion	
Pilot	Distance, ft	Distance, ft
3	1400	1800
4	1900	2100
5	1900	1200
6	1800	2000
7	1900	2000
8	2000	2400

Proposed Conditions -

The pilots demonstrated many different approaches of maneuvering the vessels, with relatively the same results for the majority of them. The parameter plots still show extended use of maximum rudder to make the ship turns at Shipyard River, onto Drum Island Reach, and onto Hog Island Reach with no appreciable differences as compared with the existing conditions. This indicates that channel deepening and realignment associated with the new terminal design has little effect on the difficulty in making transits from Shipyard River even though the proposed channel is tested with a 45-foot draft vessel which would handle more sluggishly than the 40-foot draft vessel tested for the existing condition.

Test Reach H -

Runs conducted for Test Reach H were with both ebb and flood tides. These simulation runs were conducted to investigate passing vessels in the Daniel Island Reach. Outbound vessels departed from the Navy Yard Reach while the inbound vessels began their run in Hog Island Reach prior to the Highway 17 bridges. Simulation results are summarized in Tables A-12 and A-13.

Existing Conditions - Ebb Tide

All of the runs conducted had incidents of ships leaving the authorized channel. Inbound ships had the most problems at the turn from Hog Island Reach to Drum Island Reach and when meeting the outbound ship. Ships experienced an extreme southern set due to the strong ebb currents from the Wando River. The pilot's strategy in making the turn was to take the vessel towards the mouth of the Wando River and let the currents turn the vessel to port. If the pilot turned too soon, the vessel would be set towards Drum Island. Three of the inbound ships left the starboard side of the channel prior to, during, or immediately after meeting the outbound ship.

None of the outbound runs left the authorized channel in Myers Bend or while turning from Drum Island Reach to Hog Island Reach. However, examination of the rudder angle plots shows that all outbound runs required sustained hard port rudder in Myers Bend and sustained hard starboard rudder while turning from Drum Island Reach to Hog Island Reach.

Plan 2-5 Conditions - Ebb Tide -

There were no instances of any ships leaving the channel while meeting. All of the inbound runs required hard port rudder for a sustained period of time while making the turn from Hog Island Reach to Drum Island Reach.

The test runs for the outbound ships were adequate in that one ship left the authorized channel in the Clouter Creek Reach before turning to the Navy Yard Reach. Examination of the rudder angle plots for all runs shows that all outbound runs required sustained hard port rudder in Myers Bend and sustained hard starboard rudder while turning from Drum Island Reach to Hog Island Reach.

The starboard corner of Daniel Island Bend caused difficulties for the pilots during this test scenario. Five of the ebb tide outbound runs during testing of the existing condition channel also cut this corner.

Plan 2-7 Conditions - Ebb Tide -

Considerable difficulties were experienced for these test conditions. Three of the inbound ships left the authorized Plan 2-7 channel while turning from Hog Island Reach to Drum Island Reach. One run successfully negotiated the turn from Hog Island Reach to Drum Island Reach, but left the authorized channel on the north side of Hog Island Reach prior to entering Myers Bend.

Three of the outbound vessels left the authorized channel in the Navy Yard Reach. All left the channel in the same area and none of the three left by more than 25 feet. Rudder angle plots show that the pilots did not use full rudder during the maneuver. Another ship left the channel at Myers Bend while turning onto Drum Island Reach. This incident was caused by the meeting scenario occurring on the southern end of the proposed Daniel Island Terminal. Analysis of the rudder angle plots show that all outbound runs required sustained hard port rudder in Myers Bend and sustained hard starboard rudder while turning from Drum Island Reach to Hog Island Reach.

The pilots on outbound runs also experienced problems at the corner of the Daniel Island Bend. The ships cut the starboard corner of the channel when the pilots turned too soon. Five of the outbound ebb tide runs in the existing channel cut this corner.

Table A-12

Clearances, Test Reach H, Ebb Tide

Inbound Pilots	Outbound Pilots	Clearance at Time of Meeting, ft			Distance in ft of Rudder used North of Bridge, Outbound Only	
		Between Ships	Inbound Ship to Channel	Outbound Ship to Channel		Notes
Existing Conditions						
2	1	313	14	-43	Still turning under bridge.	Inbound ship left Daniel Island Reach by 75 ft just prior to meeting. Outbound ship left Clouter Creek Reach by 156 ft, Daniel Island Reach by 175 ft, and Drum Island Reach by 82 ft.
4	3	94	21	229	1000	Inbound ship left Drum Island Reach 177 ft and Daniel Island reach by 59 ft (just after meeting) and 15 ft.
5	6	87	132	137	Still turning at completion of run, 800 ft from bridges.	Inbound ship left Daniel Island Reach by 12 ft. Outbound ship left Daniel Island Reach by 194 ft.
6	5	404	28	99	Still turning under bridge.	Inbound ship left Daniel Island Reach by 20 ft just prior to meeting. Outbound ship left Daniel Island Reach by 270 ft.
7	8	246	172	-88	Still turning at completion of run, 250 ft from bridge.	Inbound ship left Hog Island Reach by 30 ft. Outbound ship left Clouter Creek Reach by 43 ft and Daniel Island Reach by 250 ft.
10	9	282	-62	114	300	Inbound ship left Drum Island Reach 64 ft. Outbound ship left Daniel Island Reach by 106 ft.
Plan 2-5						
1	2	375	231	185	1550	Outbound ship left Shipyard River by 44 ft and Drum Island Reach by 72 ft.
2	1	242	363	262	Still turning at completion of run at bridges.	Outbound ship left Daniel Island Bend by 160 ft.
4	3	217	272	166	700	inbound ship left Drum Island Reach by 79 ft, Daniel Island Reach by 30 ft and Daniel Island Bend by 10 ft.
5	6	443	394	42	550	
6	5	385	378	105	Still turning at completion of run, 400 ft from bridges.	
10	9				650	Inbound run aborted due to equipment failure
Plan 2-7						

Maximum Ebb Tide						
1	2	305	251	265	850	Inbound ship left Drum Island Reach by 21 ft. Outbound ship left Navy Yard Reach by 123 ft, Drum Island Reach by 196 ft and Hog Island Reach by 99 ft.
3	4	264	136	-200	1600	inbound ship left Hog Island Reach by 202 ft and Drum Island Reach by 32 ft. Outbound ship left Drum Island Reach by 260 ft.
3, run 2	4, run 2	474	175	150	1200	Inbound ship left Hog Island Reach by 15 ft. Outbound ship left Navy Yard Reach by 32 ft and Daniel Island Reach by 55 ft.
4	3	503	301	-72	Still turning at completion of run at bridges.	Outbound ship left Daniel Island Reach by 33 ft, just south of the turning basin.
5	6	220	407	110	750	Outbound ship left Drum Island Reach by 28 ft.
6	5	476	243	107	Still turning at completion of run, 800 ft from bridges.	
7	8	216	417	209	Still turning at completion of run, 700 ft from bridges.	Outbound ship left Drum Island Reach by 21 ft.
8	7	323	428	143	Still turning at completion of run at bridges.	Inbound ship left Hog Island Reach by 183 ft. Outbound ship left Navy Yard Reach by 60 ft and Drum Island Reach by 22 ft.
9	10	349	328	169	900	Outbound ship left Drum I. Reach by 25 ft.
Three-Quarter Ebb Tide						
7	8	340	309	123	1600	Outbound ship left Navy Yard Reach by 30 ft and Drum Island Reach by 172 ft.
10	9	314	432	40	1150	
One-Half Ebb Tide						
8	7	314	336	232	1800	
10	9	319	306	142	650	

Existing Conditions - Flood Tide -

Four of the six inbound runs had no incidences of going outside of the authorized channel. On one instance a collision occurred between a container ship attempting to make an inbound run from Hog Island Reach to Navy Yard Reach. The pilot experienced problems while making the turn from Hog Island Reach to Drum Island Reach when he reversed the rudder from port to starboard, and then reversed the rudder again from starboard to port. This forced the vessel out of the channel and the pilot never completely recovered control. The pilot then turned late coming out of Myers Bend onto the Daniel Island Reach, crossing the channel and striking the tanker docked at the Exxon Pier. The parameter plots show that all of the inbound runs required extensive use of hard rudder to make the turns from Hog Island to Drum Island and from Myers Bend to Daniel Island Reach. Meeting and passing required brief periods of maximum rudder, especially those meeting in the Daniel Island Bend.

The outbound runs show two areas the pilots consistently had problems with. Three of the six runs went out of the channel in the Navy Yard-Clouter Creek Reaches and three pilots went out along the northern Daniel Island Reach. The major factor for this is that this is also the area that the ships met and passed. The parameter plots show that the pilots required extensive use of maximum rudder to make the turns from Daniel Island Bend to Daniel Island Reach, Myers Bend to Drum Island Reach, and Drum Island to Hog Island Reaches. However, all of the meetings and passings were performed with adequate distance between the vessels as shown in Table A-13.

Plan 2-5 Conditions - Flood Tide -

The inbound runs were performed with little apparent difficulty. There were two incidences of going out of the channel, both at the Daniel Island Bend and both while meeting and passing the outbound ship near the bend. The parameter plots show that turns from Hog Island to Drum Island and Drum Island to Myers Bend still required extended use of maximum rudder but engine rpm was usually well under maximum power, so that the pilots had more maneuvering capabilities than they used.

The outbound runs still show tendencies for the pilots to go out along the Navy Yard-Clouter Creek Reaches. The parameter plots show that the pilots tended to use less than maximum engine power for most of the runs and required extensive maximum rudder values to make the turns at Daniel Island Bend, Myers Bend, and from Drum Island to Hog Island.

Plan 2-7 Conditions - Flood Tide -

Test conditions for Plan 2-7 were run for various flood tide intensity conditions. These conditions were; full flood tide, three-quarter flood tide, and one-half flood tide.

Full Flood Tide - The inbound transits were made with less difficulty than the outbound transits. Four out of eight runs experienced the ship leaving the channel. Three of those runs had the ships out of the channel by 25 feet or less. The other instance was at the Daniel Island Bend and largely due to meeting and passing the inbound ship in the bend. The parameter plots show that most pilots used just enough engine rpm to maintain steerage and occasionally increased power when extra maneuvering power was needed. There was much rudder activity with extensive use of maximum rudder to make the turns in the bends. Although large amounts of rudder were used, engine power was usually less than full power, so the pilots had reserve maneuvering capacity that was not utilized.

For the outbound tests, seven out of eight runs left the channel. The majority of these incidences occurred in the Navy Yard-Clouter Creek and Daniel Island Bend areas as was experienced in the existing condition runs. The parameter plots show that most of the outbound runs were performed with less than full power for the majority of the transits. There was extensive rudder activity and extended usage of full rudder in the bends, but as with the inbound ships, the pilots usually had additional engine power in reserve. Furthermore, clearance distances between the two vessels as they met and passed was more than adequate.

Three-Quarter Flood Tide - The parameter plots show that two outbound pilots and one inbound pilot normally used less than full engine power for most of their transits. These pilots also only used short durations of maximum rudder. Meeting and passing was performed with no difficulty in this test scenario.

One-Half Flood Tide - Two test runs were made for this simulation condition. In one run the inbound ship started turning late, then mid-way thru the turn backed off of the engine and rudder for a short time. Once realizing the ship was not going to make the turn, the pilot applied maximum engine and rudder but could not keep the ship from leaving the channel. The outbound vessel also experienced problems due to a late turn resulting in the vessel leaving the channel at the northern limit. The second meeting and passing test run was completed without incident.

Table A-13

Clearances, Test Reach H, Flood Tide

Inbound Pilot	Outbound Pilot	Clearance at Time of Meeting, ft			Distance Rudder used North of Bridge, Outbound Only	Notes
		Between Ships	Inbound Ship to Channel	Outbound Ship to Channel		
Existing Conditions						
2	1	138	135	44	Run terminated before turn to bridges.	Outbound ship left Navy Yard Reach by 140 ft.
3	4	339	-49	-23	1100	Inbound ship left Drum Island Reach by 130 ft, hit ship docked at Exxon Pier, and left Daniel Island Bend by 324 ft. Outbound ship left Daniel Island Reach by 223 ft, Drum Island Reach by 79 ft, and Hog Island Reach by 220 ft.
5	6	379	184	-191	1700	Outbound ship left Daniel Island Reach by 209 ft.
6	5	343	55	-47	1650	Outbound ship left Clouter Creek Reach by 106 ft, Daniel Island Reach by 87 ft, and Hog Island 94 ft.
7	8	129	-45	188	1650	Inbound ship left Daniel Island Reach twice, by 22 ft on southern end and 47 ft on northern end. Outbound ship left Navy Yard Reach by 23 ft.
9	10	377	44	-83	1500	Outbound ship left Daniel I. Reach by 68 ft.
Plan 2-5						
1	2	262	460	61	Run terminated before turn to bridges	Outbound ship left Navy Yard Reach by 157 ft.
2	1	388	361	-78	1150	Outbound ship left Clouter Creek Reach by 33 ft, and Daniel Island Bend by 3 ft.
3	4	372	404	13	1400	Outbound ship left Hog I. Reach by 212 ft.
4	3	349	-11	5	Run terminated before turn to bridges	Inbound ship left Daniel Island Reach by 59 ft. Outbound ship left Clouter Creek Reach by 83 ft.
5	6	325	239	31	1650	Outbound ship left Daniel Island Bend by 10 ft.
6	5	292	102	34	Still turning at completion of run.	Inbound ship left Daniel I. Bend by 10 ft.

Plan 2-7						
Maximum Flood Tide						
2	1	360	-37	-17	1500	Inbound ship left Daniel Island Bend by 97 ft and Clouter Creek Reach by 18 ft. Outbound ship left Daniel Island Bend by 133 ft.
3	4	308	412	49	1200	Outbound ship left Navy Yard Reach by 5 ft, Clouter Creek Reach by 31 ft, Daniel Island Bend by 119 ft, Daniel Island Reach by 35 ft, the starboard of Drum Island Reach by 32 ft side, the port side of Drum Island Reach by 14 ft, and Hog Island Reach by 198 ft.
4	3	370	332	54	1400	Inbound ship left Clouter Creek Reach by 25 ft. Outbound ship left Clouter Creek Reach by 89 ft.
5	6	295	258	90	1900	
6	5	343	271	-11	1200	Outbound ship left Daniel I. Bend by 78 ft.
7	8	242	398	112	1050	Outbound ship left Daniel I. Bend by 78 ft.
8	7	220	427	57	1750	Inbound ship left Drum Island Reach by 16 ft. Outbound ship left Navy Yard Reach by 11 ft.
9	10	262	244	83	550	Outbound ship left Daniel Island Bend by 59 ft, and Hog Island Reach by 546 ft.
Three-Quarter Flood Tide						
8	7	249	394	162	2150	Outbound ship left Daniel I. Bend by 15 ft.
10	9	309	203	83	1250	Inbound ship left Drum I. Reach by 245 ft. Outbound ship left Daniel I. Bend by 110 ft.
One-Half Flood Tide						
7	8	520	328	-95	2000	Inbound ship left Drum I. Reach by 125 ft. Outbound ship left Navy Yard Reach by 83 ft, Clouter Creek Reach by 110 ft, and Daniel Island Bend by 384 ft.
9	10	347	178	82	1400	Outbound ship left Daniel I. Reach by 28 ft.

Numerical sedimentation modeling of the Plan 2-5 design for the Daniel Island Terminal indicated extensive shoaling would occur in the Daniel Island Reach and along the proposed terminal. Testing, using the numerical sedimentation model, was performed to determine of this shoaling could be reduced. The plan developed would require the two right descending bank dikes to remain in place and would add a third dike near the existing position of the Navy degaussing station.

Test Reach I -

All runs were conducted as one-way runs (no meeting or passing) with ebb and flood tide, inbound from the Drum Island Reach and outbound from North Charleston with the existing and proposed channel conditions.

Existing Conditions - Ebb Tide -

Test runs for the inbound simulations were performed without great difficulty. All the pilots came close to or just crossed the channel edge. The parameter plots show much rudder activity to control the ship, but only brief use of maximum rudder values along with maximum engine rpm. The pilots had additional maneuvering capabilities in reserve that they did not require which is an indicator of good control of the ship and minimal maneuvering difficulty. This is reflected in the pilots' individual run evaluations which have relatively small values for danger of grounding or striking any objects.

The outbound ebb tidal test runs experienced good results with four of the five transits having little difficulty with the ships occasionally coming near the channel limit but not outside the channel. The parameter plots show that the engine rpm for most of the transits was at 40 to 60 percent of maximum power. This was to keep down the speed of the ship as it was going out with the ebb tide. The pilots usually applied maximum power to assist them in making the turn from Myers Bend to Drum Island and Drum Island to Hog Island Reach. Rudder activity was reduced as compared with runs going inbound against the ebb tide. The pilots only occasionally required a large sustained rudder value for most of the transit until reaching the Myers Bend-Drum Island-Hog Island Reach area.

Existing Conditions - Flood Tide -

Four of the five runs for the inbound test scenario show that the ships came near to or left the channel in several areas. The parameter plots show that the pilots all tended to use less than full engine power for most of the transits to keep the ship speed down. They occasionally used more power when they needed extra maneuvering capability. There was considerable rudder activity, but usually no extended use of large rudder values. The pilots all rated the individual runs as being relatively easy with little danger of grounding or striking an object.

All of the outbound runs show that the ships went out of or very near to the channel limit at one or more places throughout the transits. There was no pattern of problem areas and all incidences where the ships left the channel were less than 50 feet. The parameter plots show that all the pilots tended to use less than full engine power for most of the transits, only occasionally using full power for extra maneuvering capability. There is considerable rudder activity but only a few incidences of extended use of maximum rudder. The pilots tended to rate the transit as moderately difficult.

Proposed Conditions - Ebb Tide -

Most of the transits for the inbound runs of the proposed conditions on ebb tide appear to be somewhat more difficult than with the existing conditions. All of the runs tended to go near to or out of the channel limits more often than during the existing condition runs. This may be mostly due to the increased size and draft of the vessel use for the proposed conditions (960x130x45) versus the existing conditions (860x106x40). The parameter plots show that the pilots used more maximum rudder values for longer periods than with the existing conditions. This also points out the increased difficulty of the transits during the runs with the proposed conditions.

In two of the six outbound runs the ships left the channel in the Drum Island Reach. The other four runs have several incidences of very close clearances to the channel limits throughout the transits. The track plots indicate the proposed channel to be somewhat more difficult. The parameter plots show that the pilots tended to keep down the engine rpm to keep down the ships speed. Rudder activity appears to be greater than during the existing conditions. The pilots also appeared to use slightly more and longer durations of high rudder values to make the transits. This can be attributed to the larger, deeper draft vessel used for the proposed conditions and contributed to the higher difficulty ratings by some of the pilots.

Proposed Conditions - Flood Tide -

Four of the five ships on the inbound runs for the proposed flood tide conditions show that the ships went slightly out of the channel in several areas throughout the transit. The parameter plots show that the pilots tended to use less than maximum engine power to help keep the ship speed down. There is a lot of rudder activity, but not more so than the existing condition. The amount of rudder used and the duration of large rudder values is very similar to that of the existing conditions. This would seem to indicate that the proposed conditions were either little or no more difficult than the existing conditions, although most of the pilots rated the individual runs for the proposed plans to be more difficult than the existing conditions.

Most of the runs for the outbound tests show that the pilots came near to or went slightly outside the channel limits in one or more places throughout the transits.

All of the incidences of being outside the channel were by less than 50 feet except for one run. The parameter plots show about the same usage of engine and rudder as with the existing conditions. The pilots also tended to rate the individual runs as moderately difficult.

Recommended Plan -

The recommended channel design for the Charleston Harbor federal navigation channel is for a 45-foot deep channel with various improvements to channel alignments throughout the existing project area. These improvements have been discussed previously in this report in detail. Refer to Figure 11 in the main report for improved channel alignment.

The four main reaches of channel improvement are: Entrance Channel (Fort Sumter Range), Shutes/Folly Reach, Drum Island Reach, and Daniel Island Reach. Based on the recommendation from WES, the channel width in the Fort Sumter Range will be to reduce from 1000 feet to 800 feet for the deepened channel from the oceanward limit to station -112+00. The channel would remain 1000 feet wide from station -112+00 to station 36+00 for safer navigation through the jetties. This design was an outcome of the ship simulation study and the technical guidance of the pilots. The results of the ship simulation model indicated that a 800-foot channel width was sufficient for safe maneuvering of the design vessels. Although these results were a direct result of the pilots simulation runs, the pilots were not satisfied with the reduced channel width unless the outer 100-foot tracks will continue to be maintained at the 42-foot project depth. As a result of this agreement, the 1000-foot stretch of channel within the jetties could be reduced to 800-feet along with the remaining portion of Fort Sumter Range.

The realignment in the Shutes/Folly Reach was designed as a result of the need for additional reaches for meeting and passing of vessels. Because of the Cooper River bridges and the numerous turns and other navigational hazards in the harbor, this reach will provide for additional areas of meeting and passing in the lower harbor. Without this realignment, vessels could be delayed at the terminal or entrance channel by as much as 2 hours. The realignment will provide for an additional meeting and passing reach 10,275 feet in length.

The final reach where channel realignment will take place is the Daniel Island Reach. The Daniel Island Terminal will be constructed on the west side of Daniel Island along that reach of the channel. This terminal will be 7000 feet long with seven berths for container cargo operation. The berthing area will be

125 feet wide from the edge of the dock to the edge of the federal navigation channel. Since this reach will encounter a significant increase in vessel traffic from container ships docking at the new terminal, vessels traveling to the North Charleston Terminal, vessels going to Shipyard River, and vessels utilizing the Exxon pier, a channel accommodating two-way traffic is required. In the ship simulation study, vessels were tested for meeting and passing in this reach with vessels docked at the new terminal and the Exxon pier. The outcome of this study is a channel varying in width from 875 feet at the conjunction of Myers Bend to 600 feet at Daniel Island Bend. The berthing area for the Daniel Island Terminal is not included in that width. The southwest corner of the terminal will be located over the training dike extending from Daniel Island. This training dike will be removed in order for the terminal to be constructed in the proposed location. A turning basin was added to the channel design to accommodate the new terminal traffic. An economic study was conducted to determine the justification for an additional turning basin in this region. The results of this analysis confirmed that it would be more costly for the vessels to travel to the North Charleston Terminal turning basin and return to the Daniel Island Terminal than it was to construct a new turning basin in the Daniel Island Reach. Because of the significant expansion of channel area within the Daniel Island Reach, a significant increase in shoaling was predicted by the TABS model. To alleviate the predicted increase in shoaling, WES modeled the two existing training dikes along the west side of the Daniel Island Reach at full functioning condition with an additional training dike located just north of Shipyard River and the Navy degaussing pier. This design reduced the shoaling within the reach by 50%. The existing training dikes will be restored to their original condition when the third training dike is constructed. The design and construction of all three will be consistent.

Proposed Project Dimensions

Table A-14

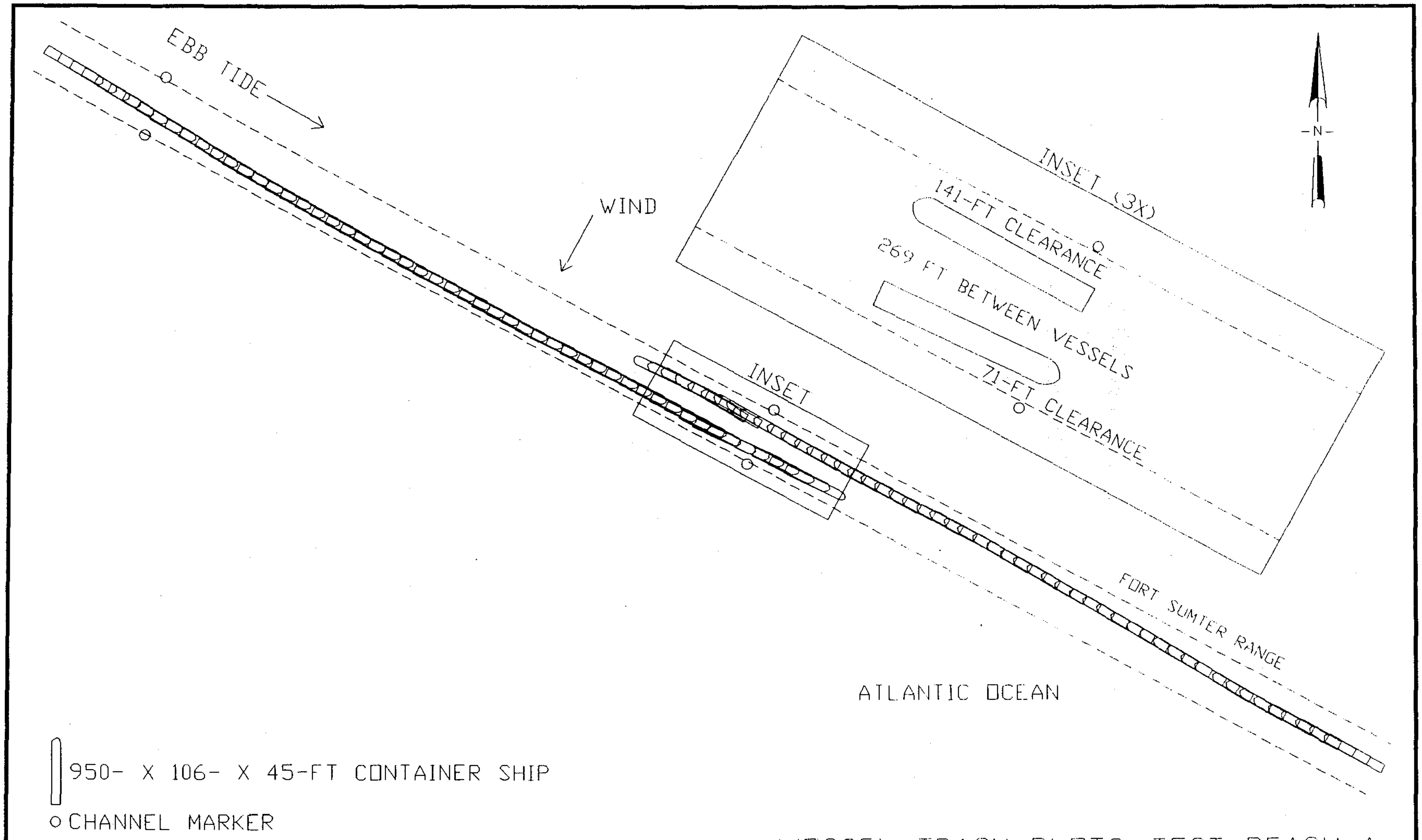
Section of Waterway	Depth (Below MLLW)	Width (Feet)	Channel Length (Miles)
Fort Sumter Range	47	800	16.25
Mount Pleasant Range	45	600-800	1.79
Rebellion Range	45	600	1.59
Shutes/Folly Reach	45	600	1.52
Horse Reach	45	600	0.49
Hog Island Reach	45	600	1.62
Drum Island Reach	45	800	0.96
Myers Bend	45	800	0.55
Daniel Island Reach	45	600-875	1.20
Daniel Island Turning Basin	45	1400	
Daniel Island Bend	45	700	0.65
Clouter Creek Reach	45	600	1.07
Navy Yard Reach	45	600-675	1.26
North Charleston Reach	45	500	1.18
Filbin Creek Reach	45	500	0.68
Port Terminal Reach	45	600	0.80
Ordnance Reach	45	1400	0.23
Custom House Reach	45	Varies	0.37
Lower Town Creek	45	400	0.47
Upper Town Creek	16	250	1.23
Shipyard River -			
Entrance Channel	45	300	0.53
Basin A	45	700	0.15
Wando Channel	45	400	2.08
Wando Turning Basin	45	1400	
Anchorage Basin	35	2250	1.40

APPENDIX B

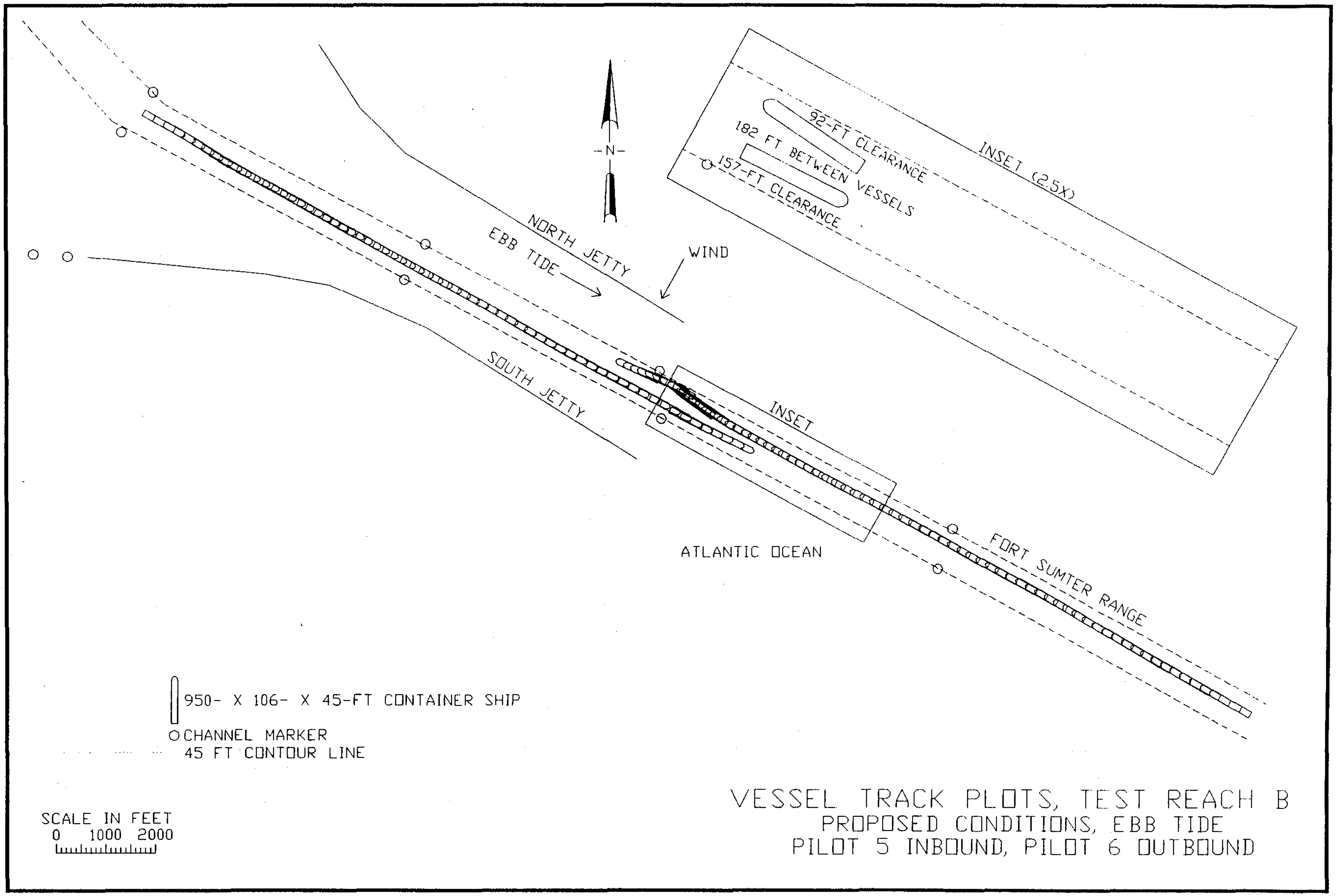
Geotechnical Investigations

SELECTED VESSEL

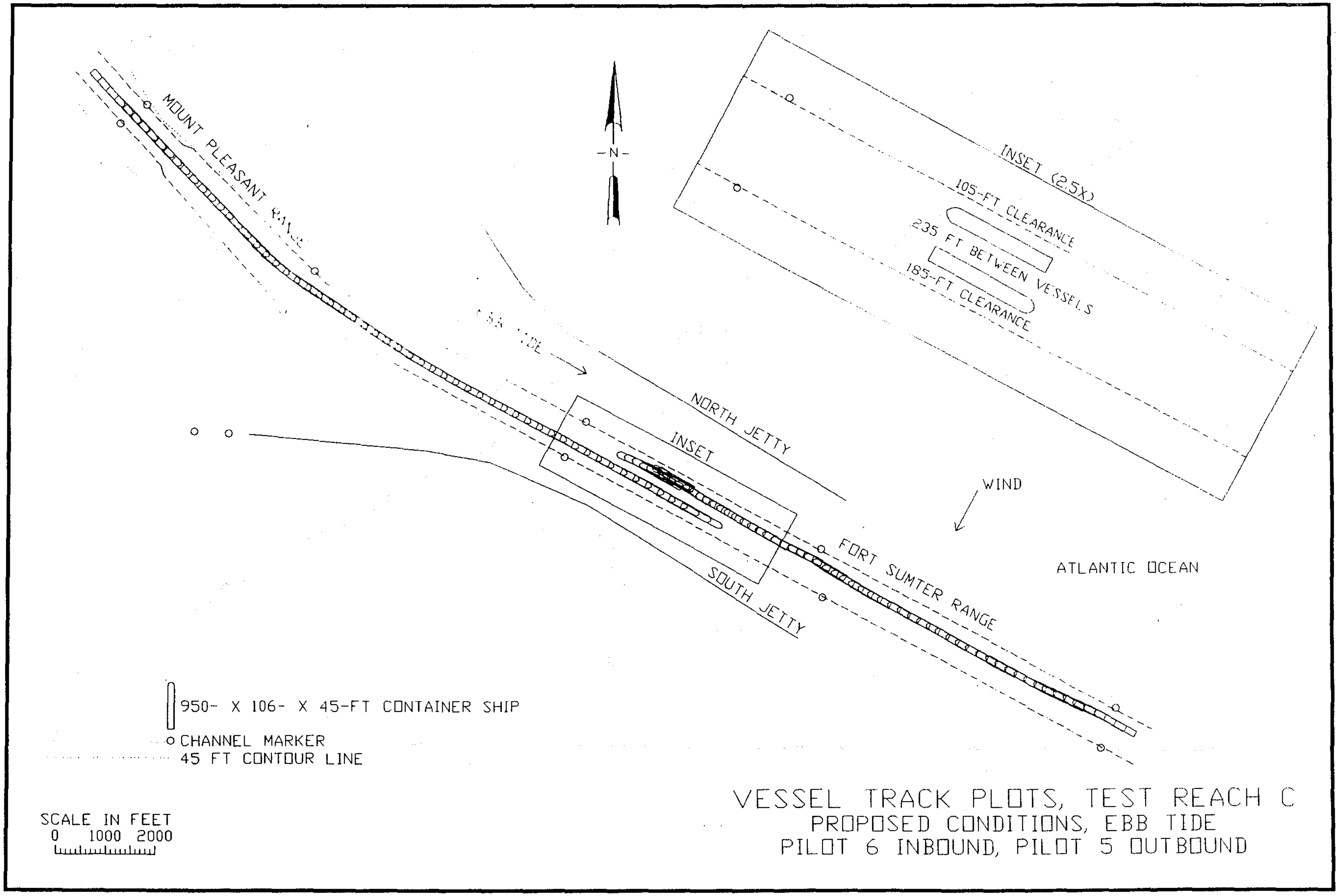
TRACK PLOTS



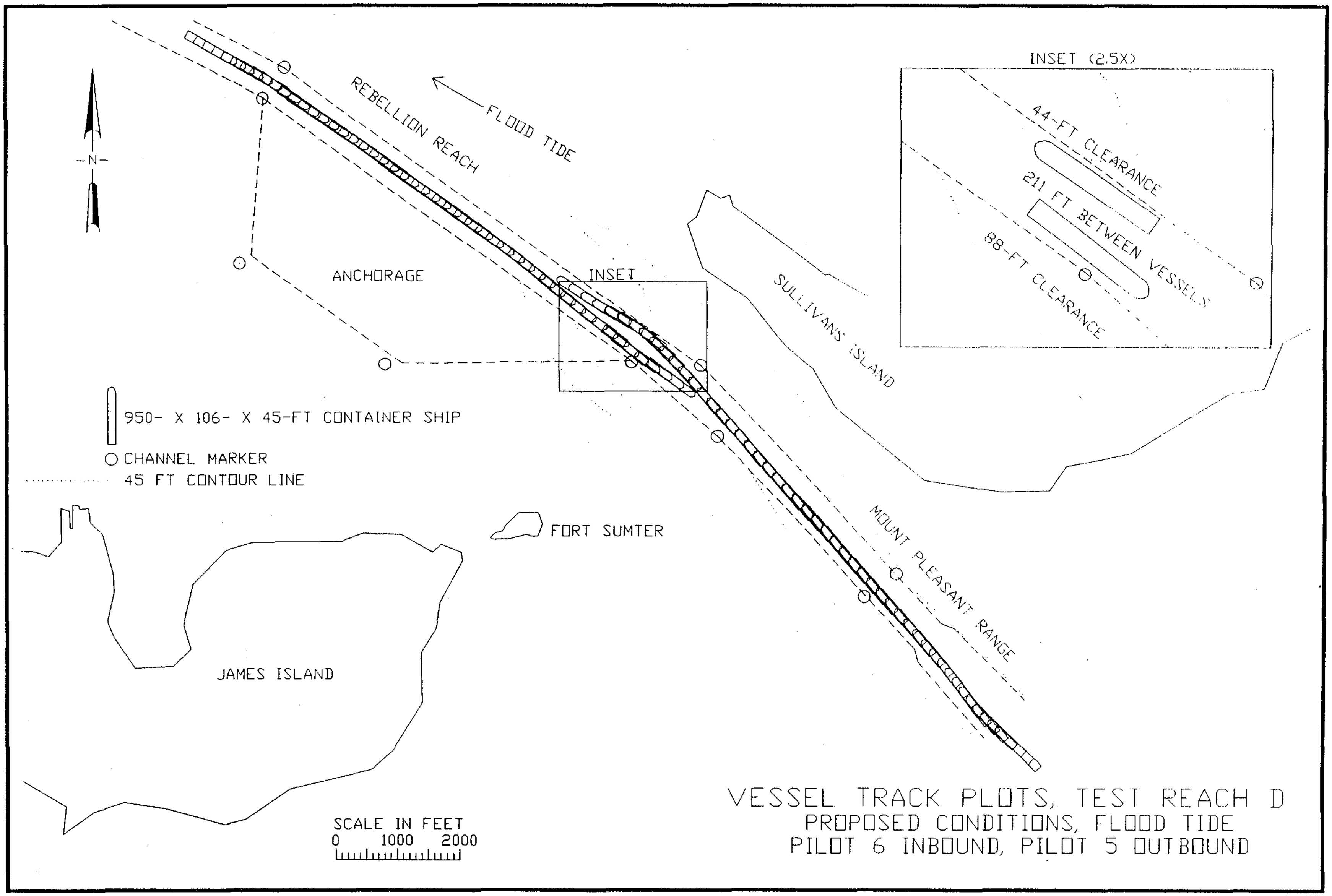
VESSEL TRACK PLOTS, TEST REACH A
PROPOSED CONDITIONS, EBB TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND



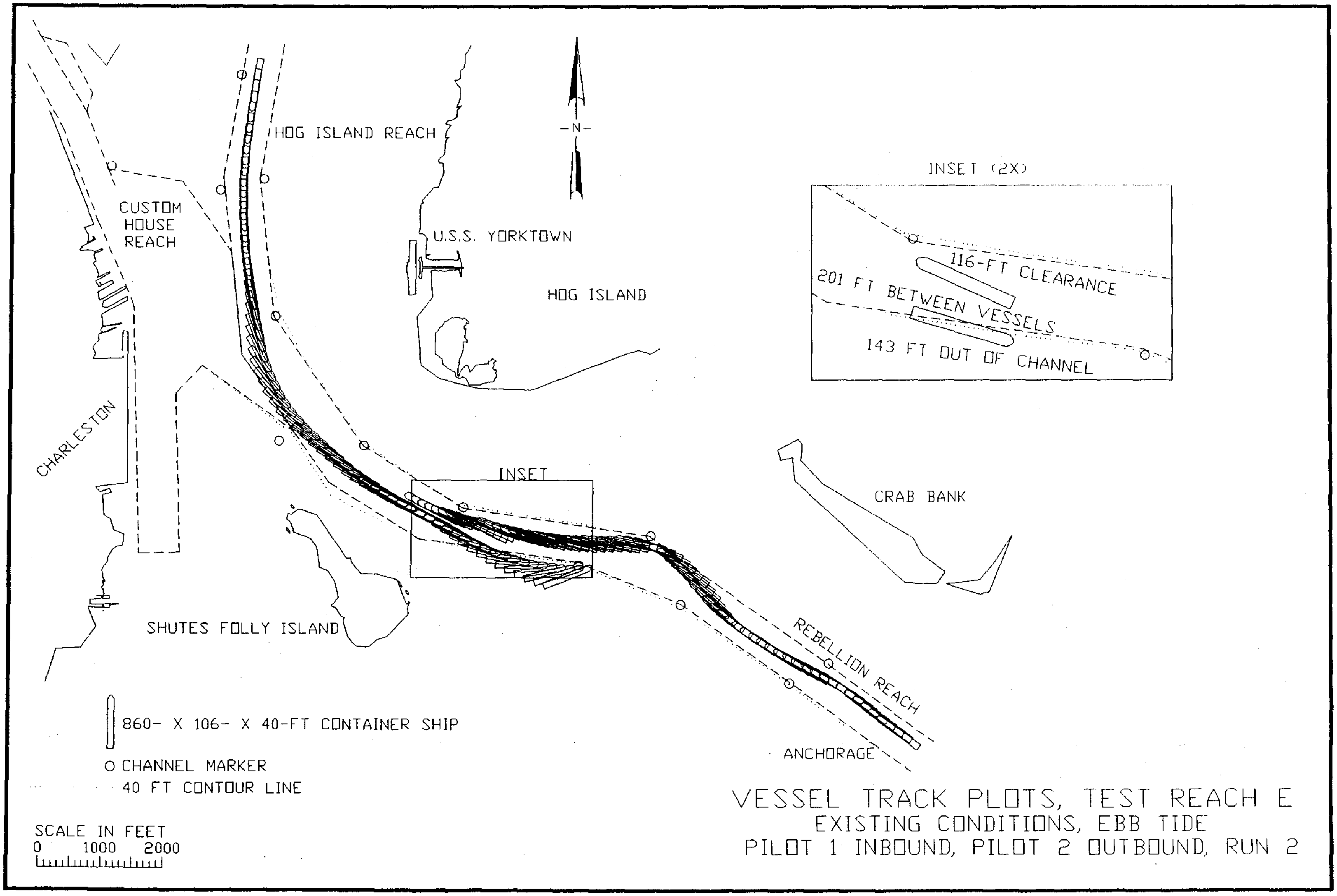
VESSEL TRACK PLOTS, TEST REACH B
PROPOSED CONDITIONS, EBB TIDE
PILOT 5 INBOUND, PILOT 6 OUTBOUND



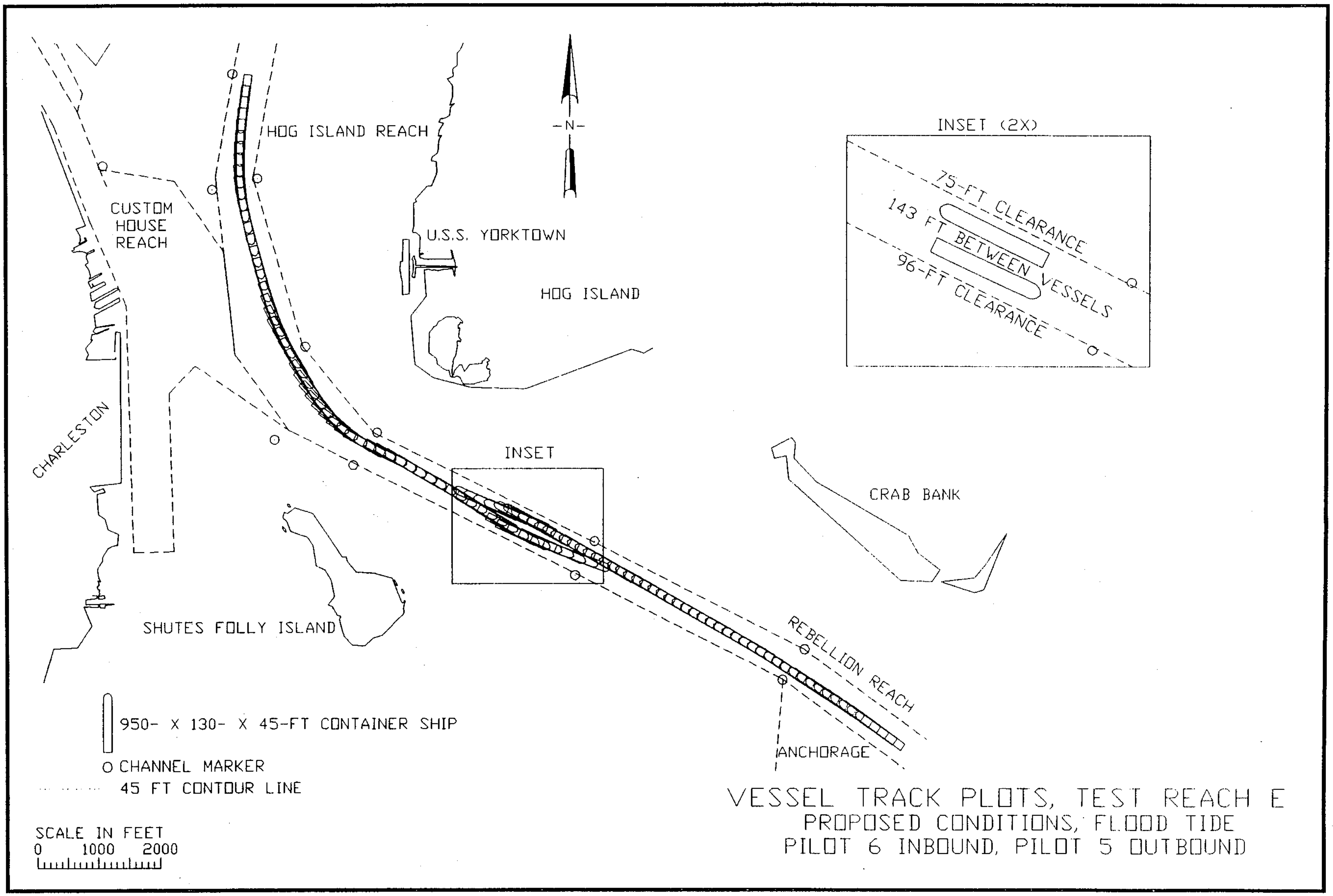
VESSEL TRACK PLOTS, TEST REACH C
PROPOSED CONDITIONS, EBB TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND



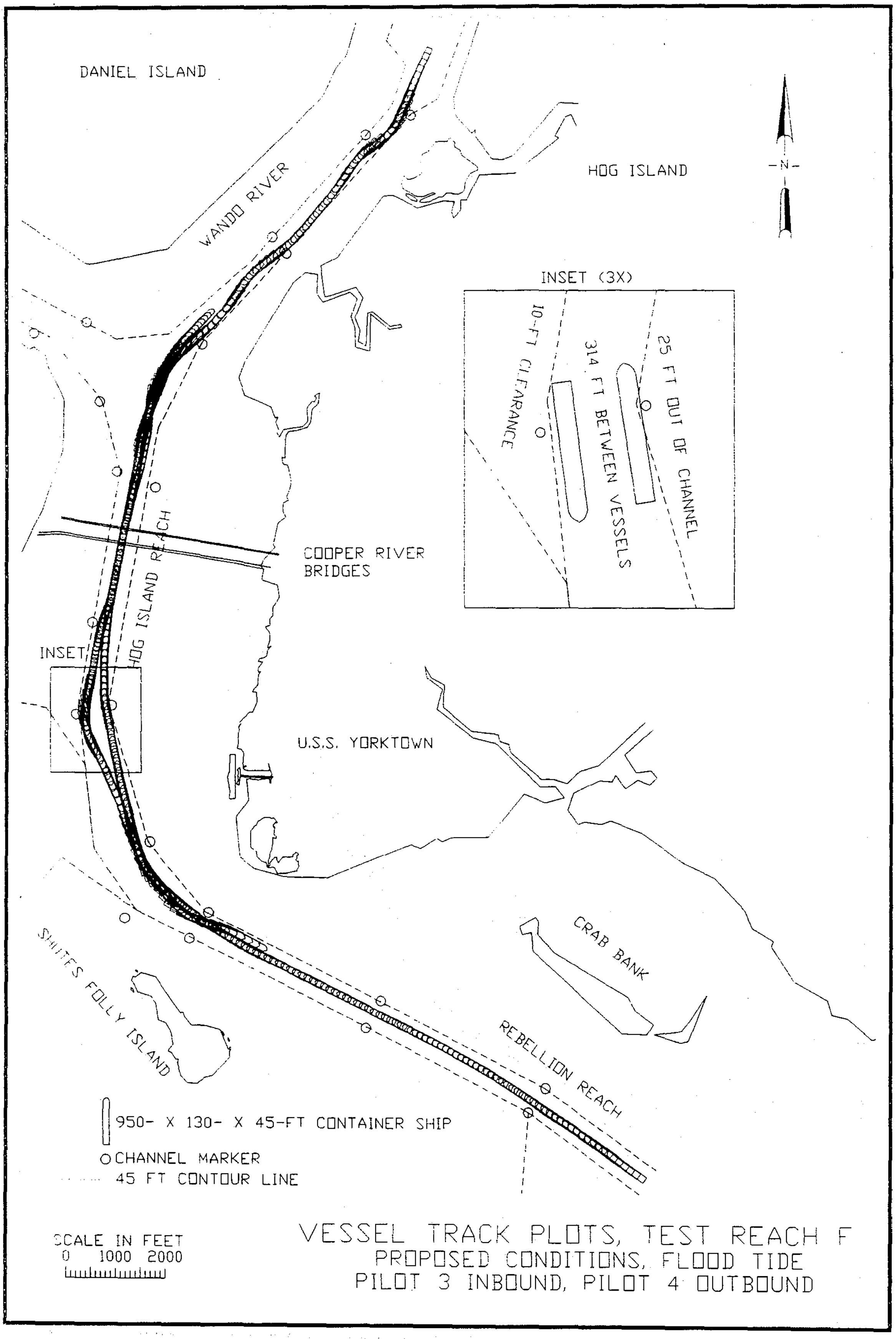
VESSEL TRACK PLOTS, TEST REACH D
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND



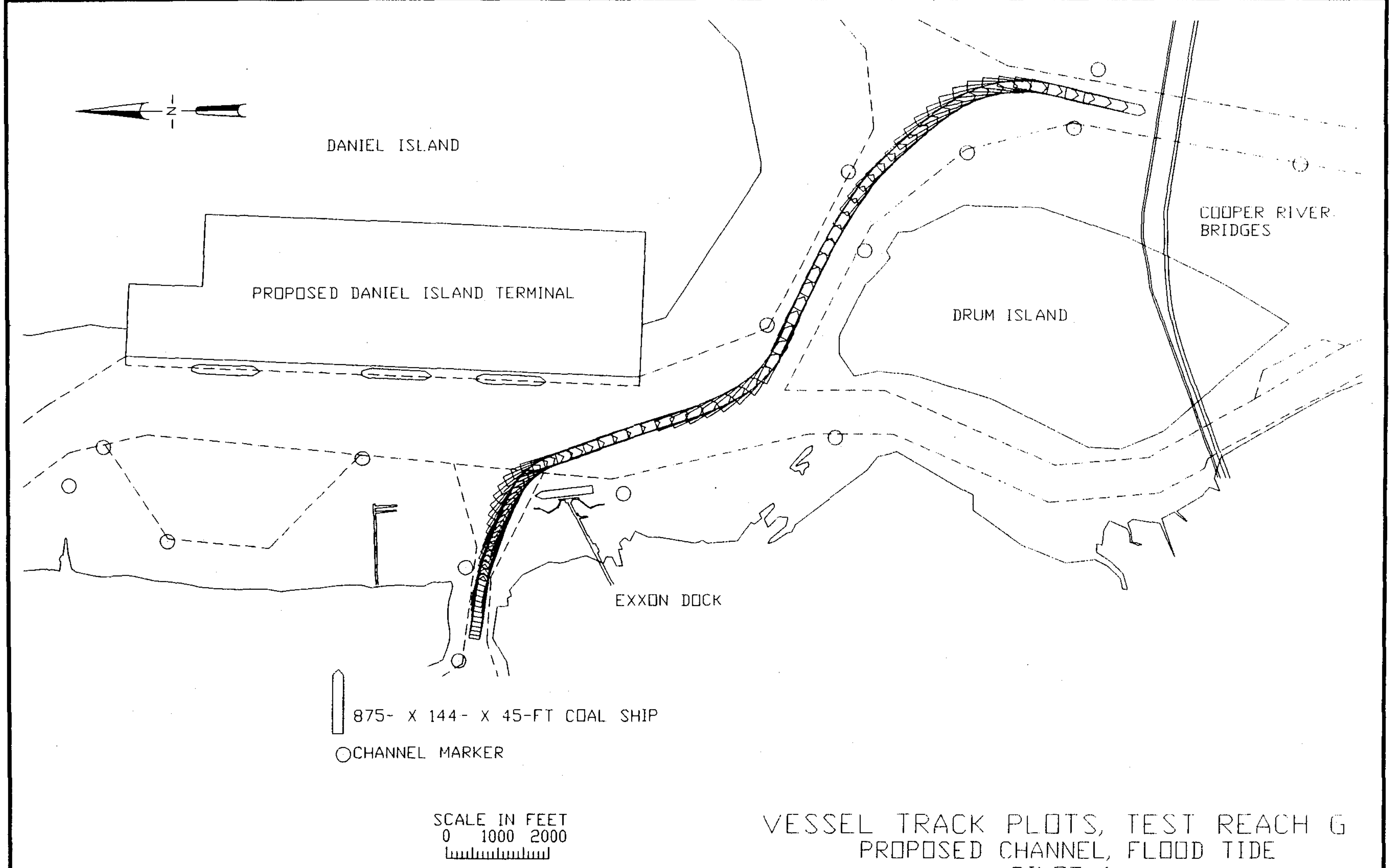
VESSEL TRACK PLOTS, TEST REACH E
EXISTING CONDITIONS, EBB TIDE
PILOT 1 INBOUND, PILOT 2 OUTBOUND, RUN 2



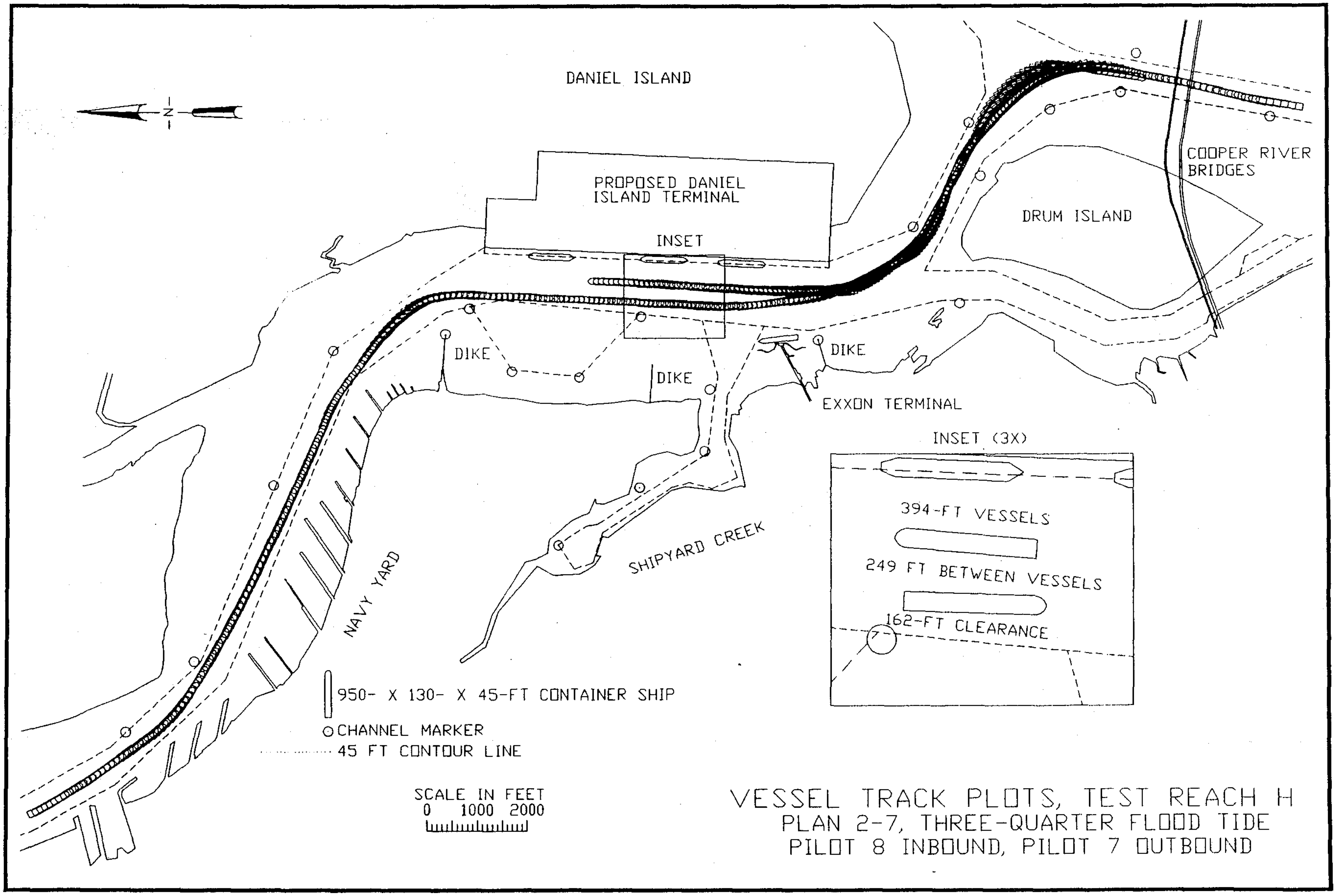
VESSEL TRACK PLOTS, TEST REACH E
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND



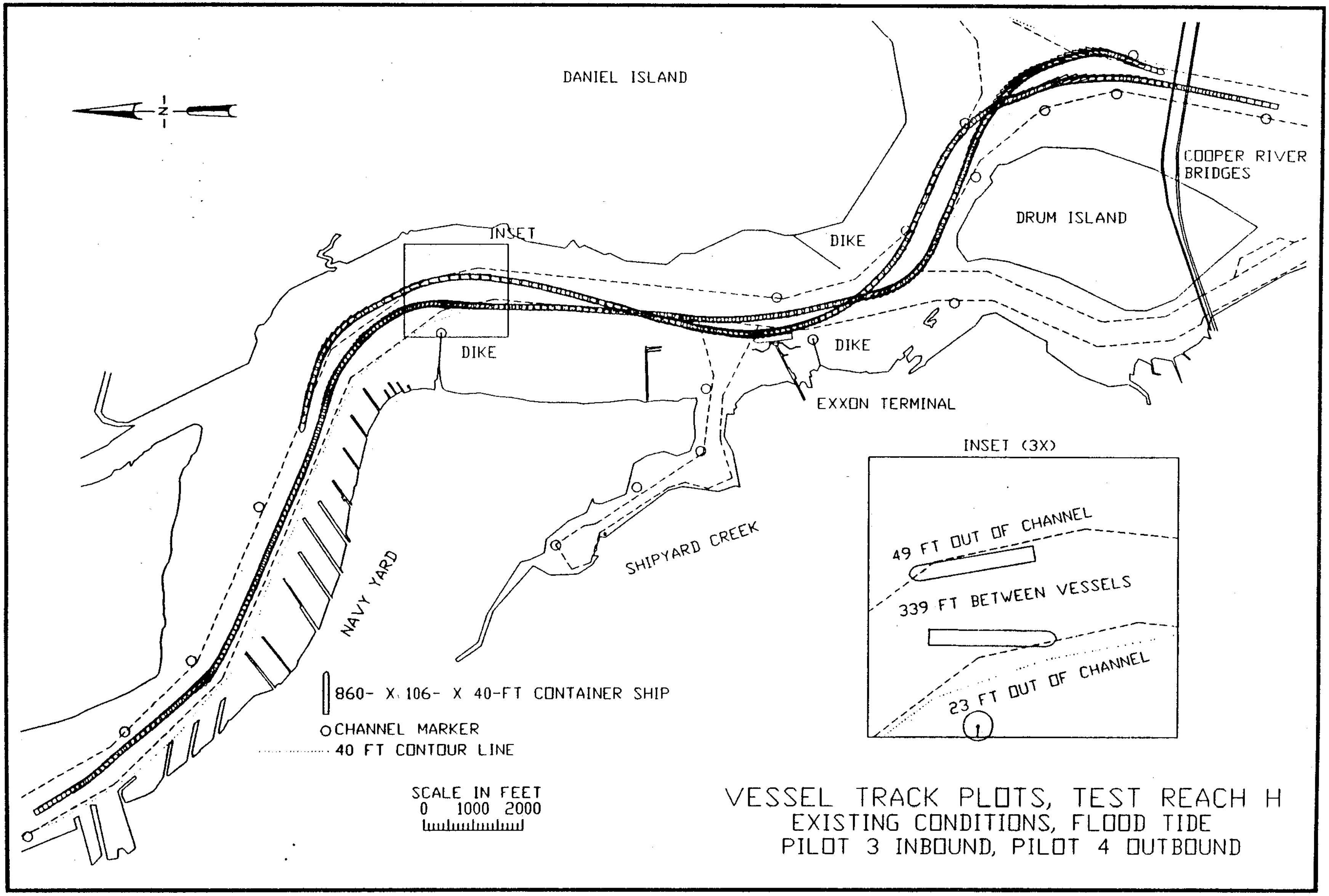
VESSEL TRACK PLOTS, TEST REACH F
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND



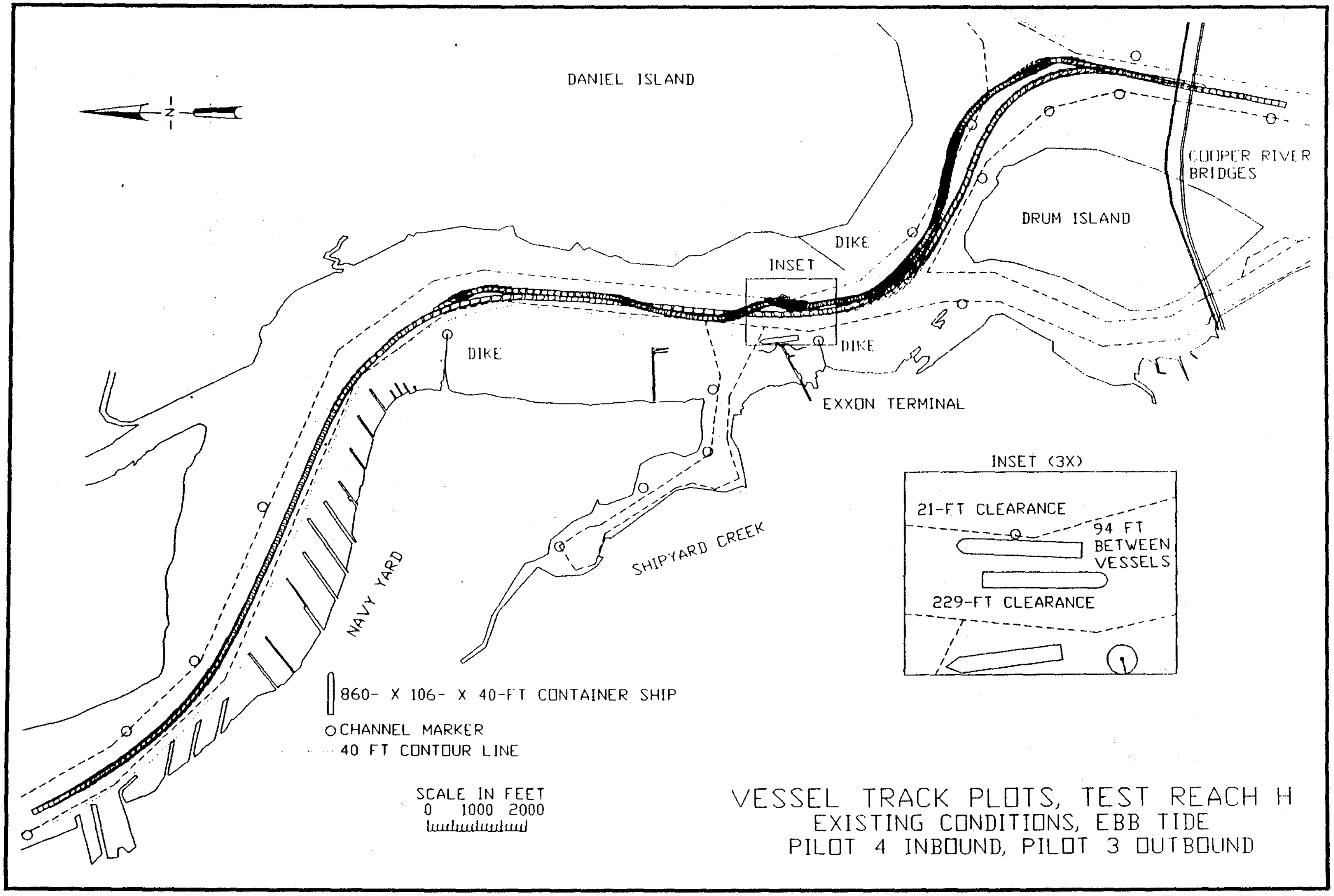
VESSEL TRACK PLOTS, TEST REACH G
PROPOSED CHANNEL, FLOOD TIDE
PILOT 6



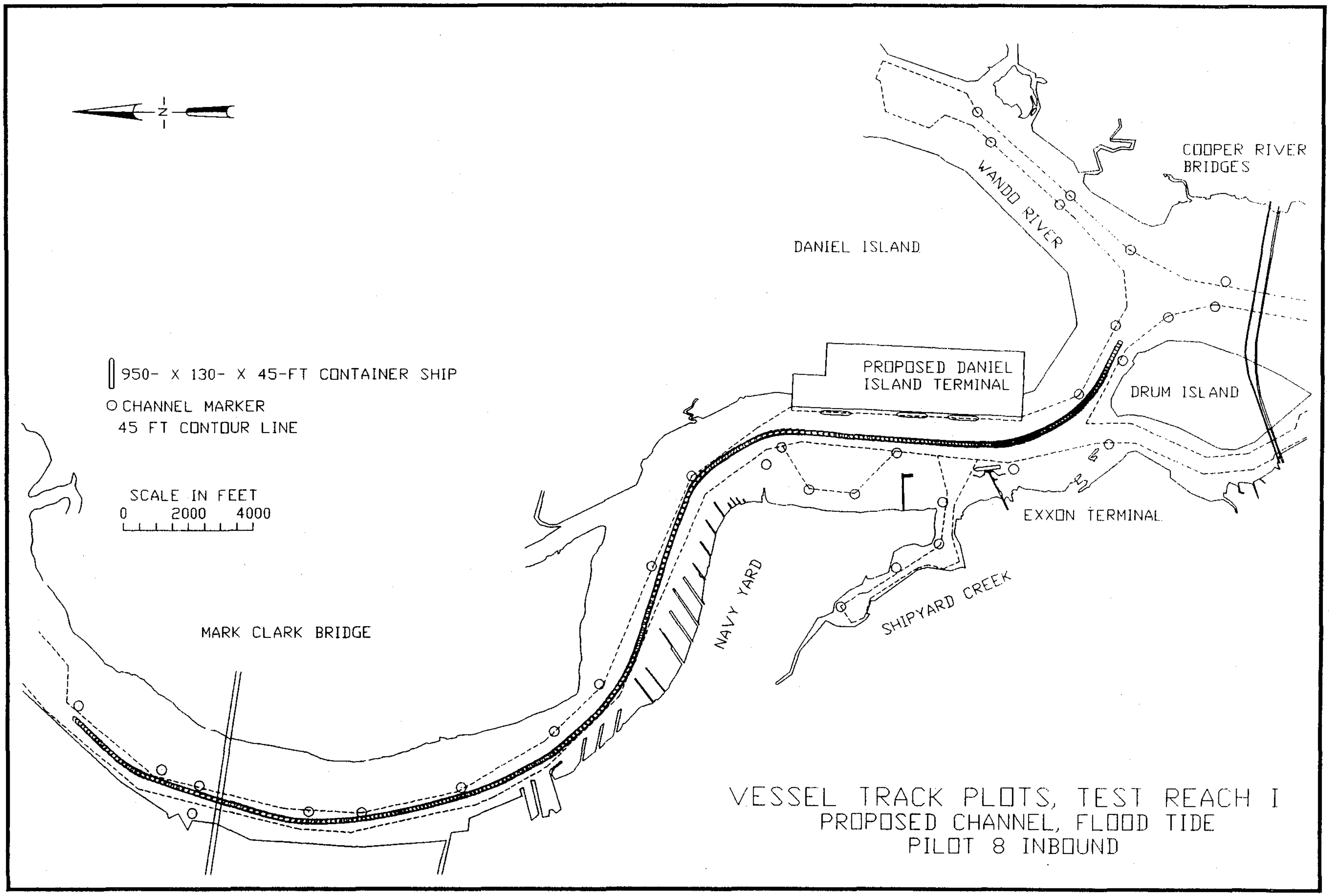
VESSEL TRACK PLOTS, TEST REACH H
PLAN 2-7, THREE-QUARTER FLOOD TIDE
PILOT 8 INBOUND, PILOT 7 OUTBOUND



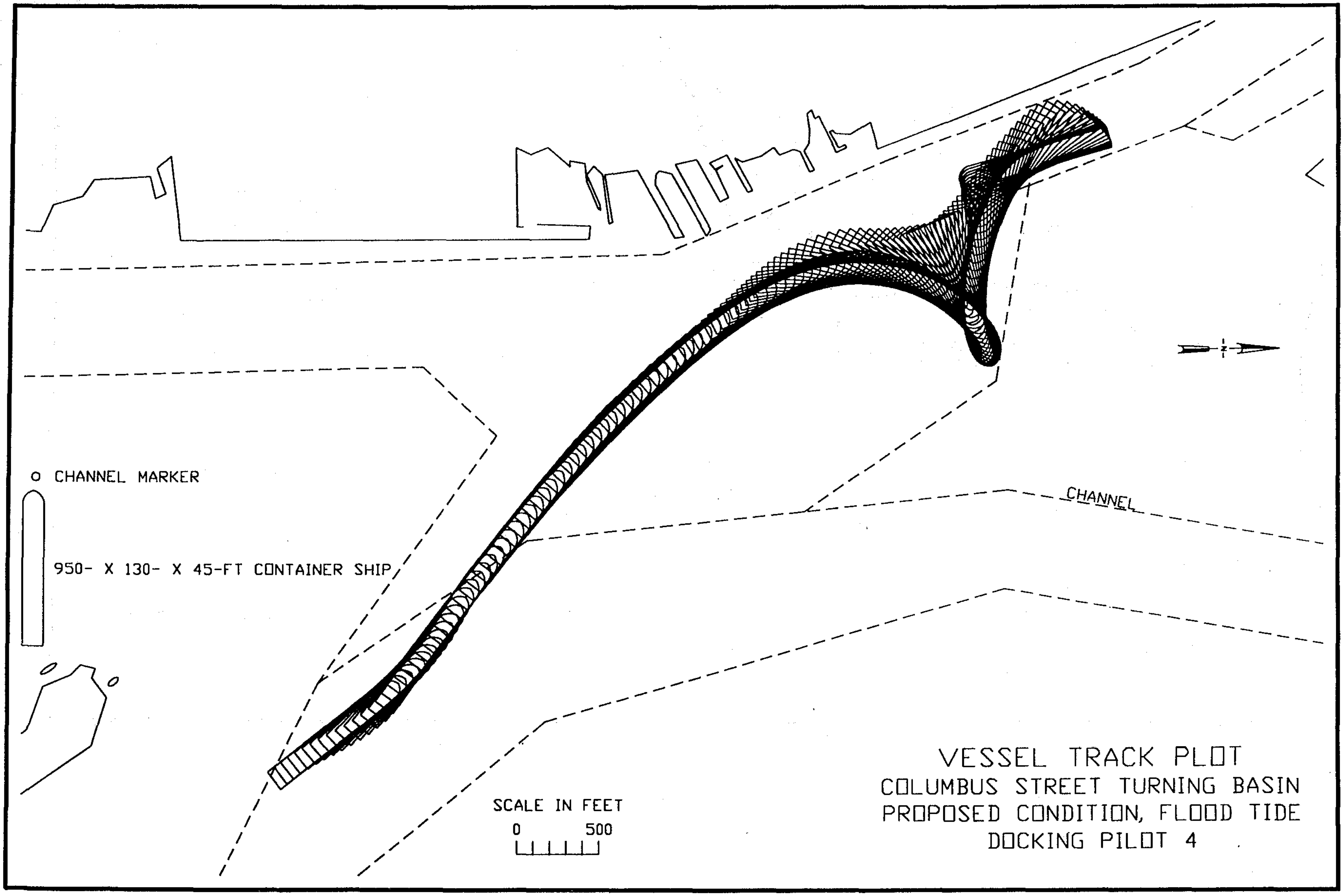
VESSEL TRACK PLOTS, TEST REACH H
EXISTING CONDITIONS, FLOOD TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND



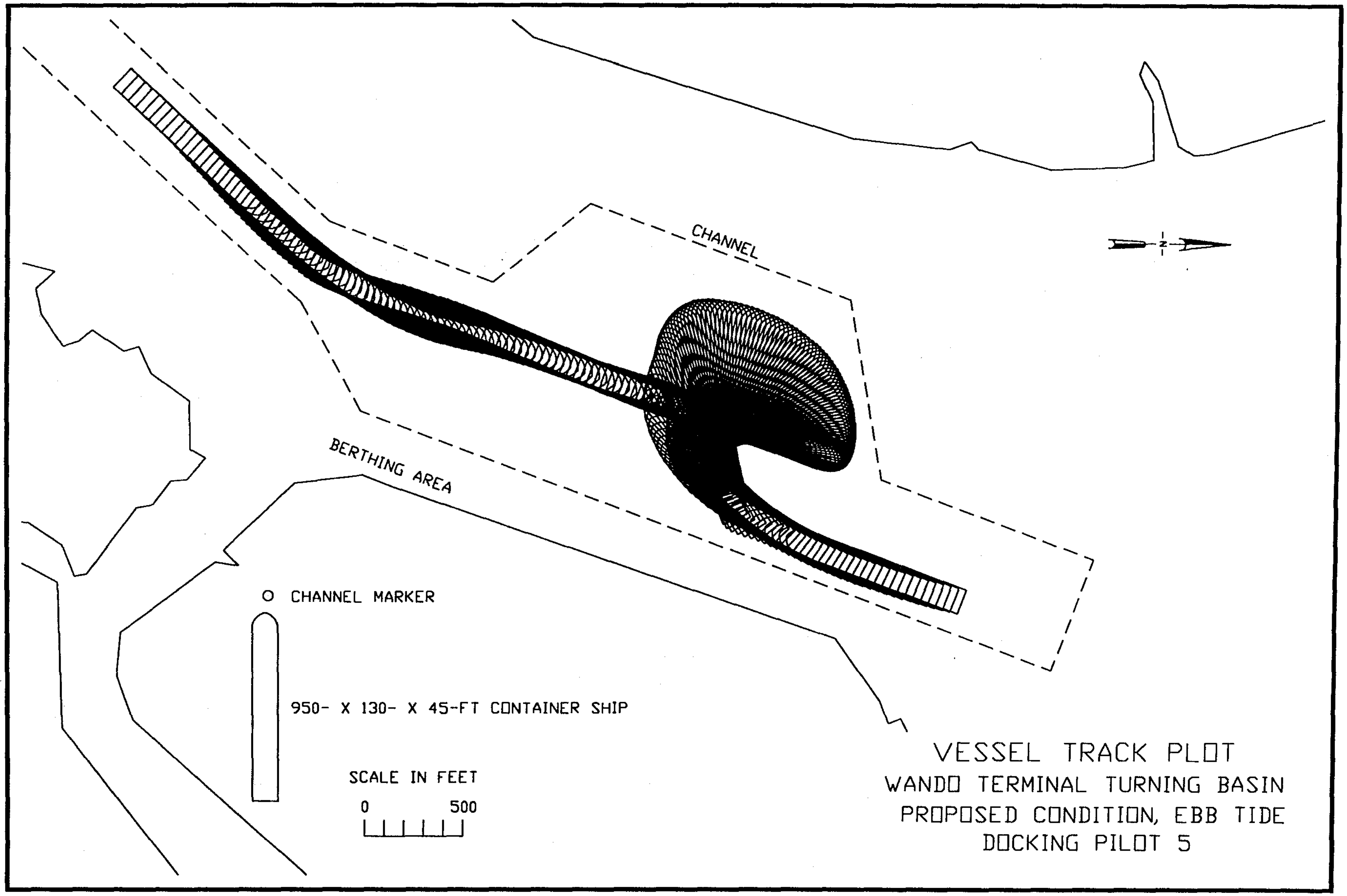
VESSEL TRACK PLOTS, TEST REACH H
EXISTING CONDITIONS, EBB TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND



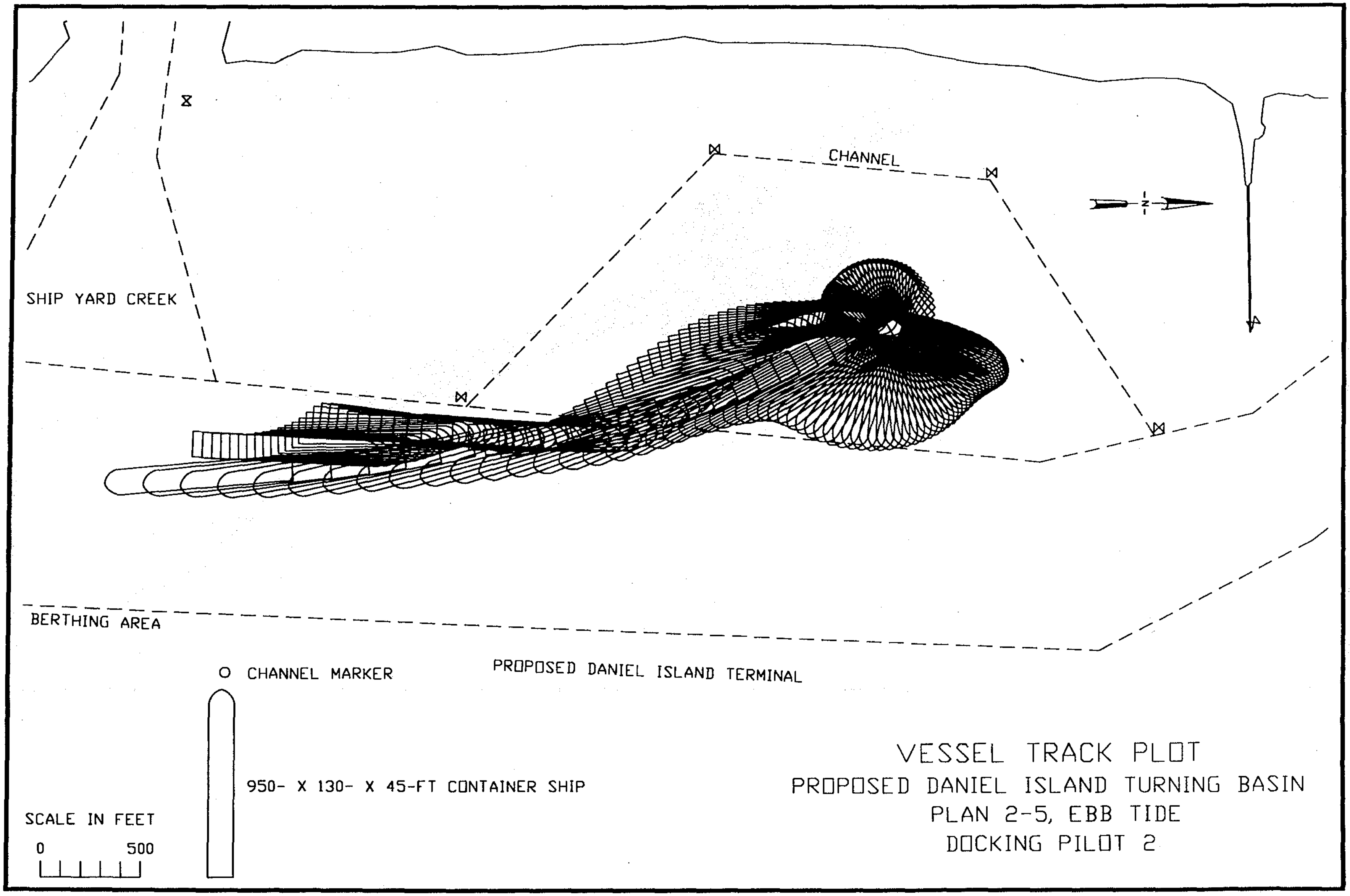
VESSEL TRACK PLOTS, TEST REACH I
PROPOSED CHANNEL, FLOOD TIDE
PILOT 8 INBOUND



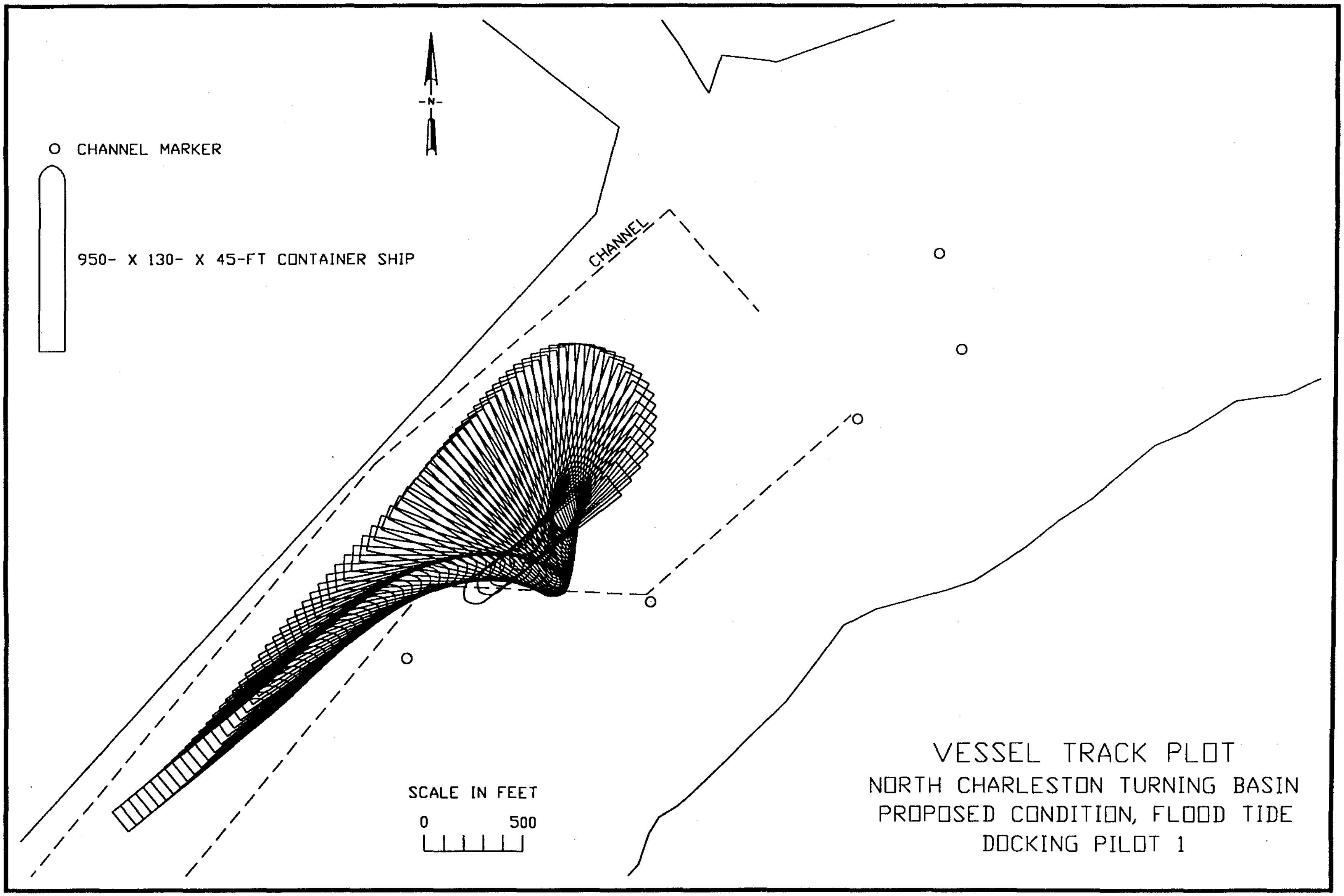
VESSEL TRACK PLOT
COLUMBUS STREET TURNING BASIN
PROPOSED CONDITION, FLOOD TIDE
DOCKING PILOT 4



VESSEL TRACK PLOT
WANDO TERMINAL TURNING BASIN
PROPOSED CONDITION, EBB TIDE
DOCKING PILOT 5



VESSEL TRACK PLOT
PROPOSED DANIEL ISLAND TURNING BASIN
PLAN 2-5, EBB TIDE
DOCKING PILOT 2



VESSEL TRACK PLOT
NORTH CHARLESTON TURNING BASIN
PROPOSED CONDITION, FLOOD TIDE
DOCKING PILOT 1

CONTENTS

LIST OF FIGURES

APPENDIX B

GEOTECHNICAL ANALYSIS

PURPOSE AND SCOPE

1. Previous soils investigations in the Charleston Harbor and Entrance Channel were conducted in 1986-1990, for deepening the harbor to a project depth of -40 feet MLLW with varying width, from the Entrance Channel at Station -700+00 to the turning basin in Ordnance Reach at Station 830+00, Shipyard River, and Wando River. The present study focusses on further deepening of the harbor to a depth between -41 feet and -46 feet MLLW, and the Entrance Channel to a depth between -43 feet and -48 feet. An additional 2 feet of advance maintenance and 2 feet of over depth would be allowed. The entrance channel will be extended to accommodate the increase in depth. Also, some realignment of the channel and new work dredging for a new port terminal are proposed. The purpose of this more recent 1994 subsurface investigation was to obtain supplemental soils information of the materials to be dredged to the depths proposed.

PREVIOUS INVESTIGATIONS

2. Previous investigations include Vibracore sampling, conducted in 1986 by Ocean Survey, Inc., using an OSI Model 1500 pneumatic powered Vibracore taking 20-foot samples. The Cores were logged, samples were field classified, and laboratory tests were performed to obtain grain-size distributions, and Atterberg limits. Pocket penetrometer test were also made on cohesive soils.

3. During the period 1988 to 1990, additional borings were made by the Savannah District, Corps of Engineers, using a Failing 314 drill rig mounted on the jack-up barge, Explorer. These borings were made to cover additional areas in the harbor and to obtain data not previously available. This equipment allowed for Standard Penetration Testing (SPT) in the subbottom soils and coring in cemented sands and rock.

4. Logs of borings and results of tests are available in the District Office. A portion of the logs from previous investigations are included on the figures.

1994 INVESTIGATIONS

5. In April 1994, a seismic (acoustic) subbottom survey was conducted by the Corps of Engineers Waterways Experiment Station. This geophysical survey utilized a low-noise, high-resolution acoustic subbottom imaging system to

determine the depths and nature of subbottom soil layers which lie along the channel alignment. The equipment was installed aboard the WES research vessel Waterways Explorer, a 36-foot tri-pontoon boat. Subbottom survey lines were run in the Entrance Channel, the inner harbor from Mount Pleasant Range to Ordnance Reach, Town Creek, Shipyard River, and the Wando River. For the Entrance Channel (Fort Sumter Range), the survey was extended to Station -870+00.Interpretive geologic profiles were made from the continuous color subbottom profile records. These profiles, along with existing boring data, provide for an accurate depiction of subbottom soil layers. A portion of these profiles are

Station 435+00 in Myers Bend Reach through Daniel Island Reach, Daniel Island Bend Reach, Clouter Creek Reach, Navy Yard Reach, North Charleston Reach, Filbin Creek Reach, Port Terminal Reach, and Ordnance Reach to about Station 840+00. A cross section of the channel at Station 498+00 in Daniel Island Reach is shown on Figure 9. Top elevations of soil borings and existing ground surface vary due to dredging subsequent to drilling.

DREDGING OF PREDOMINANT SOILS

14. Presently, dredging in the outer channel could be as deep as -51 feet MLLW (project depth at -47 feet MLLW with 2-foot advanced maintenance and 2-foot over depth) and in the inner harbor as deep as -49 feet MLLW (project depth at -45 feet MLLW with 2-foot advanced maintenance and 2-foot over depth). The cemented sand and shell and soft limestone encountered in the Entrance Channel will be the most difficult material to excavate using conventional dredging techniques, especially if only a thin layer is to be removed. Although bottom materials are not entirely uniform, these materials represent perhaps 2/3 to 3/4 of the soils to be removed in the Entrance Channel. The rest of the outer channel, particularly within the jetties, consists of stiff olive green, calcareous, over consolidated silts and clays and dense silty and clayey sands belonging to the Ashley Formation. These soil types predominate also along the bottom over the length of the inner harbor. These soils generally have high plasticity, tend to form clay balls in the slurry, are dredged at reduced production rates, and require additional effort, i.e., booster pumps, to transport by pipeline. Overburden soils on the channel side slopes, which extend above the Ashley Formation, consist of very soft to soft clays and loose sands. These soil types can also be present on the bottom over the length of the channel in isolated pockets.

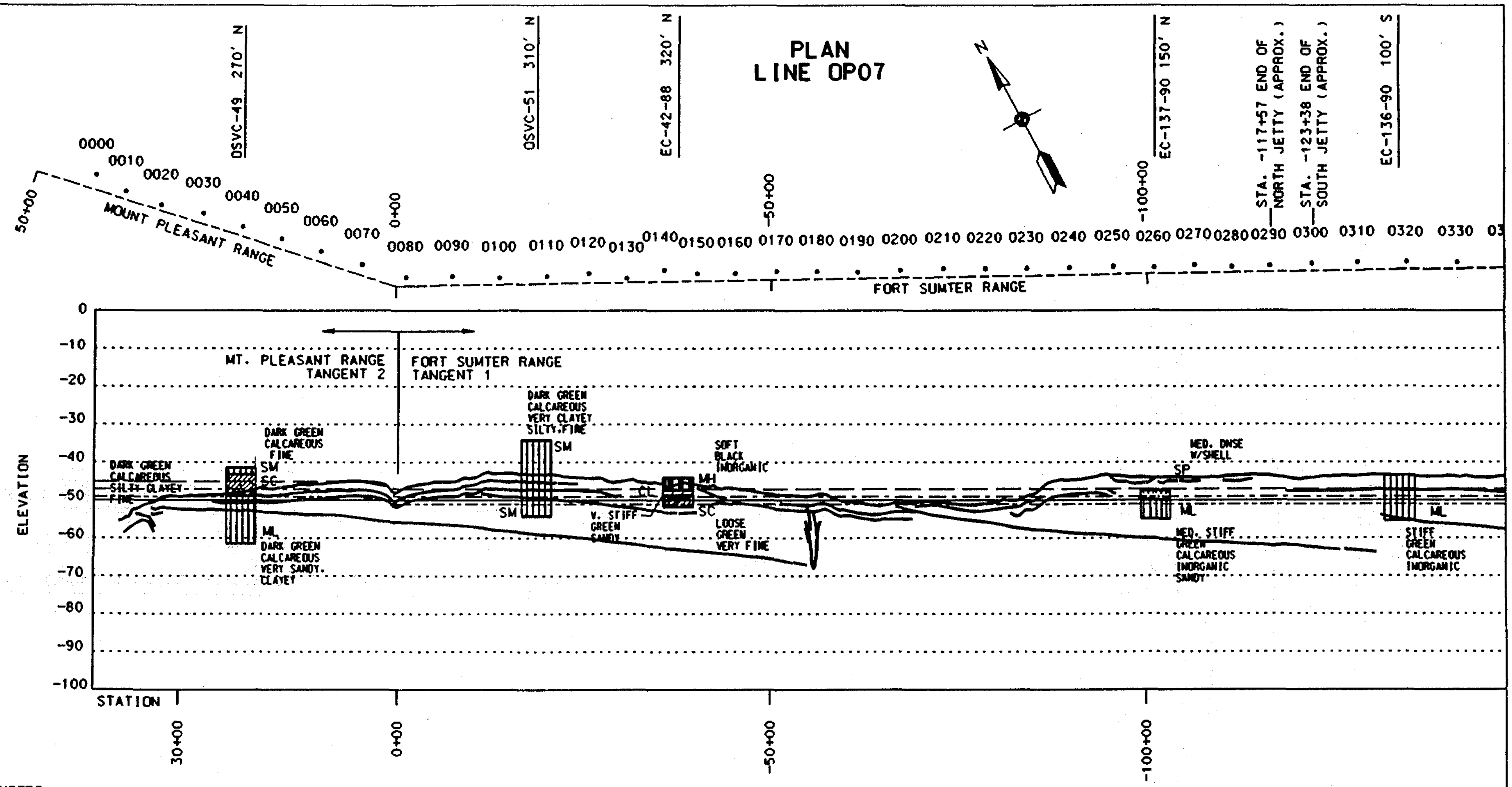
IMPACT ON AQUIFER

15. The major source of groundwater in the Charleston area as well as the rest of the Low Country are in the aquifers which lie below the Cooper Group. These are the Tertiary limestones, which include Santee limestone. Consequently, it is very important that there be no impact upon these aquifers caused by deepening the

depth of the channel excavation proposed for the harbor would have no impacts upon underlying aquifers.

USE OF DREDGED MATERIAL FOR BEACH RENOURISHMENT

17. Because of the predominant types of soils which are to be dredged, their use in beach renourishment is not considered to be practicable. There may, however, be some benefit in placing the cemented sand and shell material dredged from the Entrance Channel at offshore locations. When excavated, these materials tend to break down into medium to coarse sand and fine gravel size particles.



PLAN
LINE OP07

PROFILE - LINE OP07

FIG. 1

NOTES:
1. LINE OP07, INDICATED BY POINTS ON PLAN, ROUGHLY PARALLELS CENTERLINE OF EXISTING CHANNEL.
2. PROFILE CORRESPONDS TO POINTS ON PLAN WHICH INDICATE LOCATIONS WHERE ACOUSTIC RECORDS WERE TAKEN.
3. TOP ELEVATION OF SOIL BORINGS VARY FROM EXISTING GROUND SURFACE DUE TO DREDGING SUBSEQUENT TO DRILLING.
4. REFER TO BORING LOGS AND TEST RESULTS FOR COMPLETE SOIL DESCRIPTIONS.

LEGEND

— — — — — PROJECT DEPTH

—·—·—·—·— +2 FT MAINTENANCE

-------------- +2 FT OVERDEPTH ALLOWANCE

HORIZONTAL SCALE: 1" = 2000'
VERTICAL SCALE : 1" = 40'

U.S. ARMY ENGINEER DISTRICT, CHARLESTON
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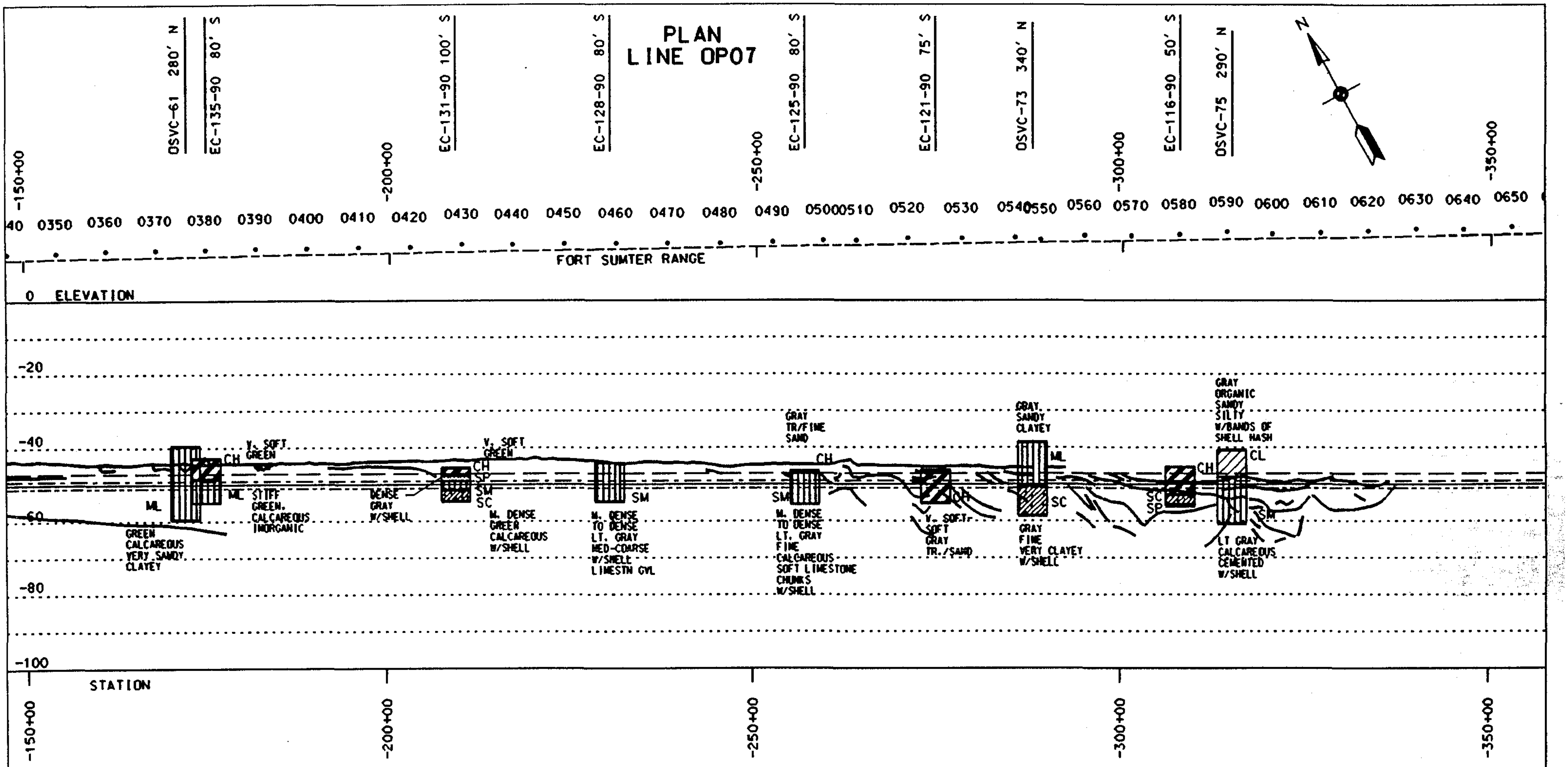
CHARLESTON, SOUTH CAROLINA

CHARLESTON HARBOR DEEPENING FEASIBILITY STUDY

LINE OP07
ACOUSTIC REFLECTION PROFILE
WITH CORE BORINGS

CHARLESTON SOUTH CAROLINA

SCALE: AS SHOWN					SHEET 1 OF 5
DATE: MAR 1995	DR. BY DLH	CK. BY	CK. BY		file: op07.dgn



PROFILE - LINE OP07

FIG. 2

LEGEND

— — — — — — PROJECT DEPTH

—·—·—·—·—·— +2 FT MAINTENANCE

----·----·---- +2 FT OVERDEPTH ALLOWANCE

HORIZONTAL SCALE: 1" = 2000'
VERTICAL SCALE : 1" = 40'

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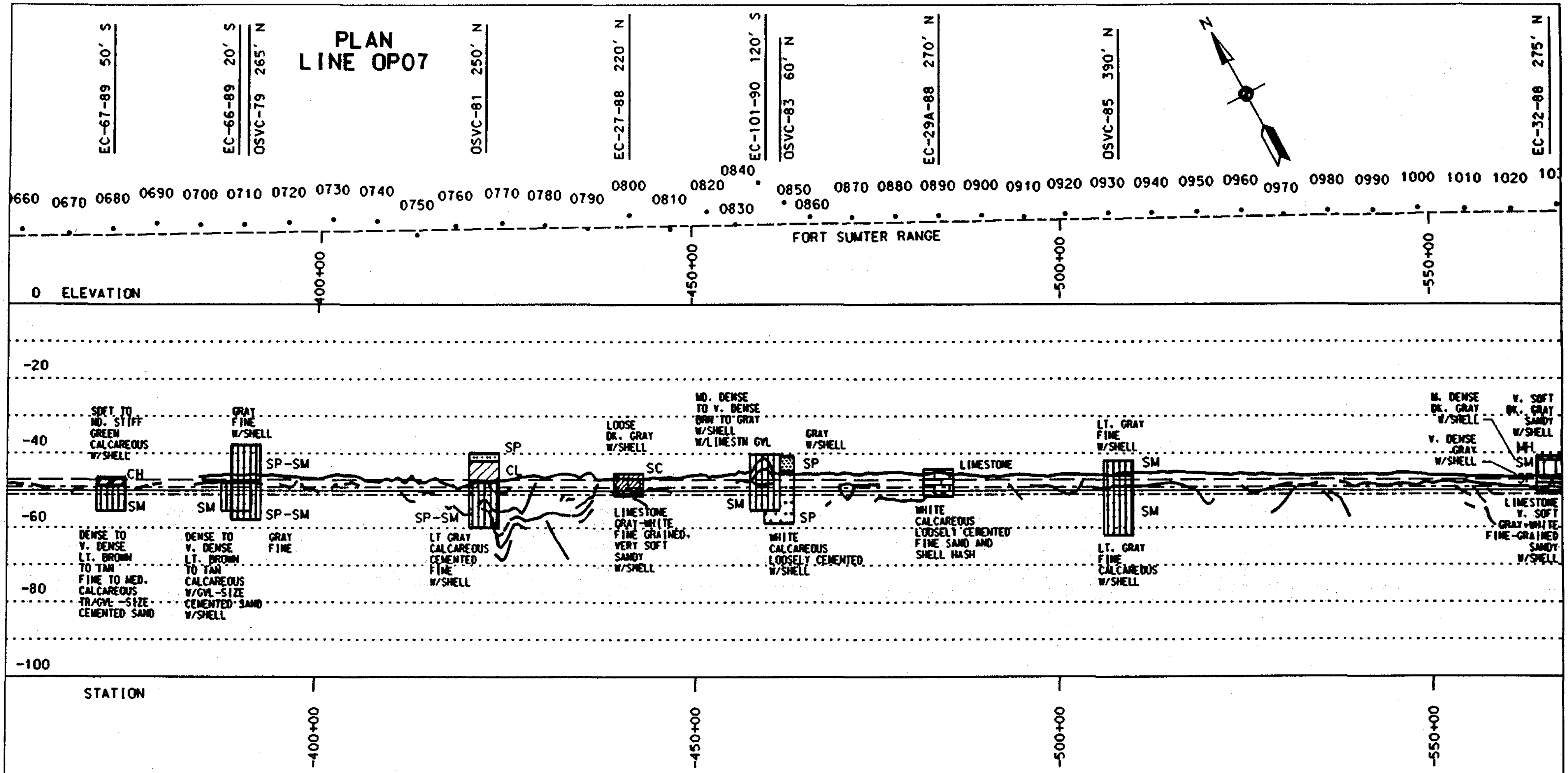
LINE OP07
ACOUSTIC REFLECTION PROFILE
WITH CORE BORINGS

CHARLESTON SOUTH CAROLINA

SCALE: AS SHOWN				SHEET 2 OF 5
DATE: MAR 1995	DR. BY DLH	CK. BY	CK. BY	file: op07.dgn



PROFILE - LINE OP07

FIG. 3

LEGEND

— — — — — PROJECT DEPTH

— · — · — · — +2 FT MAINTENANCE

- - - - - - - - - +2 FT OVERDEPTH ALLOWANCE

HORIZONTAL SCALE: 1" = 2000'
VERTICAL SCALE : 1" = 40'

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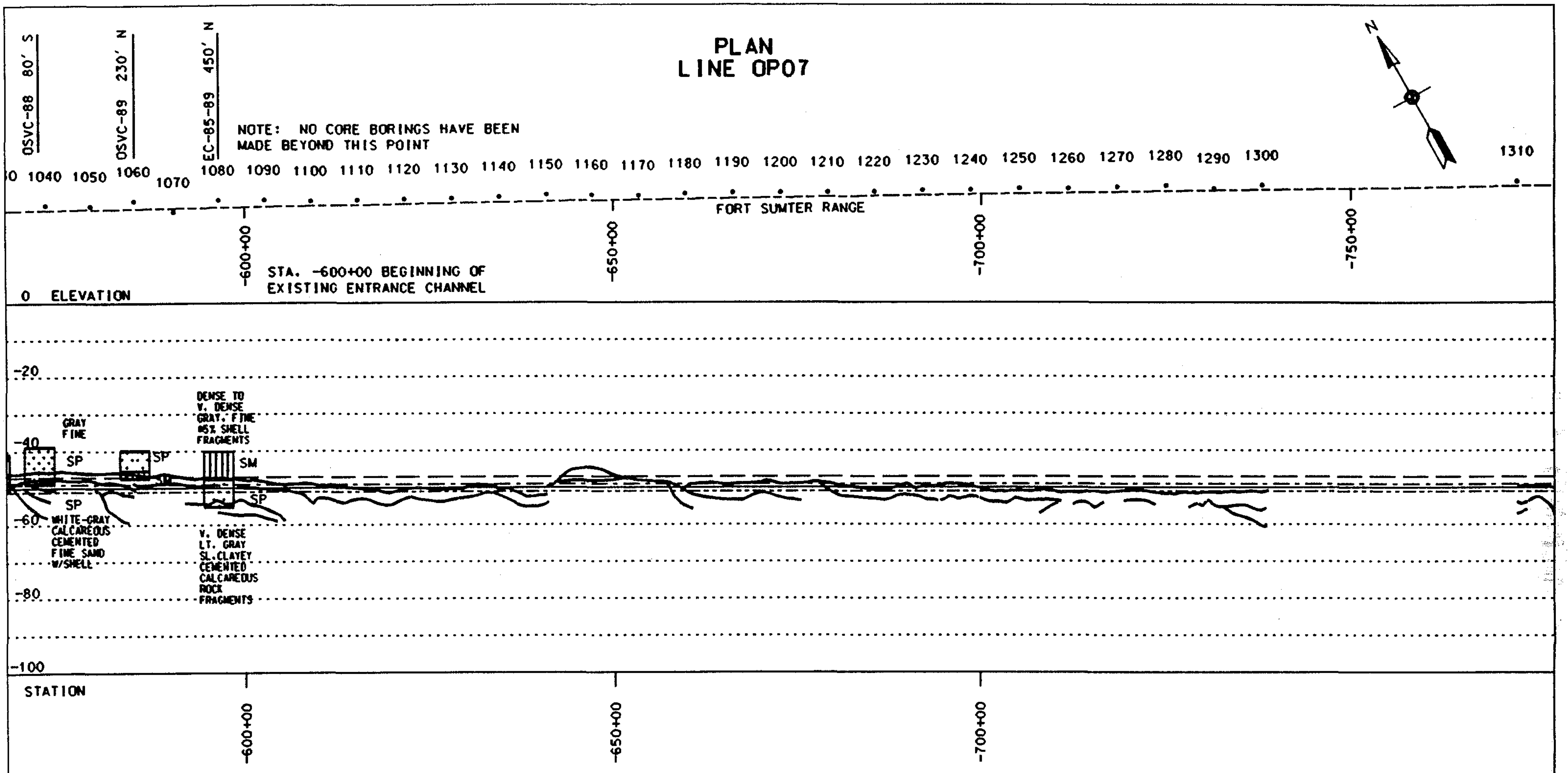
LINE OP07
ACOUSTIC REFLECTION PROFILE
WITH CORE BORINGS

CHARLESTON SOUTH CAROLINA

SCALE: AS SHOWN				SHEET 3 OF 5
DATE: MAR 1995	DR. BY DLH	CK. BY	CK. BY	file: op07.dgn



PROFILE - LINE OP07

FIG. 4

LEGEND

— — — — — — PROJECT DEPTH

— · — · — · — +2 FT MAINTENANCE

- - - - - - - - - - +2 FT OVERDEPTH ALLOWANCE

HORIZONTAL SCALE: 1" = 2000'
VERTICAL SCALE : 1" = 40'

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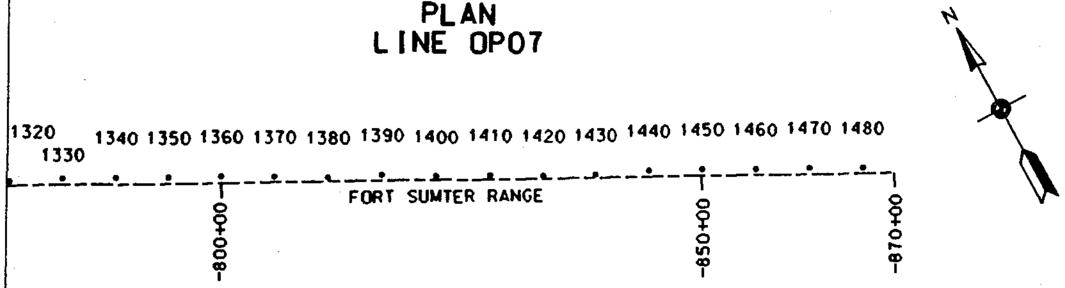
CHARLESTON HARBOR DEEPENING FEASIBILITY STUDY

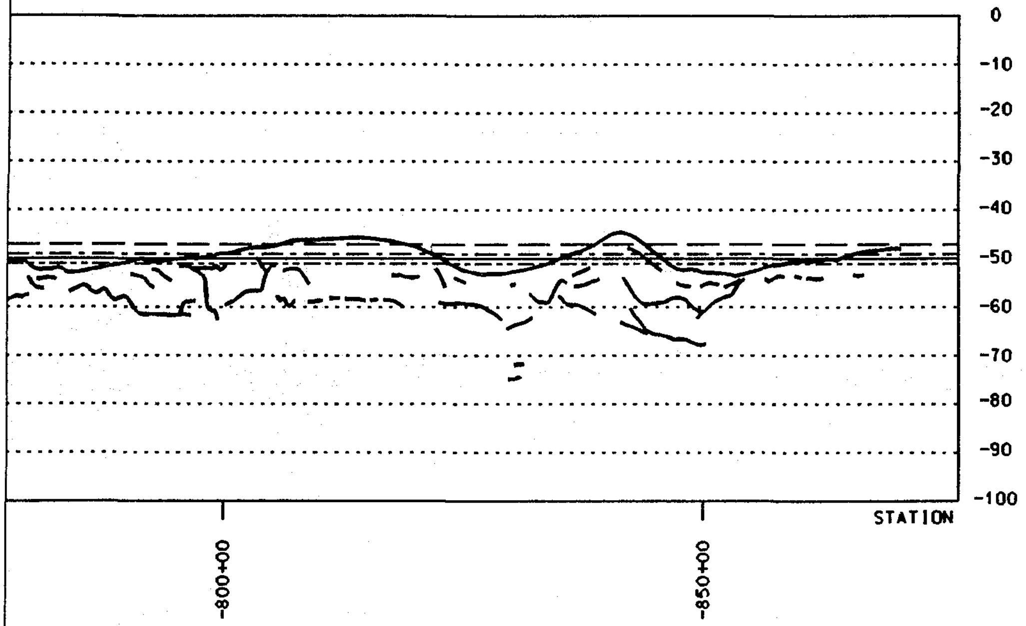
LINE OP07
ACOUSTIC REFLECTION PROFILE
WITH CORE BORINGS

CHARLESTON SOUTH CAROLINA

SCALE: AS SHOWN				SHEET 4 OF 5
DATE: MAR 1995	DR. BY DLH	CK. BY	CK. BY	file: op07.dgn

PLAN
LINE OP07





PROFILE - LINE OP07

LEGEND

— — — — — — PROJECT DEPTH

— · — · — · — · — +2 FT MAINTENANCE

— · · — · · — · · — +2 FT OVERDEPTH ALLOWANCE

HORIZONTAL SCALE: 1" = 2000'
VERTICAL SCALE : 1" = 40'

FIG. 5

U.S. ARMY ENGINEER DISTRICT, CHARLESTON
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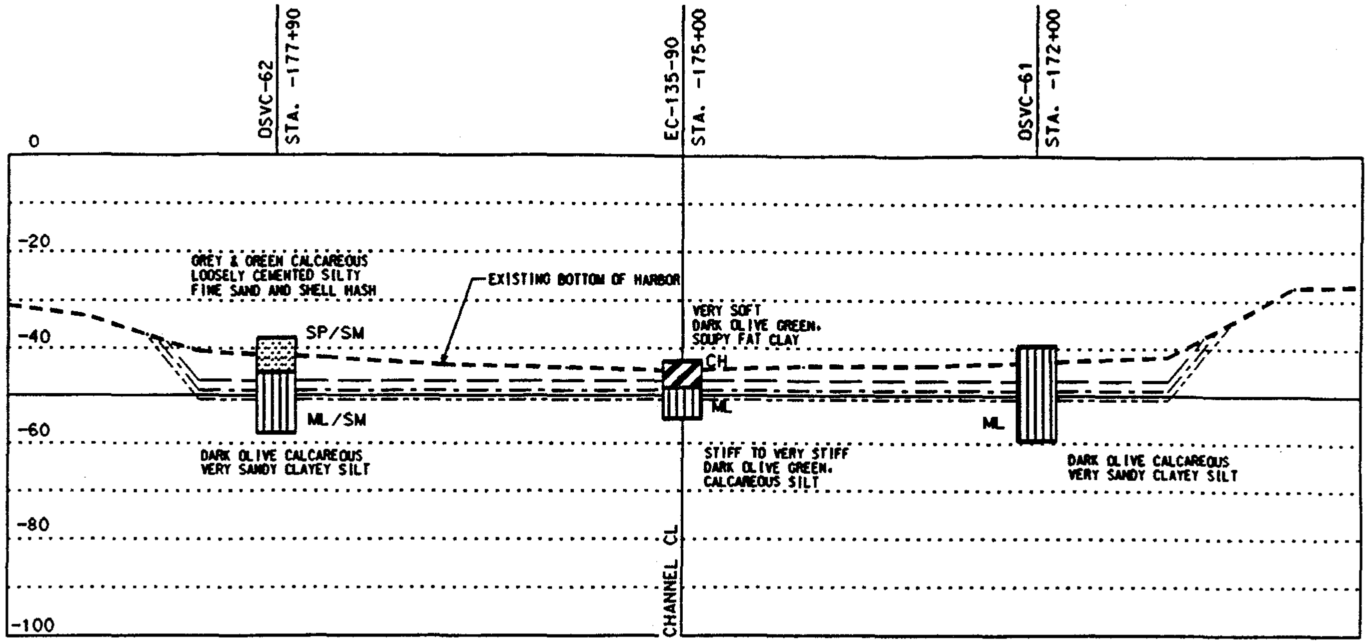
CHARLESTON HARBOR DEEPENING FEASIBILITY STUDY

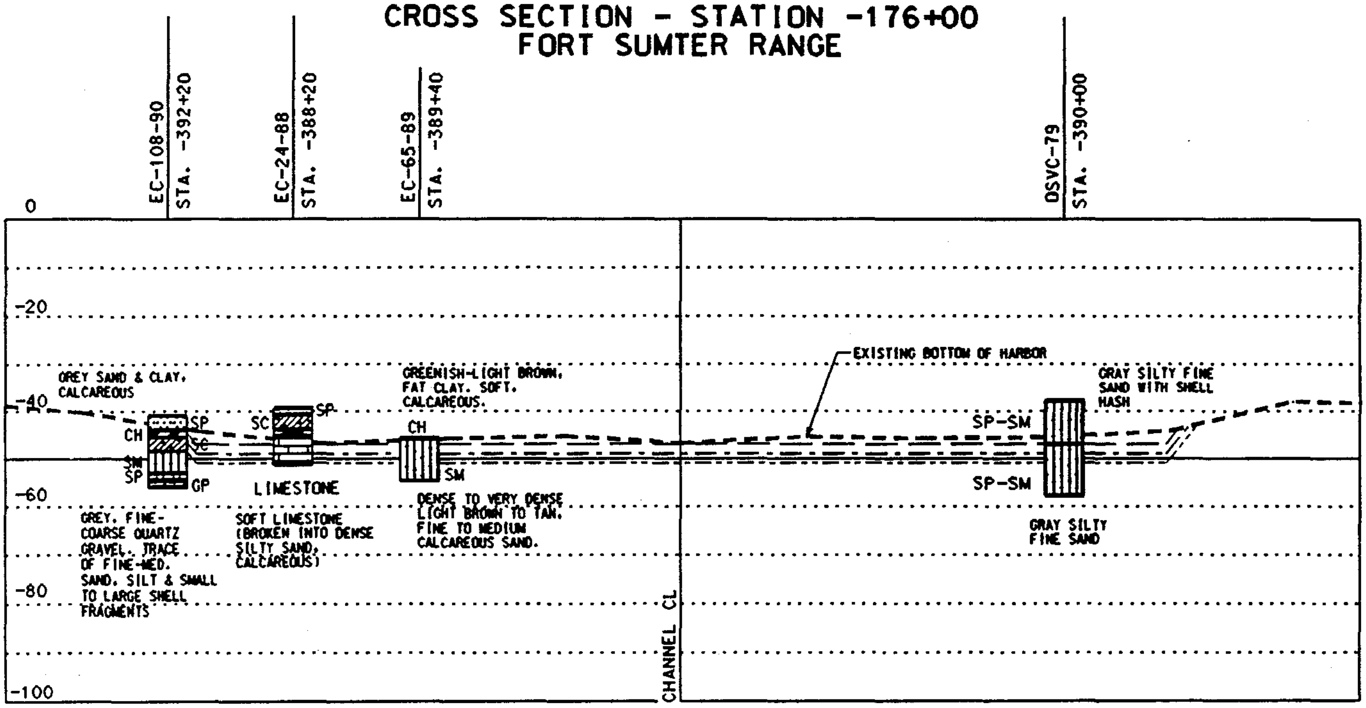
LINE OP07
ACOUSTIC REFLECTION PROFILE
WITH CORE BORINGS

CHARLESTON SOUTH CAROLINA

SCALE: AS SHOWN					SHEET 5 of 5
DATE: MAR 1995	DR. BY DLH	CK. BY	CK. BY		file: op07.dgn



CROSS SECTION - STATION -176+00
FORT SUMTER RANGE



CROSS SECTION - STATION -392+00
FORT SUMTER RANGE

HORIZONTAL SCALE: 1" = 200'
VERTICAL SCALE : 1" = 40'

FIG. 6

LEGEND

— — — — — — —	PROJECT DEPTH
—·—·—·—·—·—	+2 FT MAINTENANCE
-·-·-·-·-·-·-·-	+2 FT OVERDEPTH ALLOWANCE

NOTES:
1. REFER TO BORING LOGS AND TEST RESULTS FOR COMPLETE SOIL DESCRIPTIONS.
2. DATE OF SURVEY - MARCH 1994
3. TOPS OF SOIL BORINGS VARY FROM EXISTING GROUND SURFACE DUE TO DREDGING SUBSEQUENT TO DRILLING.

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CHARLESTON HARBOR DEEPENING FEASIBILITY STUDY

HARBOR CROSS SECTIONS
WITH CORE BORINGS

CHARLESTON SOUTH CAROLINA

SCALE: AS SHOWN					SHEET 1 OF 1
DATE: APRIL 1995	DR. BY TPM	CK. BY DLH	CK. BY		file: xsects1.dgn

LEGEND

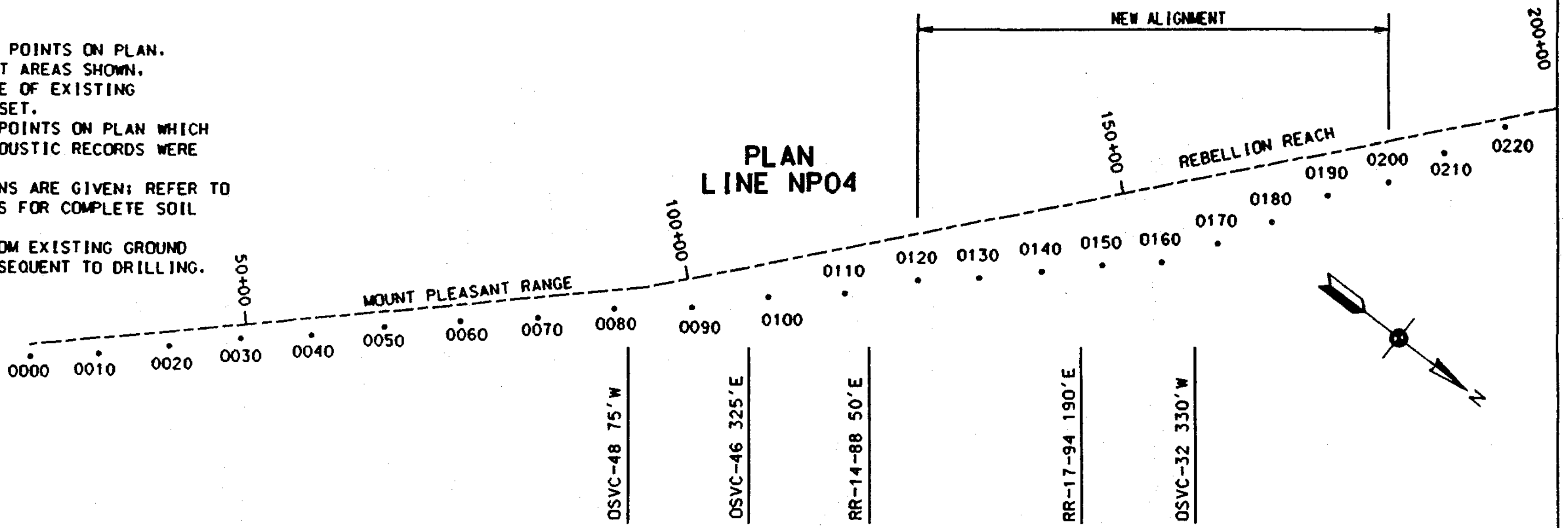
— — — — — — PROJECT DEPTH

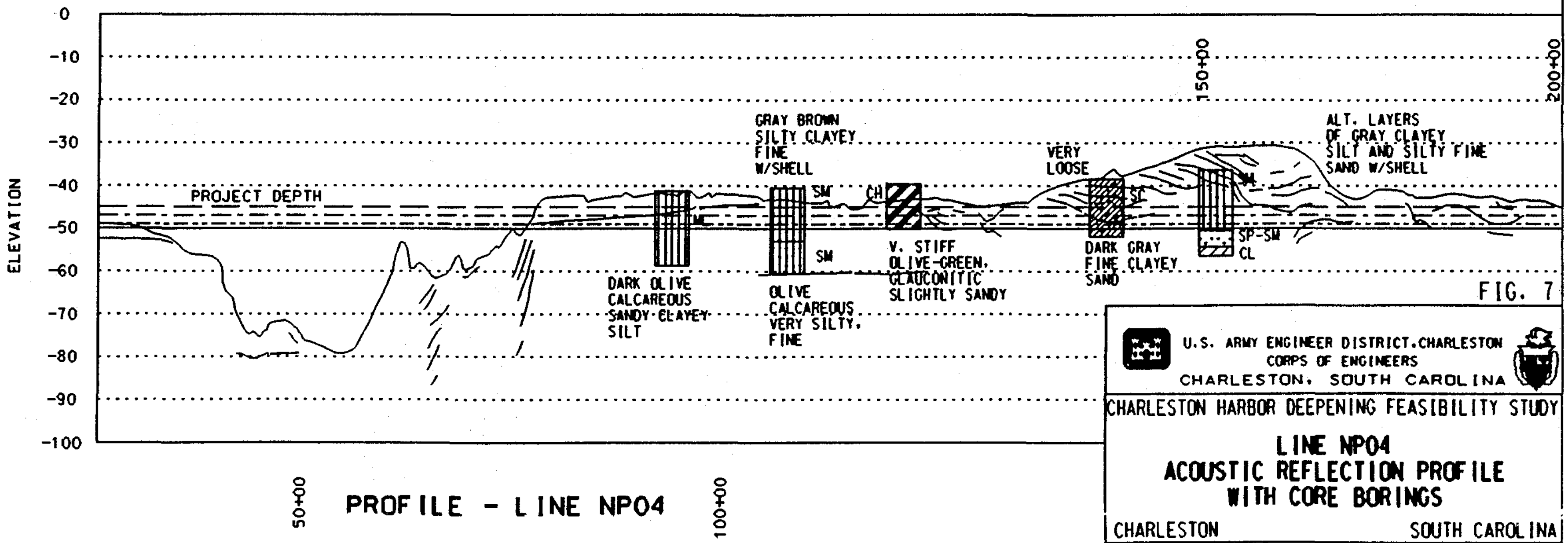
— · — · — · — +2 FT MAINTENANCE

- - - - - - - - - +2 FT OVERDEPTH ALLOWANCE

NOTES:

1. LINE NP04, INDICATED BY POINTS ON PLAN, AND EXCEPT FOR NEW ALIGNMENT AREAS SHOWN, ROUGHLY PARALLELS CENTERLINE OF EXISTING CHANNEL, WITH 100'-200' OFFSET.
2. PROFILE CORRESPONDS TO POINTS ON PLAN WHICH INDICATE LOCATIONS WHERE ACOUSTIC RECORDS WERE TAKEN.
3. PARTIAL SOIL DESCRIPTIONS ARE GIVEN; REFER TO BORING LOGS AND TEST RESULTS FOR COMPLETE SOIL DESCRIPTIONS.
4. TOPS OF BORINGS VARY FROM EXISTING GROUND SURFACE DUE TO DREDGING SUBSEQUENT TO DRILLING.





PROFILE - LINE NP04

FIG. 7

U.S. ARMY ENGINEER DISTRICT, CHARLESTON
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CHARLESTON, SOUTH CAROLINA

CHARLESTON HARBOR DEEPENING FEASIBILITY STUDY

LINE NP04
ACOUSTIC REFLECTION PROFILE
WITH CORE BORINGS

CHARLESTON SOUTH CAROLINA

HORIZONTAL SCALE: 1" = 2000'
VERTICAL SCALE : 1" = 40'

SCALE: AS SHOWN					SHEET 1 OF 2
DATE: APR 1995	DR. BY DLH	CK. BY	CK. BY		file: np04.dgn

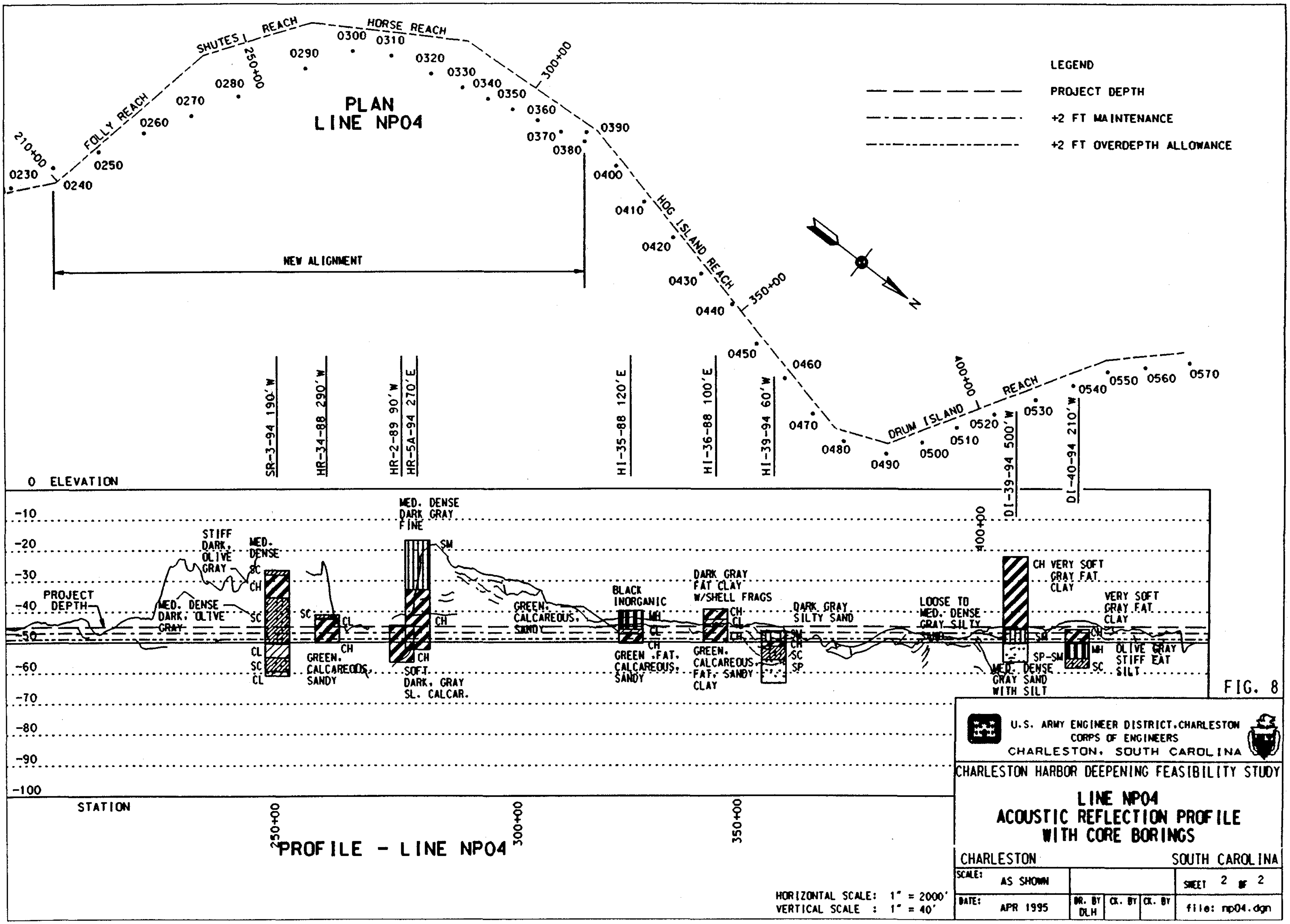

FIG. 8

U.S. ARMY ENGINEER DISTRICT, CHARLESTON
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CHARLESTON, SOUTH CAROLINA

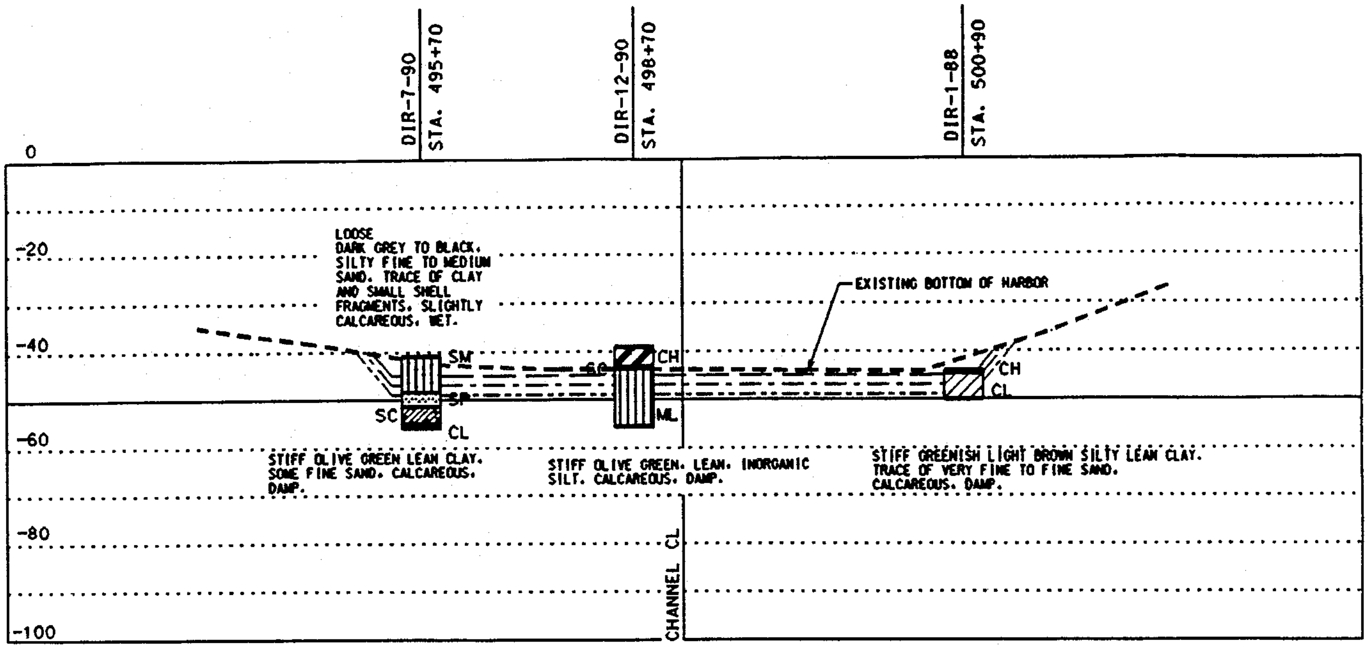
CHARLESTON HARBOR DEEPENING FEASIBILITY STUDY

LINE NP04
ACOUSTIC REFLECTION PROFILE
WITH CORE BORINGS

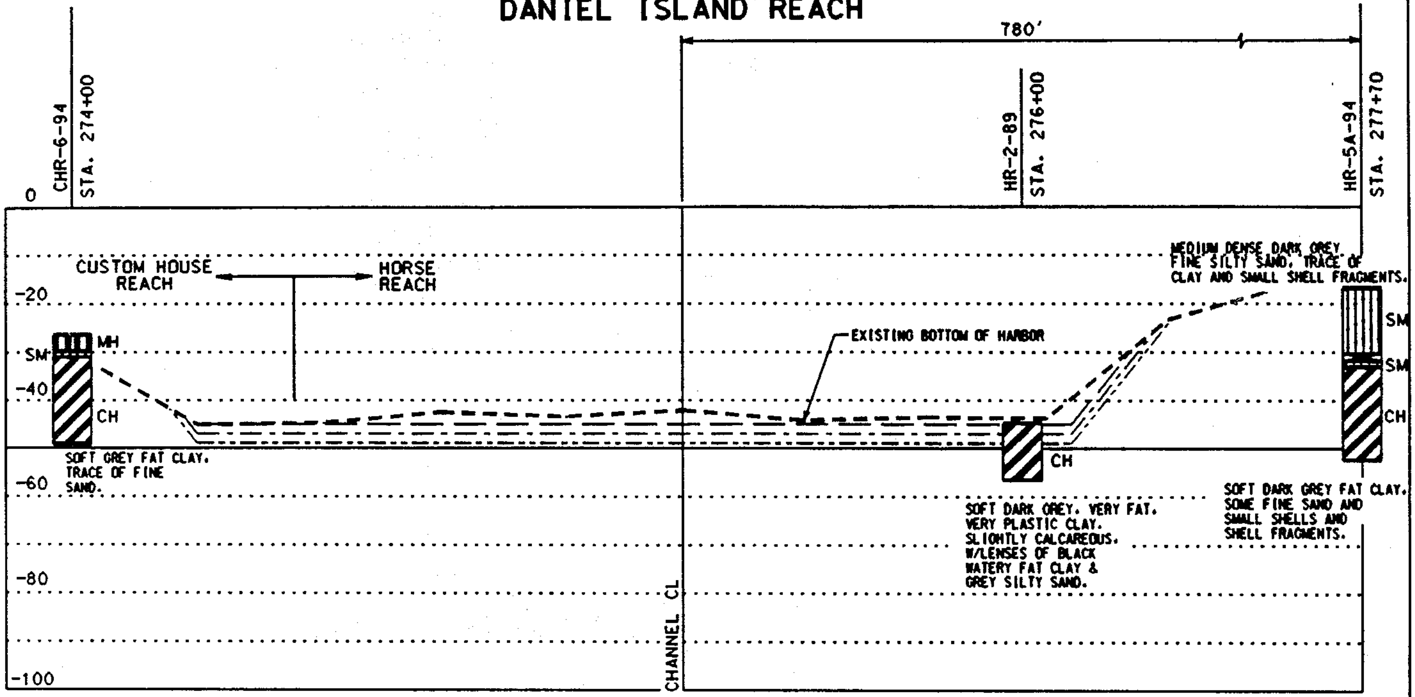
CHARLESTON SOUTH CAROLINA

HORIZONTAL SCALE: 1" = 2000'
VERTICAL SCALE : 1" = 40'

SCALE: AS SHOWN				SHEET 2 OF 2
DATE: APR 1995	DR. BY DLH	CK. BY	CK. BY	file: np04.dgn



CROSS SECTION - STATION 498+00
DANIEL ISLAND REACH



CROSS SECTION - STATION 275+00
HORSE REACH

HORIZONTAL SCALE: 1" = 200'
VERTICAL SCALE : 1" = 40'

FIG. 9

LEGEND

— — — — — — PROJECT DEPTH

—·—·—·—·—·— +2 FT MAINTENANCE

—··—··—··—··— +2 FT OVERDEPTH ALLOWANCE

NOTES:
1. REFER TO BORING LOGS AND TEST RESULTS FOR COMPLETE SOIL DESCRIPTIONS.
2. DATES OF SURVEY: HORSE REACH, JAN. 1989; DANIEL ISLAND REACH, APRIL 1991.
3. TOPS OF SOIL BORINGS VARY FROM EXISTING GROUND SURFACE DUE TO DREDGING SUBSEQUENT TO DRILLING.

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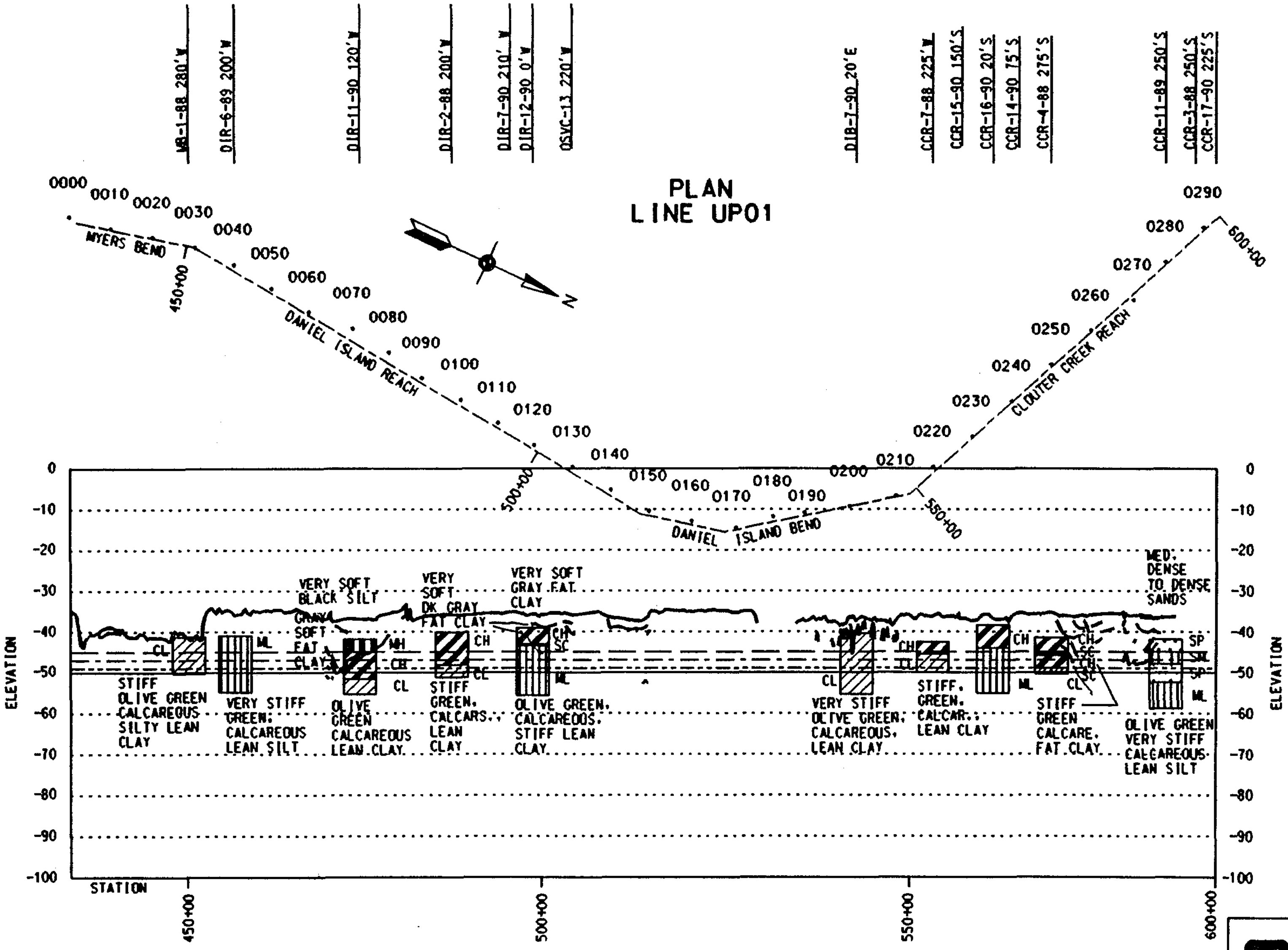
CHARLESTON HARBOR DEEPENING FEASIBILITY STUDY

HARBOR CROSS SECTIONS
WITH CORE BORINGS

CHARLESTON SOUTH CAROLINA

SCALE: AS SHOWN				SHEET 1 OF 1
DATE: APRIL 1995	DR. BY TPM	CK. BY DLH	CK. BY	file: xsects2.dgn

HORIZONTAL SCALE: 1" = 2000'
VERTICAL SCALE : 1" = 40'



PROFILE - LINE UP01

FIG. 10

NOTES:
1. LINE UP01, INDICATED BY POINTS ON PLAN, ROUGHLY FOLLOWS CENTERLINE OF CHANNEL.
2. PROFILE CORRESPONDS TO POINTS ON PLAN WHICH INDICATE LOCATIONS WHERE ACOUSTIC RECORDS WERE TAKEN.
3. REFER TO BORING LOGS AND TEST RESULTS FOR COMPLETE SOIL DESCRIPTIONS.
4. TOPS OF SOIL BORINGS VARY FROM EXISTING GROUND SURFACE DUE TO DREDGING SUBSEQUENT TO DRILLING.

LEGEND
— — — — PROJECT DEPTH
— · — · — +2 FT MAINTENANCE
— · · — · · — +2 FT OVERDEPTH ALLOWANCE

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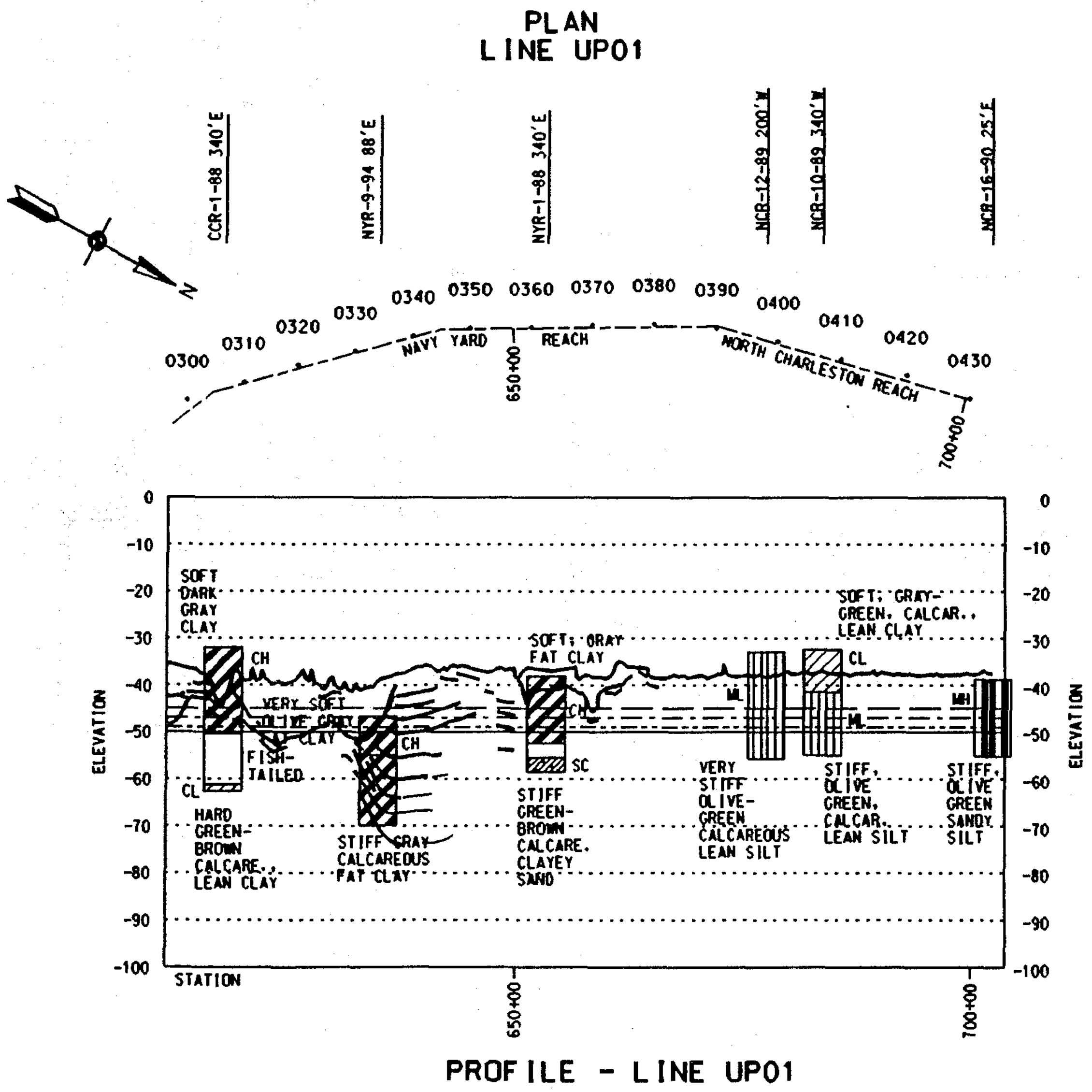
CHARLESTON HARBOR DEEPENING FEASIBILITY STUDY

LINE UP01
ACOUSTIC REFLECTION PROFILE WITH CORE BORINGS

CHARLESTON				SOUTH CAROLINA
SCALE: AS SHOWN				SHEET 1 OF 3
DATE: APR 1995	DR. BY DLH	CK. BY	CK. BY	file: up01.dgn

HORIZONTAL SCALE: 1" = 2000'
VERTICAL SCALE : 1" = 40'


PLAN
LINE UP01

PROFILE - LINE UP01

FIG. 11

LEGEND

— — — — — PROJECT DEPTH
— · — · — · — +2 FT MAINTENANCE
- - - - - - - - - +2 FT OVERDEPTH ALLOWANCE

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CHARLESTON HARBOR DEEPENING FEASIBILITY STUDY

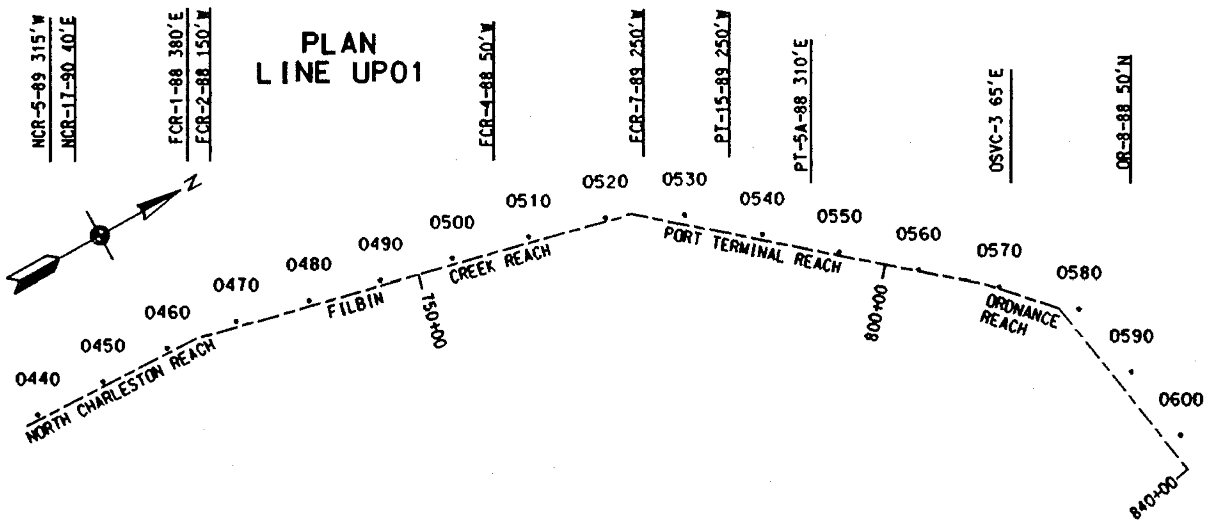
LINE UP01
ACOUSTIC REFLECTION PROFILE WITH CORE BORINGS

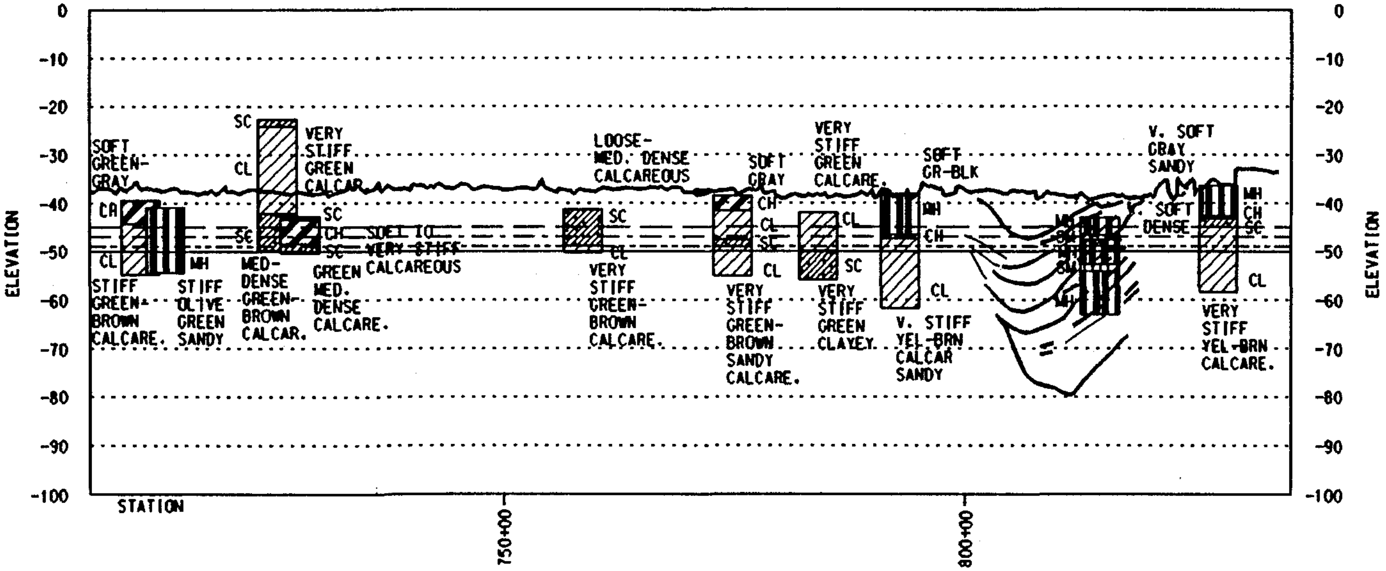
CHARLESTON SOUTH CAROLINA

SCALE: AS SHOWN					SHEET 2 OF 3
DATE: APR 1995	DR. BY DLH	CK. BY	CK. BY		file: up01.dgn

HORIZONTAL SCALE: 1" = 2000'
VERTICAL SCALE : 1" = 40'

PLAN
LINE UP01





PROFILE - LINE UP01

LEGEND

— — — — — — PROJECT DEPTH

— · — · — · — +2 FT MAINTENANCE

- - - - - - - - - - +2 FT OVERDEPTH ALLOWANCE

FIG. 12

U.S. ARMY ENGINEER DISTRICT, CHARLESTON
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CHARLESTON HARBOR DEEPENING FEASIBILITY STUDY

LINE UP01
ACOUSTIC REFLECTION PROFILE
WITH CORE BORINGS

CHARLESTON SOUTH CAROLINA

SCALE: AS SHOWN					SHEET 3 OF 3
DATE: APR 1995	DR. BY DLH	CK. BY	CK. BY		file: up01.dgn

APPENDIX B

Geotechnical Investigations

CONTENTS

LIST OF FIGURES

APPENDIX B

GEOTECHNICAL ANALYSIS

PURPOSE AND SCOPE

1. Previous soils investigations in the Charleston Harbor and Entrance Channel were conducted in 1986-1990, for deepening the harbor to a project depth of -40 feet MLLW with varying width, from the Entrance Channel at Station -700+00 to the turning basin in Ordnance Reach at Station 830+00, Shipyard River, and Wando River. The present study focusses on further deepening of the harbor to a depth between -41 feet and -46 feet MLLW, and the Entrance Channel to a depth between -43 feet and -48 feet. An additional 2 feet of advance maintenance and 2 feet of over depth would be allowed. The entrance channel will be extended to accommodate the increase in depth. Also, some realignment of the channel and new work dredging for a new port terminal are proposed. The purpose of this more recent 1994 subsurface investigation was to obtain supplemental soils information of the materials to be dredged to the depths proposed.

PREVIOUS INVESTIGATIONS

2. Previous investigations include Vibracore sampling, conducted in 1986 by Ocean Survey, Inc., using an OSI Model 1500 pneumatic powered Vibracore taking 20-foot samples. The Cores were logged, samples were field classified, and laboratory tests were performed to obtain grain-size distributions, and Atterberg limits. Pocket penetrometer test were also made on cohesive soils.

3. During the period 1988 to 1990, additional borings were made by the Savannah District, Corps of Engineers, using a Failing 314 drill rig mounted on the jack-up barge, Explorer. These borings were made to cover additional areas in the harbor and to obtain data not previously available. This equipment allowed for Standard Penetration Testing (SPT) in the subbottom soils and coring in cemented sands and rock.

4. Logs of borings and results of tests are available in the District Office. A portion of the logs from previous investigations are included on the figures.

1994 INVESTIGATIONS

5. In April 1994, a seismic (acoustic) subbottom survey was conducted by the Corps of Engineers Waterways Experiment Station. This geophysical survey utilized a low-noise, high-resolution acoustic subbottom imaging system to

much of the existing entrance channel back toward Station -200+00. Also, it can be expected that there may be present relatively shallow and discontinuous layers of soft silts and clays or loose sands at the surface.

9. Between Station -200+00 and 0+00 in the Entrance Channel, the existing channel has been excavated into layers of stiff, olive green, calcareous, over consolidated silts and clays and medium dense, olive green, calcareous clayey sands. Geologically, these soils lie within the Ashley Formation of the Cooper Group. The Ashley Formation is a widespread unit in the shallow subsurface of the area, and consists of weakly cemented phosphatic and quartzose calcarenite with variable color from light olive brown to olive green. The depth to this formation is variable, particularly in this portion of the entrance channel, as well as within the harbor where paleochannels, which were eroded into the layer, have been subsequently filled in with unconsolidated soils.

10. Line OP07, acoustic subbottom profile, Figures 1 through 5, represents the soil profile near the centerline of the Entrance Channel, Station -870+00 to Station 0+00 Fort Sumter Range, and Station 0+00 to Station 40+00 Mount Pleasant Range. Cross sections of the channel are shown on Figure 6. Station -392+00 is located outside the jetties while Station -176+00 is inside. Top elevations of soil borings and existing ground surface vary due to dredging subsequent to drilling.

SOILS WITHIN THE HARBOR

11. Within the harbor from Station 0+00, Mount Pleasant Range, to Station 831+00, Ordnance Reach, the bottom of the harbor extends into predominantly olive green, calcareous, stiff over consolidated silts and clays and dense sands of the Ashley Formation. There are sections of soft clays to be excavated, particularly within the Navy Yard Reach. The predominant soils to be excavated in the new alignment areas in Rebellion Reach, Folly Reach, Shutes Reach, Horse Reach, and extending into Hog Island Reach include medium dense sands, stiff clays, and very soft to soft clays.

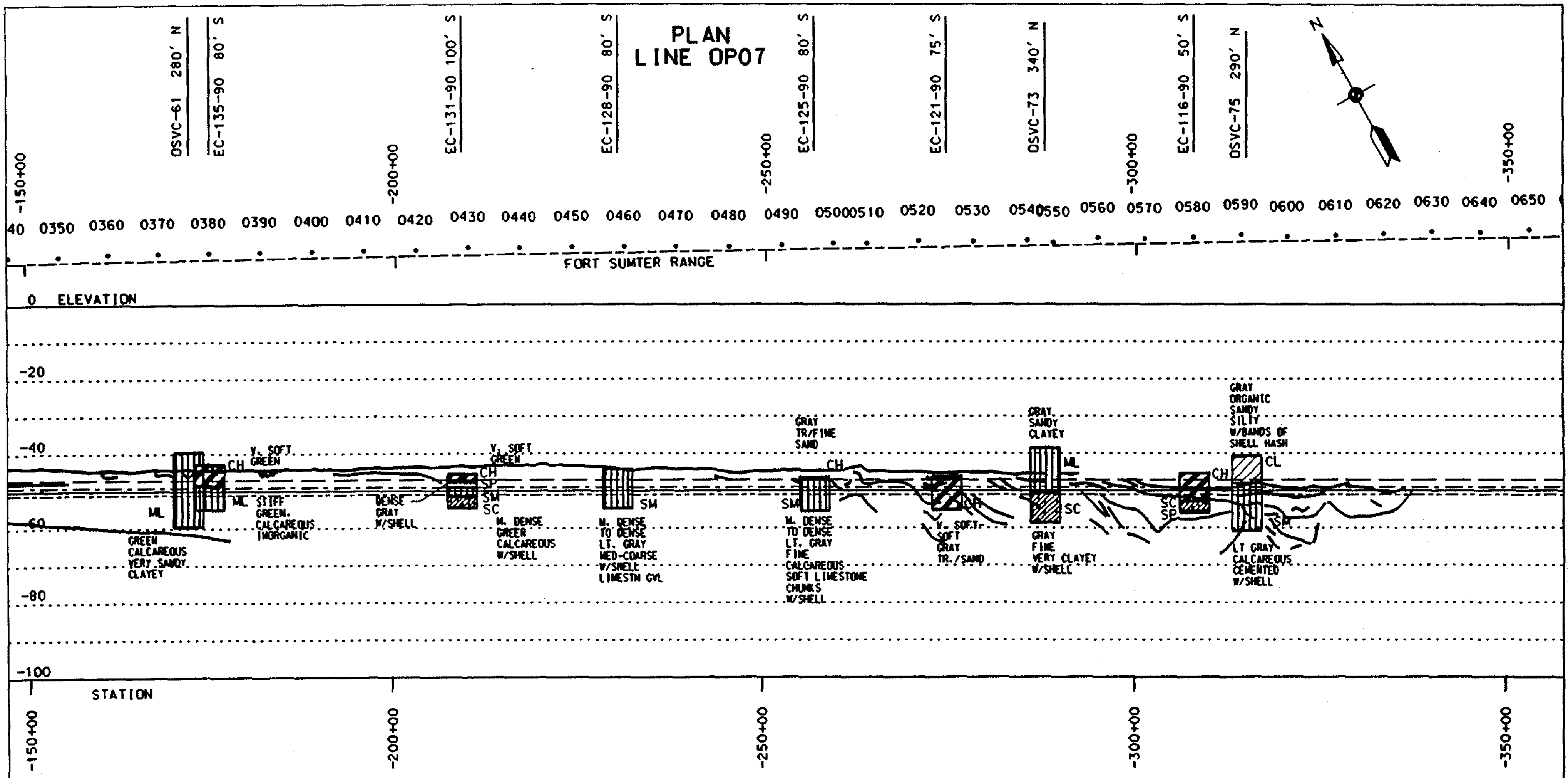
12. Line NP04, acoustic subbottom profile, Figures 7 and 8, represents the soil profile which roughly approximates the centerline of the channel beginning at about Station 25+00 in Mount Pleasant Range, then through Rebellion Reach, Folly Reach, Shutes Reach, Horse Reach, Hog Island Reach, Drum Island Reach, and into Myers Bend Reach to about Station 435+00. A cross section of the channel at Station 275+00 in Horse Reach is shown in Figure 9. Top elevations of soil borings and existing ground surface vary due to dredging subsequent to drilling.

13. Line UP01, acoustic subbottom profile, Figure 10 through 12, represents the soil profile which approximately follows the centerline of the channel from about

depth of the channel excavation proposed for the harbor would have no impacts upon underlying aquifers.

USE OF DREDGED MATERIAL FOR BEACH RENOURISHMENT

17. Because of the predominant types of soils which are to be dredged, their use in beach renourishment is not considered to be practicable. There may, however, be some benefit in placing the cemented sand and shell material dredged from the Entrance Channel at offshore locations. When excavated, these materials tend to break down into medium to coarse sand and fine gravel size particles.



PROFILE - LINE OP07

FIG. 2

LEGEND

— — — — — — PROJECT DEPTH

—·—·—·—·—·— +2 FT MAINTENANCE

-·-·-·-·-·-·- +2 FT OVERDEPTH ALLOWANCE

HORIZONTAL SCALE: 1" = 2000'
VERTICAL SCALE : 1" = 40'

U.S. ARMY ENGINEER DISTRICT, CHARLESTON
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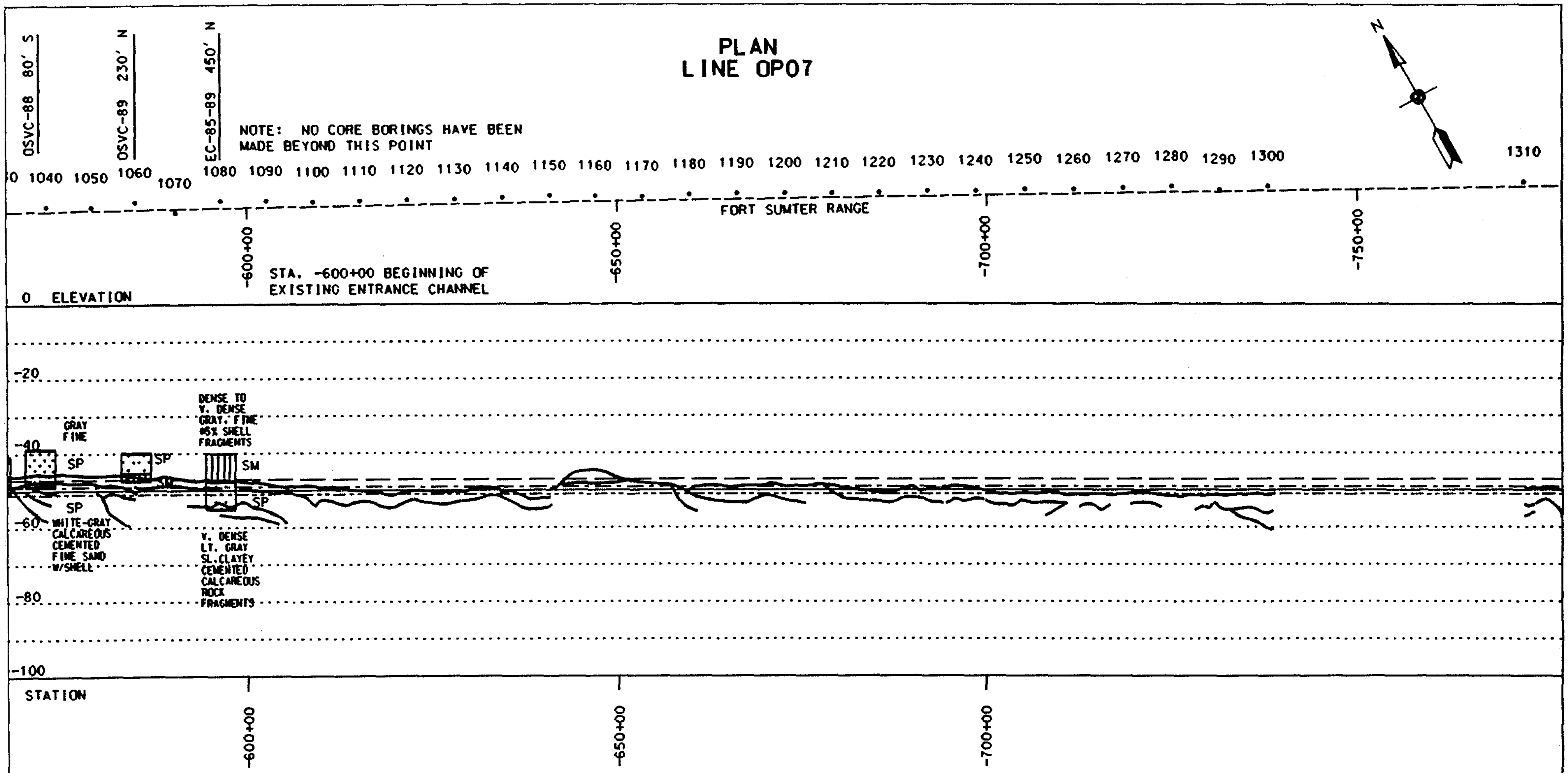
CHARLESTON HARBOR DEEPENING FEASIBILITY STUDY

LINE OP07
ACOUSTIC REFLECTION PROFILE
WITH CORE BORINGS

CHARLESTON				SOUTH CAROLINA
SCALE: AS SHOWN				SHEET 2 OF 5
DATE: MAR 1995	DR. BY DLH	CK. BY	CK. BY	file: op07.dgn



PROFILE - LINE OP07

FIG. 4

LEGEND

— — — — — — PROJECT DEPTH

—·—·—·—·—·— +2 FT MAINTENANCE

-------------------- +2 FT OVERDEPTH ALLOWANCE

HORIZONTAL SCALE: 1" = 2000'
VERTICAL SCALE : 1" = 40'

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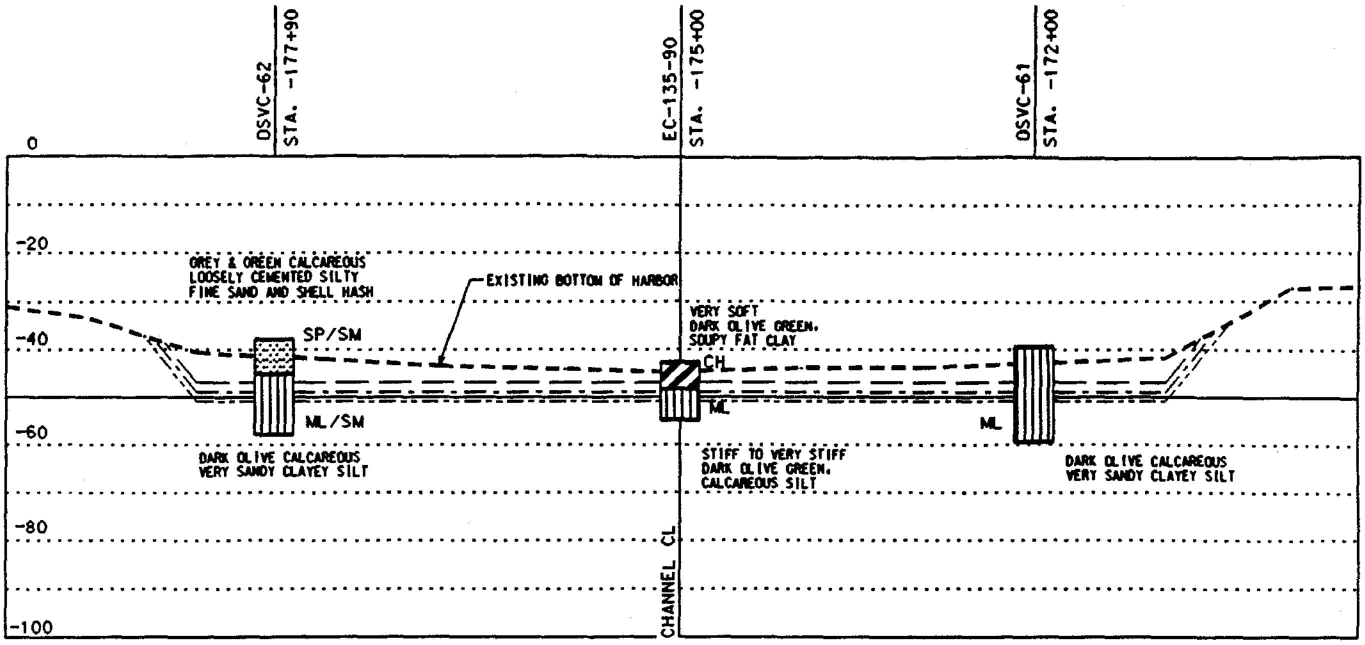
CHARLESTON HARBOR DEEPENING FEASIBILITY STUDY

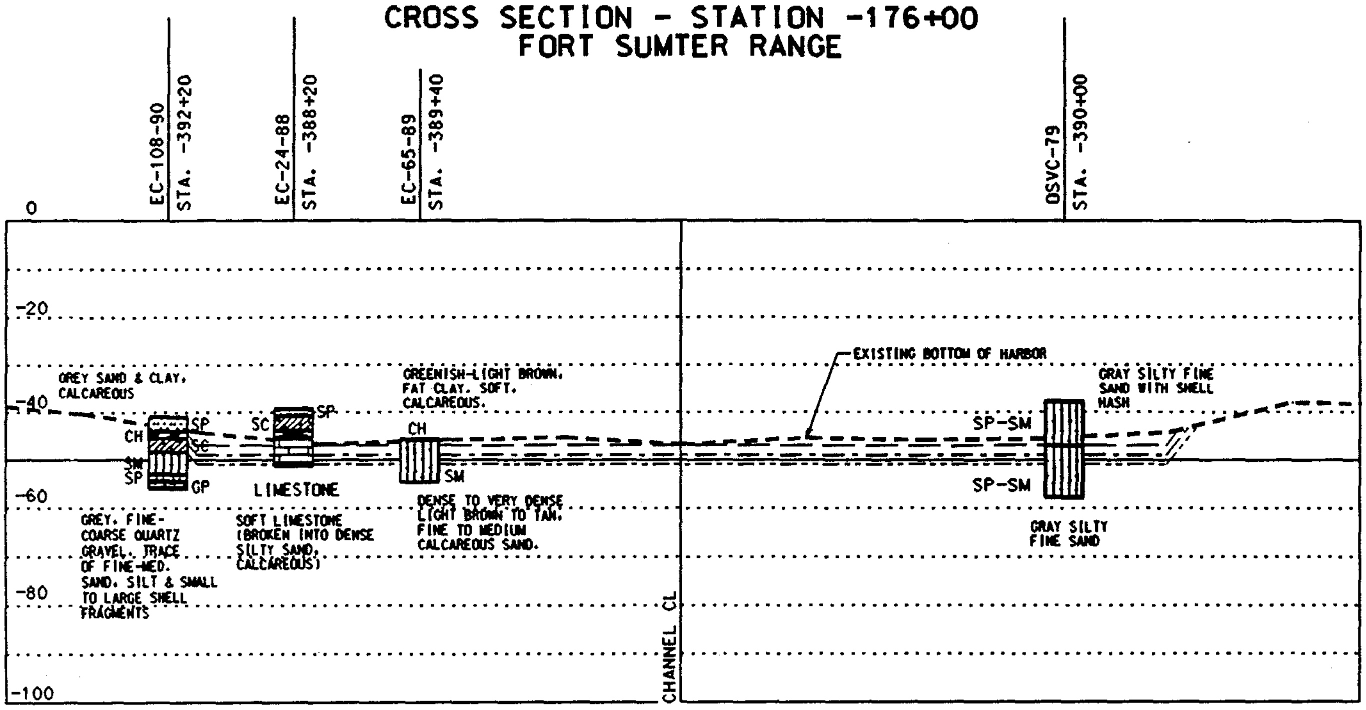
LINE OP07
ACOUSTIC REFLECTION PROFILE WITH CORE BORINGS

CHARLESTON SOUTH CAROLINA

SCALE: AS SHOWN				SHEET 4 OF 5
DATE: MAR 1995	DR. BY DLH	CK. BY	CK. BY	file: op07.dgn



CROSS SECTION - STATION -176+00
FORT SUMTER RANGE



CROSS SECTION - STATION -392+00
FORT SUMTER RANGE

HORIZONTAL SCALE: 1" = 200'
VERTICAL SCALE : 1" = 40'

FIG. 6

LEGEND

— — — — — — PROJECT DEPTH

— - — - — - — - +2 FT MAINTENANCE

- - - — - - - — - - - +2 FT OVERDEPTH ALLOWANCE

NOTES:
1. REFER TO BORING LOGS AND TEST RESULTS FOR COMPLETE SOIL DESCRIPTIONS.
2. DATE OF SURVEY - MARCH 1994
3. TOPS OF SOIL BORINGS VARY FROM EXISTING GROUND SURFACE DUE TO DREDGING SUBSEQUENT TO DRILLING.

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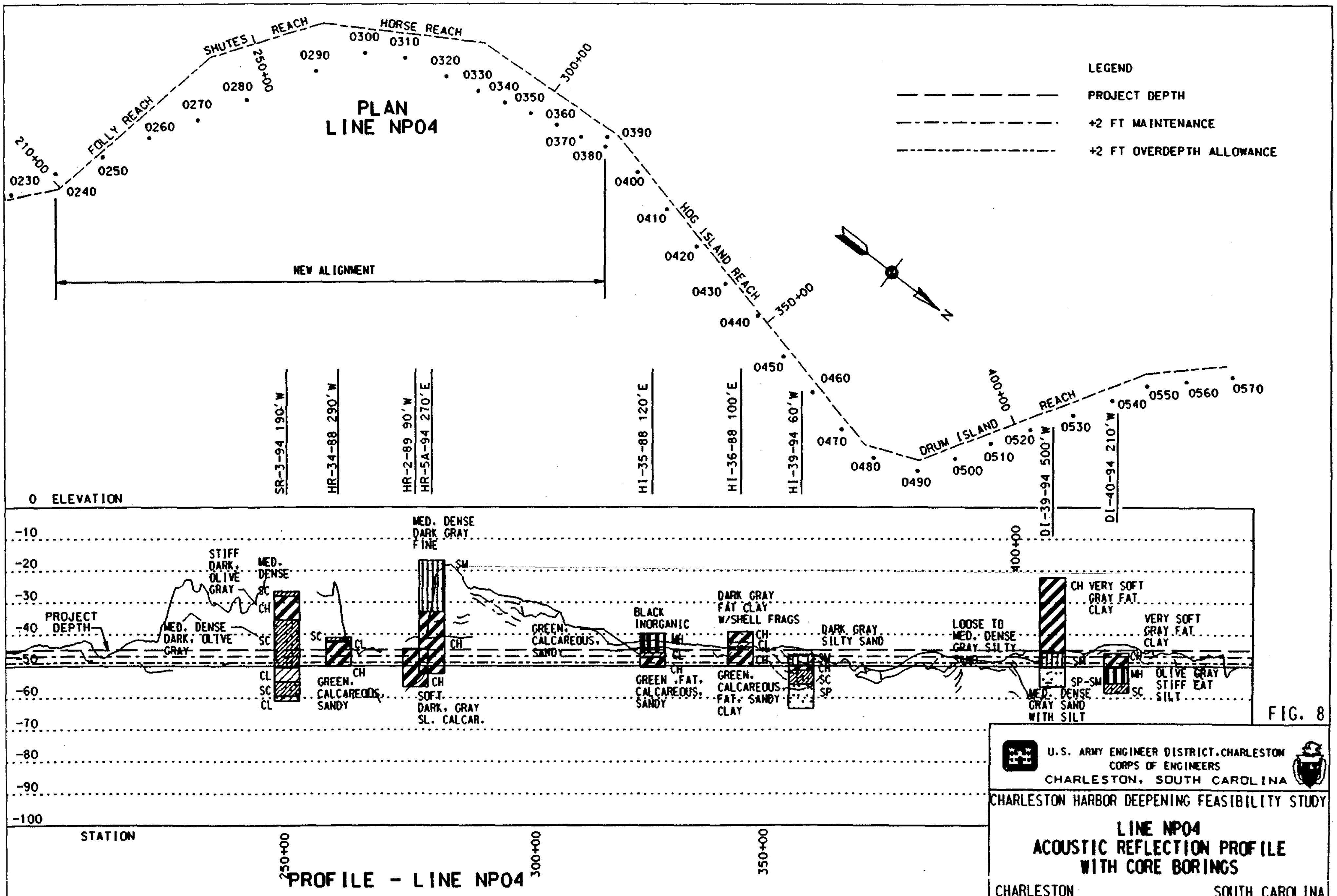
HARBOR CROSS SECTIONS
WITH CORE BORINGS

CHARLESTON SOUTH CAROLINA

SCALE: AS SHOWN
SHEET 1 OF 1
DATE: APRIL 1995
DR. BY TPM
CK. BY DLH
CK. BY
file: xsects1.dgn



PLAN
LINE NP04

PROFILE - LINE NP04

HORIZONTAL SCALE: 1" = 2000'
VERTICAL SCALE : 1" = 40'

FIG. 8

U.S. ARMY ENGINEER DISTRICT, CHARLESTON
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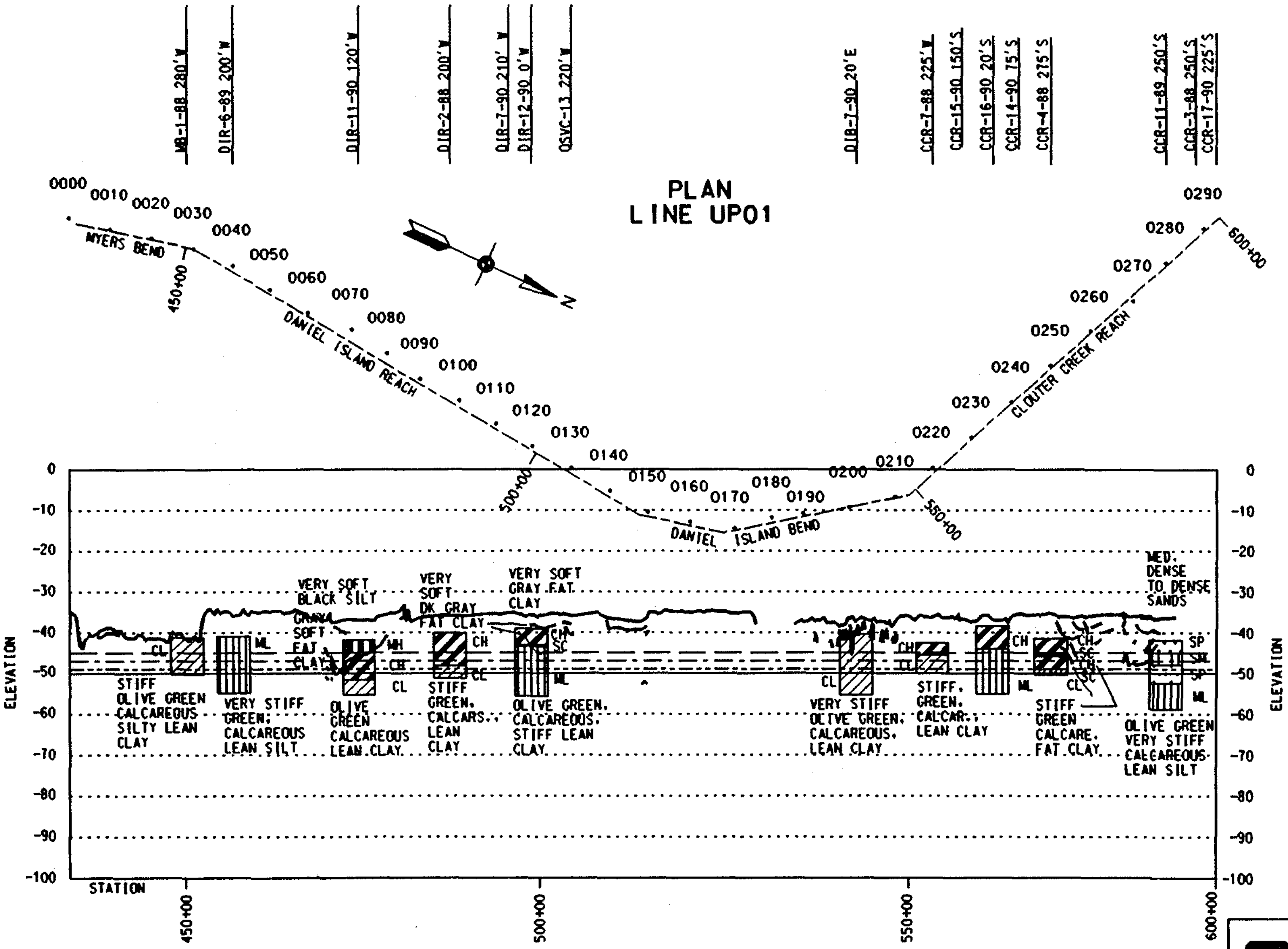
CHARLESTON, SOUTH CAROLINA

CHARLESTON HARBOR DEEPENING FEASIBILITY STUDY

LINE NP04
ACOUSTIC REFLECTION PROFILE
WITH CORE BORINGS

CHARLESTON				SOUTH CAROLINA
SCALE: AS SHOWN				SHEET 2 OF 2
DATE: APR 1995	DR. BY DLH	CK. BY	CK. BY	file: np04.dgn

HORIZONTAL SCALE: 1" = 2000'
VERTICAL SCALE : 1" = 40'



PROFILE - LINE UP01

FIG. 10

NOTES:
1. LINE UP01, INDICATED BY POINTS ON PLAN, ROUGHLY FOLLOWS CENTERLINE OF CHANNEL.
2. PROFILE CORRESPONDS TO POINTS ON PLAN WHICH INDICATE LOCATIONS WHERE ACOUSTIC RECORDS WERE TAKEN.
3. REFER TO BORING LOGS AND TEST RESULTS FOR COMPLETE SOIL DESCRIPTIONS.
4. TOPS OF SOIL BORINGS VARY FROM EXISTING GROUND SURFACE DUE TO DREDGING SUBSEQUENT TO DRILLING.

LEGEND
— — — — — — PROJECT DEPTH
—·—·—·—·—·— +2 FT MAINTENANCE
-·-·-·-·-·-·- +2 FT OVERDEPTH ALLOWANCE

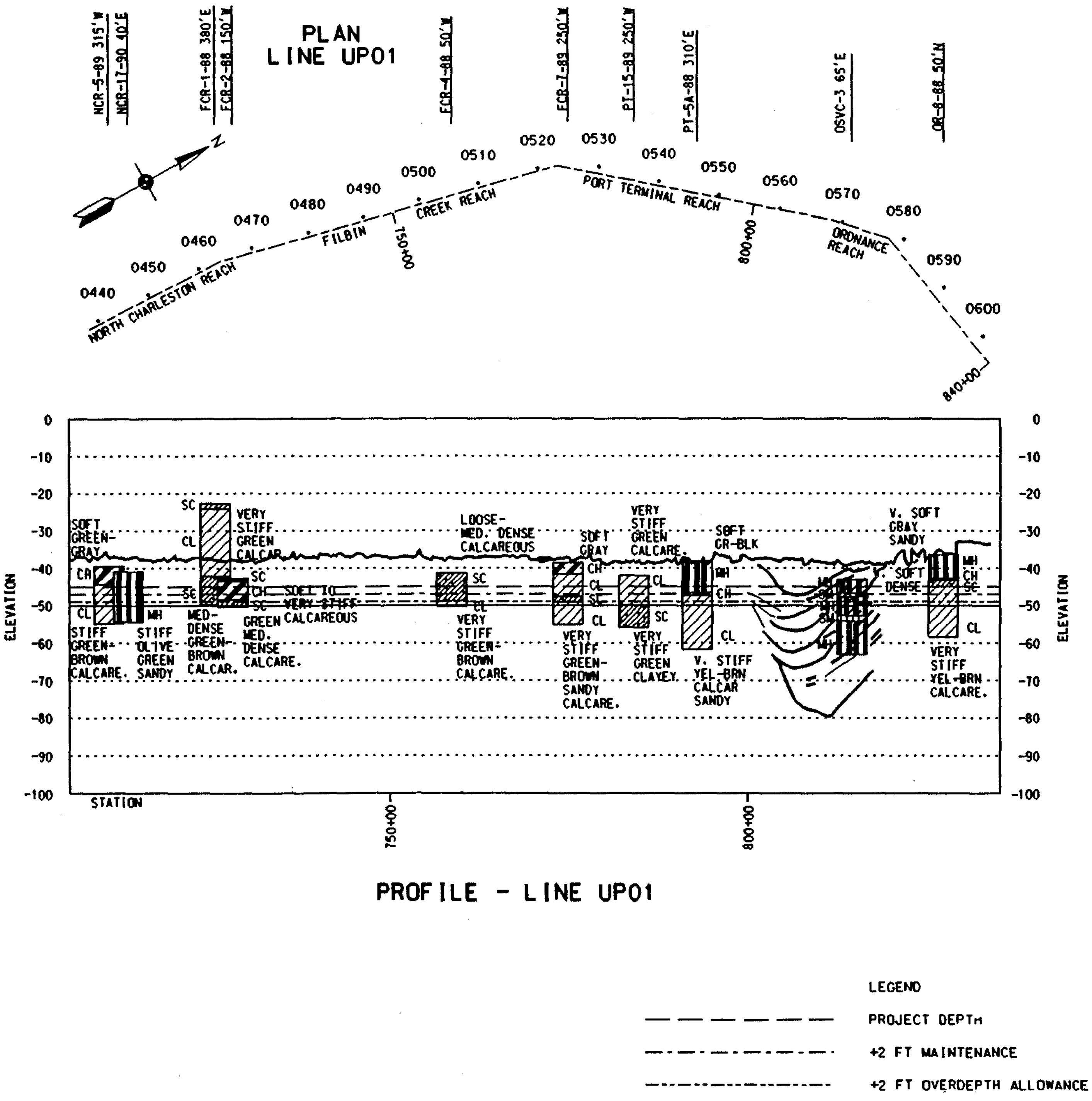
U.S. ARMY ENGINEER DISTRICT, CHARLESTON
CORPS OF ENGINEERS
CHARLESTON, SOUTH CAROLINA

CHARLESTON HARBOR DEEPENING FEASIBILITY STUDY

LINE UP01
ACOUSTIC REFLECTION PROFILE
WITH CORE BORINGS

CHARLESTON				SOUTH CAROLINA
SCALE: AS SHOWN				SHEET 1 OF 3
DATE: APR 1995	DR. BY DLH	CK. BY	CK. BY	file: up01.dgn

HORIZONTAL SCALE: 1" = 2000'
VERTICAL SCALE : 1" = 40'



PLAN
LINE UP01

PROFILE - LINE UP01

FIG. 12

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

CHARLESTON HARBOR DEEPENING FEASIBILITY STUDY

LINE UP01
ACOUSTIC REFLECTION PROFILE WITH CORE BORINGS

CHARLESTON SOUTH CAROLINA

SCALE: AS SHOWN				SHEET 3 OF 3
DATE: APR 1995	DR. BY DLH	CK. BY	CK. BY	file: up01.dgn

APPENDIX C

Cost Estimates

CONTENTS

EXHIBITS

APPENDIX C

COST ESTIMATES

Section 1: Computation Procedure

Cost Estimates were prepared for all project costs associated with dredging and dredged material disposal and construction of one new contraction dike and replacing two existing contraction dikes. The dredging estimates included 1 percent bond, 14 percent overhead, and 10 percent profit. Contingencies were calculated at 15 percent for all construction costs.

Dredging cost estimates were derived utilizing the latest version of the Corps of Engineers Dredge Estimating Program (CEDEP). Detailed and extensive data was collected and utilized for analysis and computation for the most reasonable cost for performing the work on each individual project plan.

Three examples of these cost estimates are provided in Exhibit 8 of this appendix. The first is a cost estimate for constructing the 45-foot channel at the Clouter Creek Reach and is typical for all estimates which required upland disposal. This estimate assumed utilizing an 18-inch hydraulic pipeline dredge to excavate all material and depositing the material into the Clouter Creek Disposal Area.

The second is a cost estimate for constructing the 45-foot channel at the Custom House Reach and is typical for all inner harbor estimates which require ocean disposal. This estimate assumed utilizing a 26 cubic yard clam shell dredge to excavate all material and placing the material into 4000 cubic yard scows to be towed by tugs and deposited into the Ocean Dredged Material Disposal Site (ODMDS) located 17.2 miles away.

The third is a cost estimate for constructing the 45-foot channel in the Charleston Harbor Entrance Channel and is typical for all shoals within the entrance channel. This estimate assumed utilizing a 30-inch hydraulic pipeline dredge to excavate all material and placing the material into 6000 cubic yard scows to be towed by tugs and deposited into the ODMDS.

All cost estimates considered all available information concerning material types which were derived from available boring logs and any other conditions present which would influence the production rates for performing the work. All cost estimates included the removal of the required quantities plus two-foot advanced maintenance plus two-foot allowable overdepth materials. All cost estimates assumed removing one-foot of non-pay yardage over the entire area to be dredged and assumed that 10 percent of the available overdepth material would not be removed. It should be noted that most of the quantities for new work required for any of these plans lies in the advanced maintenance and allowable overdepth region of the dredge prism. Mobilization and demobilization costs were calculated and included in the summary sheets.

Estimates for projected maintenance dredging and upland disposal site diking were calculated based on historical practices and data combined with predicted increased shoaling quantities determined from the numerical sedimentation models and existing dredged material disposal practices. Upland dredged material disposal sites were utilized for placement of harbor maintenance material while entrance channel material was determined to be taken offshore to the ODMDS.

No associated project costs were included for the Navy's Degaussing pier. Future operation of the pier is uncertain as a result of the closure of the Naval Shipyard and presence of other degaussing facilities in Charleston harbor. Instrument cables from the degaussing pier are designated to be buried at -50 MLLW beneath the existing navigation channel. Data was unobtainable regarding costs associated with relocating the instrument cable. Further coordination of this issue will be pursued throughout the project.

The cost estimates for the contraction dikes were prepared using the Micro-Computer Aided Cost Engineering System (MCACES). The two existing contraction dikes along the west side of the channel will be demolished and replaced with new contraction dikes. The existing rip rap material will be utilized in the construction of the new replacement contraction dikes. The new contraction dike will be constructed on a newly placed underwater foundation dike constructed of placed excavated marl. New rip rap material will be placed around the new contraction dike to prevent scour. The new contraction dike will be connected to the existing bank by a newly constructed rip rap embankment. The construction of these contraction dikes will be by barge mounted equipment. The MCACES estimate is located in Exhibit 9 of this appendix.

The total first cost of the recommended project is $116,639,000. This includes the cost of deepening the channel, constructing the Daniel Island turning basin, and realigning the channel in the Shutes and Folly Reaches. This also includes the cost of widening the Daniel Island Reach, which is recommended in the interest of safety as a modification of the without-project condition. These costs, with the Federal and non-Federal shares and fully funded costs, are displayed in the Total Project Cost Summary Sheet [TPCS], which is included as Exhibit 1 of this appendix.

Exhibit 2 summarizes data from the more detailed cost estimates shown in Exhibits 3 through 9. The financial analysis shown in the TPCS and the economic analysis described in Appendix E of this report require different aggregations of this data. However, both the TPCS and the economic analysis are based upon the data summarized in Exhibit 2.

The aggregation of data in Exhibit 2 is that which was required for the economic analysis. The totals include costs for all project components except the without-project widening of the Daniel Island Reach, which is justified as a safety measure. The cost of widening the existing 40-foot channel in the Daniel Island reach[1] was subtracted from other costs so that these items, with a first cost of $106,330,000, could be considered separately in the economic analysis. Adding the cost of the Daniel Island widening ($10,309,000) to this total yields the Total Project Cost of $116,639,000 shown in the TPCS.

The Total Construction Cost, with contingencies, of $102,939,000 shown in the TPCS is also derived from the data in Exhibit 2. The subtotal of direct construction costs in Exhibit 2 ($92,653,000) includes mitigation costs; however, mitigation costs are shown as a separate item in the TPCS. As noted above, the cost of the Daniel Island widening is included in the TPCS total construction cost, but is excluded from the totals in Exhibit 2. Adjusting the subtotal from Shared Costs shown in Exhibit 2 to reflect these differences in aggregation yields the Total Construction Cost shown in the TPCS:

$ 92,653,000	- Total Shared Cost, Exhibit 2
- 23,000	- Mitigation Cost, Exhibit 2 ($20,000 + 15% contingencies)

92,630,000	
+ 10,309,000	- Daniel Island Widening ($8,964,000 from Exhibit 2 + 15% contingencies)

$102,939,000	- Total Construction Cost, TPCS

---

[1] As shown in Exhibit 5, the cost of this widening is $10,309,000 ($8,964,000 plus $1,345,000 contingencies.)

The cost of "Lands and Damages" in the TPCS is the total Non-Federal Cost shown in Exhibit 2. "Planning, Engineering, and Design" costs shown in the TPCS are the sum of the costs of "PED" and "Monitoring of ODMDS" from Exhibit 2. Costs for "Mitigation" and "Aids to Navigation" are identical in both tables.

The remaining exhibits present more detailed cost estimates for each of the main components. Exhibit 3 shows the costs of work in the inner harbor; Exhibit 4, the entrance channel; Exhibit 5, the Daniel Island Widening; Exhibit 6, the Daniel Island Turning Basin; Exhibit 7, the berthing area for the new Daniel Island Terminal; and Exhibit 9, the contraction dikes. As noted above, Exhibit 8 contains a sample of detailed dredging cost computations.

The information in Exhibits 3 through 9 is provided as a supplement to the summary of project costs shown in Exhibit 2. For example, Exhibit 2 includes a cost of $31.7 million [without contingencies] for the entrance channel. Exhibit 4 shows the disposal site, quantity of material and unit costs associated with this total cost. Similar information is presented in Exhibit 3 to explain the derivation of main channel costs [without contingencies] of $28.7 million that are shown in the summary in Exhibit 2.

Exhibit 1

Total Project Cost Summary Sheet

**** TOTAL PROJECT COST SUMMARY ****

PAGE 1 OF 2

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE FEASIBILITY REPORT, DATED: FEB 96

PROJECT: CHARLESTON HARBOR (DEEPENING/WIDENING)
DISTRICT: CHARLESTON
LOCATION: CHARLESTON, SOUTH CAROLINA

		CURRENT MCACES ESTIMATE PREPARED: FEB 96 CURRENT MCACES EFFECTIVE PRICING: OCT 95				BUDGET YEAR: 1998 EFFECT. PRICING LEVEL: 1 OCT 95			........FULLY FUNDED ESTIMATE........		
ACCOUNT NUMBER	FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	COST ($K)	CNTG ($K)	TOTAL ($K)	COST ($K)	CNTG ($K)	FULL ($K)
12---	NAVIGATION PORTS AND HARBORS	89,555	13,384	15%	102,939	92,240	13,765	106,025	105,498	15,351	120,849
	TOTAL CONSTRUCTION COSTS =====>	89,555	13,384	15%	102,939	92,240	13,765	106,025	105,498	15,351	120,849
01---	LANDS AND DAMAGES	7,376	1,103	15%	8,479	7,597	1,136	8,733	8,760	204	8,964
06---	MITIGATION	20	3	15%	23	21	3	24	25	4	29
30---	PLANNING, ENGINEERING AND DESIGN	2,902	218	8%	3,120	3,009	226	3,235	3,229	262	3,491
31---	CONSTRUCTION MANAGEMENT	1,869	131	7%	2,000	1,938	136	2,074	2,245	158	2,403
	AIDS TO NAVIGATION	78	0	0%	78	70	10	80	83	12	95
	TOTAL PROJECT COSTS ========>	101,800	14,839	15%	116,639	104,875	15,296	120,171	119,840	15,991	135,831

TOTAL FEDERAL COSTS ======================> 72,798

TOTAL NON-FEDERAL COSTS ==================> 43,840

TOTAL FEDERAL COSTS ==============> 85,019

TOTAL NON-FEDERAL COSTS ==========> 50,812

THIS TPCS REFLECTS A PROJECT COST CHANGE OF $0.

THE MAXIMUM PROJECT COST IS ========== 162,997

DISTRICT APPROVED:

CHIEF, COST ENGINEERING
CHIEF, REAL ESTATE
CHIEF, PLANNING
CHIEF, PROGRAMS MANAGEMENT
CHIEF, ENGINEERING
CHIEF, CON-OPS
PROJECT MANAGER
DDE (PM)

DIVISION APPROVED:

CHIEF, COST ENGINEERING
DIRECTOR, REAL ESTATE
For CHIEF, PROGRAMS MANAGEMENT
DIRECTOR OF PPMD
APPROVED DATE: 19 MAR 96

**** TOTAL PROJECT COST SUMMARY ****

PAGE 2 OF 2

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE FEASIBILITY REPORT, DATED: FEB 96

PROJECT: CHARLESTON HARBOR (DEEPENING/WIDENING)
DISTRICT: CHARLESTON
LOCATION: CHARLESTON, SOUTH CAROLINA

		CURRENT MCACES ESTIMATE PREPARED: FEB 96 CURRENT MCACES EFFECTIVE PRICING: OCT 95				BUDGET YEAR: 1998 EFFECT. PRICING LEVEL: 1 OCT 95				.........FULLY FUNDED ESTIMATE.........				
ACCOUNT NUMBER	FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
12---	NAVIGATION CONTRACT #1	24,182	3,614	15%	27,796	3.0%	24,907	3,722	28,629	JAN 99	11.3%	27,719	4,142	31,861
12---	NAVIGATION CONTRACT #2	33,904	5,067	15%	38,971	3.0%	34,921	5,219	40,140	JUL 99	11.3%	38,864	5,393	44,257
12---	NAVIGATION CONTRACT #3	8,282	1,238	15%	9,520	3.0%	8,530	1,275	9,805	JUN 00	14.7%	9,787	1,463	11,250
12---	NAVIGATION CONTRACT #4	19,616	2,931	15%	22,547	3.0%	20,204	3,019	23,223	AUG 02	22.0%	24,642	3,682	28,324
12---	NAVIGATION CONTRACT #5	3,571	534	15%	4,105	3.0%	3,678	550	4,228	MAR 02	22.0%	4,486	671	5,157
	TOTAL CONSTRUCTION COSTS =====>	89,555	13,384	15%	102,939		92,240	13,785	106,025			105,498	15,351	120,849
01---	BERTHS	5,231	782	15%	6,013	3.0%	5,388	805	6,193	FEB 01	18.3%	6,374	68	6,442
01---	REAL ESTATE	15	2	15%	17	3.0%	15	2	17	APR 01	18.3%	18	68	86
01---	DISPOSAL/DIKING	2,130	319	15%	2,449	3.0%	2,194	329	2,523	APR 98	7.9%	2,368	68	2,436
06---	MITIGATION	20	3	15%	23	3.0%	21	3	24	APR 01	18.3%	25	4	29
30---	PLANNING, ENGINEERING AND DESIGN	2,437	183	8%	2,620	3.7%	2,527	190	2,717	APR 00	15.8%	2,799	220	3,019
30---	MONITORING	465	35	8%	500	3.7%	482	36	518	JUN 00	15.8%	430	42	472
31---	CONSTRUCTION MANAGEMENT	1,869	131	7%	2,000	3.7%	1,938	136	2,074	JUN 00	15.8%	2,245	158	2,403
	AIDS TO NAVIGATION - COAST GUARD	68	10	15%	78	3.0%	70	10	80	APR 01	18.3%	83	12	95
	TOTAL COSTS =============>	101,790	14,849	15%	116,639		104,875	15,296	120,171			119,840	15,991	135,831
	TOTAL GNF (FEATURE 12,06,30,31) ================>				108,082									

Exhibit 2

Summary of Project Costs by Major Component

	Main Channel Depth					
	41	42	43	44	45	46
Shared Costs						
Channel Deepening						
Entrance Channel	$21,188,745	$28,008,245	$29,554,476	$30,840,921	$31,687,768	$35,063,165
Main Channel	$17,140,658	$19,580,206	$22,968,577	$25,746,836	$28,737,613	$31,826,154
Columbus Street Channel	1,008,592	1,408,196	1,996,564	2,419,069	3,111,229	3,198,312
Wando River Channel	1,052,691	1,671,867	2,457,918	4,154,977	4,862,077	5,561,176
Shipyard River Channel	293,705	435,317	543,758	652,248	763,803	921,855
Mob/Demob, EC	1,100,000	1,100,000	1,100,000	2,200,000	2,200,000	3,300,000
Mob/Demob, Other	1,273,000	1,678,000	2,141,000	2,546,000	3,009,000	3,009,000
W/O Project Widening *	(8,964,000)	(8,964,000)	(8,964,000)	(8,964,000)	(8,964,000)	(8,964,000)
Subtotal	$34,093,390	$44,917,832	$51,798,293	$59,596,051	$65,407,489	$73,915,662
Contraction Dikes						
Dike A	$1,006,781	$1,006,781	$1,006,781	$1,006,781	$1,006,781	$1,006,781
Dike B	580,912	580,912	580,912	580,912	580,912	580,912
Dike C	1,943,934	1,943,934	1,943,934	1,943,934	1,943,934	1,943,934
Mob/Demob	37,444	37,444	37,444	37,444	37,444	37,444
Subtotal	$3,569,071	$3,569,071	$3,569,071	$3,569,071	$3,569,071	$3,569,071
Daniel Island Turning Basin	$6,388,349	$6,656,470	$6,950,043	$7,243,615	$7,482,139	$7,674;937
Shutes/Folly Realignment	$5,348,376	$4,820,057	$4,706,280	$4,787,679	$4,088,854	$3,839,941
Mitigation	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000
Subtotal	$49,419,187	$59,983,430	$67,043,686	$75,216,416	$80,567,553	$89,019,611
Contingencies, 15 Percent	$7,412,878	$8,997,514	$10,056,553	$11,282,462	$12,085,133	$13,352,942
Subtotal	$56,832,065	$68,980,944	$77,100,239	$86,498,879	$92,652,686	$102,372,553
Monitoring of ODMDS	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000
PED	$2,620,000	$2,620,000	$2,620,000	$2,620,000	$2,620,000	$2,620,000
Construction Management	$1,600,000	$1,600,000	$2,000,000	$2,000,000	$2,000,000	$2,400,000
Total Shared Costs	**$61,552,065**	**$73,700,944**	**$82,220,239**	**$91,618,879**	**$97,772,686**	**$107,892,553**
Federal Costs						
Aids to Navigation	**$78,000**	**$78,000**	**$78;000**	**$78,000**	**$78,000**	**$78,000**
Non-Federal Costs						
Berthing Areas	$4,290,136	$4,504,927	$4,679,253	$4,697,577	$5,228,507	$5,404,838
Disposal Diking	$582,846	$939,044	$1,321,950	$1,719,999	$2,129,521	$2,548,602
Real Estate	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000
Subtotal	$4,887,982	$5,458,971	$6,016,202	$6,432,576	$7,373,028	$7,968,440
Contingencies, 15 Percent	$733,197	$818,846	$902,430	$964,886	$1,105,954	$1,195,266
Total Non-Fed. Costs	**$5,621,179**	**$6,277,816**	**$6,918,633**	**$7,397,463**	**$8,478,982**	**$9,163,706**
Total First Costs	**$67,251,244**	**$80,056,760**	**$89,216,872**	**$99,094,342**	**$106,329,668**	**$117,134,259**
Interest During Construction	$11,134,252	$13,712,379	$14,637,626	$16,471,009	$17,543,645	$18,822,556
Total Investment Cost	$78,385,496	$93,769,139	$103,854,498	$115,565,351	$123,873,313	$135,956,815
Average Annual Cost						
Interest	$5,976,894	$7,149,897	$7,918,905	$8,811,858	$9,445,340	$10,366,707
Amortization	$155,589	$186,124	$206,143	$229,388	$245,878	$269,863
Annual O&M	$202,000	$404,000	$606,000	$808,000	$1,010,000	$1,212,000
Total AAC	$6,334,483	$7,740,021	$8,731,048	$9,849,246	$10,701,218	$11,848,570

* See Exhibit 5, Dredging Cost Summary Sheet for Daniel Island Channel Widening.

Exhibit 3

Dredging Cost Summary Sheets for Inner Harbor

CHARLESTON HARBOR DEEPENING PROJECT - 41' CHANNEL, INNER HARBOR

SHOAL	DISPOSAL SITE	QUANTITY CY	COST/CY	TOTAL COST	CONTINGENCY 15%	TOTAL COST INC. CONT.
Mount Pleasant Range	Ocean	28,850	$8.76	$252,726	$37,909	$290,635
Rebellion/Folly Reach	Ocean	313,380	$5.46	$1,711,055	$256,658	$1,967,713
Horse/Shutes Reach	Ocean	202,334	$3.21	$649,492	$97,424	$746,916
Hog Island Reach	Ocean	224,539	$6.69	$1,502,166	$225,325	$1,727,491
Drum Island Bend	Ocean	16,221	$18.82	$305,279	$45,792	$351,071
Drum Island Reach	Ocean	127,499	$3.52	$448,796	$67,319	$516,116
Daniel Island Reach	Clouter Creek	160,577	$1.83	$293,856	$44,078	$337,934
Daniel Island Bend	Clouter Creek	140,682	$3.65	$513,489	$77,023	$590,513
Daniel I. Widening	Ocean	3,800,000	$2.49	$9,462,000	$1,419,300	$10,881,300
Clouter Creek Reach	Clouter Creek	200,992	$2.23	$448,212	$67,232	$515,444
Navy Yard Reach - Lower	Clouter Creek	40,273	$1.11	$44,703	$6,705	$51,408
Navy Yard Reach - Upper	Clouter Creek	141,993	$0.99	$140,573	$21,086	$161,659
North Charleston Reach	Clouter Creek	162,381	$1.19	$193,233	$28,985	$222,218
Filbin Creek Reach	Clouter Creek	147,365	$2.87	$422,938	$63,441	$486,378
Port Terminal Reach	Clouter Creek	97,356	$3.18	$309,592	$46,439	$356,031
Ordinance Reach	Clouter Creek	80,846	$3.91	$316,108	$47,416	$363,524
Ordinance Turning Basin	Clouter Creek	44,996	$2.81	$126,439	$18,966	$145,405
Main Channel Subtotal		5,930,284		$17,140,658	$2,571,099	$19,711,756
Custom House Reach	Ocean	30,873	$3.73	$115,156	$17,273	$132,430
Tidewater - Upper Reach	Ocean	37,139	$6.26	$232,490	$34,874	$267,364
Lower Towncreek - Lower	Ocean	126,256	$3.87	$488,611	$73,292	$561,902
Turning Basin	Ocean	45,471	$3.79	$172,335	$25,850	$198,185
Columbus Street Subtotal		239,739		$1,008,592	$151,289	$1,159,881
Shipyard River	Clouter Creek	122,377	$2.40	$293,705	$44,056	$337,761
Wando Reach	Ocean	80,601	$4.40	$354,644	$53,197	$407,841
Wando Terminal	Ocean	67,047	$6.37	$427,089	$64,063	$491,153
Wando Extension	Ocean	62,004	$4.37	$270,957	$40,644	$311,601
Wando River Subtotal		209,652		$1,052,691	$157,904	$1,210,595
Custom House Berth	Ocean	125,930	$2.59	$326,159	$48,924	$375,083
N. Charleston Berth	Clouter Creek	163,200	$1.64	$267,648	$40,147	$307,795
Allied Berth	Clouter Creek	27,780	$3.92	$108,898	$16,335	$125,232
Hess Berth	Clouter Creek	80,560	$1.70	$136,952	$20,543	$157,495
Shipyard Berth	Clouter Creek	7,640	$17.00	$129,880	$19,482	$149,362
Wando Berth	Ocean	34,260	$3.92	$134,299	$20,145	$154,444
Daniel I. Berth	Ocean	1,290,000	$2.47	$3,186,300	$477,945	$3,664,245
Berthing Area Subtotal		1,729,370		$4,290,136	$643,520	$4,933,656
Daniel I. Turning Basin	Ocean	2,545,159	$2.51	$6,388,349	$958,252	$7,346,601
Shutes/Folly Realignment	Ocean	3,116,826		$5,348,376	$802,256	$6,150,633
TOTALS		**13,893,407**		**$35,522,507**	**$5,328,376**	**$40,850,883**

CHARLESTON HARBOR DEEPENING PROJECT - 43' CHANNEL, INNER HARBOR

SHOAL	DISPOSAL SITE	QUANTITY CY	COST/CY	TOTAL COST	CONTINGENCY 15%	TOTAL COST INC. CONT.
Mount Pleasant Range	Ocean	81508	$3.42	$278,757	$41,814	$320,571
Rebellion/Folly Reach	Ocean	992727	$3.03	$3,007,963	$451,194	$3,459,157
Horse/Shutes Reach	Ocean	443073	$2.63	$1,165,282	$174,792	$1,340,074
Hog Island Reach	Ocean	599,754	$3.23	$1,937,205	$290,581	$2,227,786
Drum Island Bend	Ocean	45,771	$6.80	$311,243	$46,686	$357,929
Drum Island Reach	Ocean	362,704	$2.60	$943,030	$141,455	$1,084,485
Daniel Island Reach	Clouter Creek	381,487	$2.35	$896,494	$134,474	$1,030,969
Daniel Island Bend	Clouter Creek	327,840	$1.94	$636,010	$95,401	$731,411
Daniel I. Widening	Ocean	4,200,000	$2.48	$10,416,000	$1,562,400	$11,978,400
Clouter Creek Reach	Clouter Creek	528,936	$1.12	$592,408	$88,861	$681,270
Navy Yard Reach - Lower	Clouter Creek	131,034	$1.88	$246,344	$36,952	$283,296
Navy Yard Reach - Upper	Clouter Creek	322,736	$1.22	$393,738	$59,061	$452,799
North Charleston Reach	Clouter Creek	398,317	$1.69	$673,156	$100,973	$774,129
Filbin Creek Reach	Clouter Creek	335,017	$1.52	$509,226	$76,384	$585,610
Port Terminal Reach	Clouter Creek	257,492	$1.54	$396,538	$59,481	$456,018
Ordinance Reach	Clouter Creek	244,931	$1.66	$406,585	$60,988	$467,573
Ordinance Turning Basin	Clouter Creek	106,441	$1.49	$158,597	$23,790	$182,387
Main Channel Subtotal		9,759,768		$22,968,577	$3,445,287	$26,413,863
Custom House Reach	Ocean	106,866	$2.26	$241,517	$36,228	$277,745
Tidewater - Upper Reach	Ocean	111,785	$2.84	$317,468	$47,620	$365,088
Lower Towncreek - Lower	Ocean	289,174	$3.06	$884,872	$132,731	$1,017,603
Turning Basin	Ocean	156,574	$3.53	$552,706	$82,906	$635,612
Columbus Street Subtotal		664,399		$1,996,564	$299,485	$2,296,048
Shipyard River	Clouter Creek	261,422	$2.08	$543,758	$81,564	$625,321
Wando Reach	Ocean	373,516	$2.56	$956,201	$143,430	$1,099,631
Wando Terminal	Ocean	298,544	$3.40	$1,015,050	$152,257	$1,167,307
Wando Extension	Ocean	148,828	$3.27	$486,668	$73,000	$559,668
Wando River Subtotal		820,888		$2,457,918	$368,688	$2,826,606
Custom House Berth	Ocean	155,560	$2.41	$374,900	$56,235	$431,135
N. Charleston Berth	Clouter Creek	209,970	$1.58	$331,753	$49,763	$381,515
Allied Berth	Clouter Creek	38,890	$3.60	$140,004	$21,001	$161,005
Hess Berth	Clouter Creek	114,830	$1.50	$172,245	$25,837	$198,082
Shipyard Berth	Clouter Creek	12,740	$8.31	$105,869	$15,880	$121,750
Wando Berth	Ocean	68,520	$2.85	$195,282	$29,292	$224,574
Daniel I. Berth	Ocean	1,360,000	$2.47	$3,359,200	$503,880	$3,863,080
Berthing Area Subtotal		1,960,510		$4,679,253	$701,888	$5,381,140
Daniel I. Turning Basin	Ocean	2,780,017	$2.50	$6,950,043	$1,042,506	$7,992,549
Shutes/Folly Realignment	Ocean	2,488,705		$4,706,280	$705,942	$5,412,222
TOTALS		**18,735,709**		**$44,302,391**	**$6,645,359**	**$50,947,750**

CHARLESTON HARBOR DEEPENING PROJECT - 45' CHANNEL, INNER HARBOR

SHOAL	DISPOSAL SITE	QUANTITY CY	COST/CY	TOTAL COST	CONTINGENCY 15%	TOTAL COST INC. CONT.
Mount Pleasant Range	Ocean	135,589	$2.23	$302,363	$45,355	$347,718
Rebellion/Folly Reach	Ocean	1,764,842	$2.32	$4,094,433	$614,165	$4,708,598
Horse/Shutes Reach	Ocean	715,660	$2.42	$1,731,897	$259,785	$1,991,682
Hog Island Reach	Ocean	1,000,377	$2.85	$2,851,074	$427,661	$3,278,736
Drum Island Bend	Ocean	84,262	$3.82	$321,881	$48,282	$370,163
Drum Island Reach	Ocean	623,031	$2.90	$1,806,790	$271,018	$2,077,808
Daniel Island Reach	Clouter Creek	614,031	$1.91	$1,172,799	$175,920	$1,348,719
Daniel Island Bend	Clouter Creek	534,515	$1.53	$817,808	$122,671	$940,479
Daniel I. Widening	Ocean	4,500,000	$2.47	$11,115,000	$1,667,250	$12,782,250
Clouter Creek Reach	Clouter Creek	877,361	$1.08	$947,550	$142,132	$1,089,682
Navy Yard Reach - Lower	Clouter Creek	249,896	$1.20	$299,875	$44,981	$344,856
Navy Yard Reach - Upper	Clouter Creek	514,573	$1.09	$560,885	$84,133	$645,017
North Charleston Reach	Clouter Creek	656,204	$1.25	$820,255	$123,038	$943,293
Filbin Creek Reach	Clouter Creek	534,223	$1.27	$678,463	$101,769	$780,233
Port Terminal Reach	Clouter Creek	427,733	$1.20	$513,280	$76,992	$590,272
Ordinance Reach	Clouter Creek	415,606	$1.21	$502,883	$75,432	$578,316
Ordinance Turning Basin	Clouter Creek	174,240	$1.15	$200,376	$30,056	$230,432
Main Channel Subtotal		13,822,143		$28,737,613	$4,310,642	$33,048,255
Custom House Reach	Ocean	198,175	$2.90	$574,708	$86,206	$660,914
Tidewater - Upper Reach	Ocean	196,152	$2.61	$511,957	$76,794	$588,750
Lower Towncreek - Lower	Ocean	464,070	$2.64	$1,225,145	$183,772	$1,408,917
Turning Basin	Ocean	287,561	$2.78	$799,420	$119,913	$919,333
Columbus Street Subtotal		1,145,958		$3,111,229	$466,684	$3,577,913
Shipyard River	Clouter Creek	424,335	$1.80	$763,803	$114,570	$878,373
Wando Reach	Ocean	727,219	$3.00	$2,181,657	$327,249	$2,508,906
Wando Terminal	Ocean	585,001	$3.44	$2,012,403	$301,861	$2,314,264
Wando Extension	Ocean	242,035	$2.76	$668,017	$100,202	$768,219
Wando River Subtotal		1,554,255		$4,862,077	$729,312	$5,591,389
Custom House Berth	Ocean	185,190	$2.37	$438,900	$65,835	$504,735
N. Charleston Berth	Clouter Creek	271,070	$1.53	$414,737	$62,211	$476,948
Allied Pier	Clouter Creek	50,000	$3.53	$176,500	$26,475	$202,975
Hess Pier	Clouter Creek	149,090	$1.46	$217,671	$32,651	$250,322
Shipyard Berth	Clouter Creek	22,460	$6.97	$156,546	$23,482	$180,028
Wando Berth	Ocean	102,780	$3.22	$330,952	$49,643	$380,594
Daniel I. Berth	Ocean	1,420,000	$2.46	$3,493,200	$523,980	$4,017,180
Berthing Area Subtotal		2,200,590		$5,228,507	$784,276	$6,012,783
Daniel I. Turning Basin	Ocean	3,004,875	$2.49	$7,482,139	$1,122,321	$8,604,460
Shutes/Folly Realignment	Ocean	1,736,208		$4,088,854	$613,328	$4,702,183
TOTALS		**23,888,364**		**$54,274,222**	**$8,141,133**	**$62,415,355**

Exhibit 4

Dredging Cost Summary Sheets for Entrance Channel

CHARLESTON HARBOR DEEPENING PROJECT
ENTRANCE CHANNEL

AUTHORIZED PROJECT DEPTH	DISPOSAL SITE	QUANTITY CY	COST/CY	TOTAL COST	15 PERCENT CONTINGENCY	TOTAL COST
41 Feet	Ocean	4,927,615	$4.30	$21,188,745	$3,178,312	$24,367,056
42 Feet	Ocean	7,163,234	$3.91	$28,008,245	$4,201,237	$32,209,482
43 Feet	Ocean	9,207,002	$3.21	$29,554,476	$4,433,171	$33,987,648
44 Feet	Ocean	11,338,574	$2.72	$30,840,921	$4,626,138	$35,467,059
45 Feet	Ocean	13,541,781	$2.34	$31,687,768	$4,753,165	$36,440,933
46 Feet	Ocean	15,378,581	$2.28	$35,063,165	$5,259,475	$40,322,639

Exhibit 5

Dredging Cost Summary Sheets for Daniel Island Widening

CHARLESTON HARBOR DEEPENING PROJECT - Daniel Island Widening

CHANNEL DEPTH	DISPOSAL SITE	QUANTITY CY	COST/CY	TOTAL COST	CONTINGENCY 15%	TOTAL COST INC. CONT.
40 Feet	Ocean	3,600,000	$2.49	$8,964,000	$1,344,600	$10,308,600
41 Feet	Ocean	3,800,000	$2.49	$9,462,000	$1,419,300	$10,881,300
42 Feet	Ocean	4,000,000	$2.48	$9,920,000	$1,488,000	$11,408,000
43 Feet	Ocean	4,200,000	$2.48	$10,416,000	$1,562,400	$11,978,400
44 Feet	Ocean	4,300,000	$2.48	$10,664,000	$2,666,000	$13,330,000
45 Feet	Ocean	4,500,000	$2.47	$11,115,000	$1,667,250	$12,782,250
46 Feet	Ocean	4,600,000	$2.47	$11,362,000	$1,704,300	$13,066,300

Exhibit 6

Dredging Cost Summary Sheets for Daniel Island Turning Basin

CHARLESTON HARBOR DEEPENING PROJECT - 41' to 46' CHANNEL

Daniel Island Turning Basin

CHANNEL DEPTH	DISPOSAL SITE	QUANTITY CY	COST/CY	TOTAL COST	CONTINGENCY 15%	TOTAL COST INC. CONT.
41 Feet	Ocean	2,545,159	$2.51	$6,388,349	$958,252	$7,346,601
	Clouter Ck	2,545,159	$1.59	$4,046,803	$607,020	$4,653,823
42 Feet	Ocean	2,662,588	$2.50	$6,656,470	$998,471	$7,654,941
	Clouter Ck	2,662,588	$1.63	$4,340,018	$651,003	$4,991,021
43 Feet	Ocean	2,780,017	$2.50	$6,950,043	$1,042,506	$7,992,549
	Clouter Ck	2,780,017	$1.70	$4,726,029	$708,904	$5,434,933
44 Feet	Ocean	2,897,446	$2.50	$7,243,615	$1,086,542	$8,330,157
	Clouter Ck	2,897,446	$1.75	$5,070,531	$760,580	$5,831,110
45 Feet	Ocean	3,004,875	$2.49	$7,482,139	$1,122,321	$8,604,460
	Clouter Ck	3,004,875	$1.80	$5,408,775	$811,316	$6,220,091
46 Feet	Ocean	3,082,304	$2.49	$7,674,937	$1,151,241	$8,826,178
	Clouter Ck	3,082,304	$1.88	$5,794,732	$869,210	$6,663,941

Exhibit 7

Dredging Cost Summary Sheets for Daniel Island Berthing Area

CHARLESTON HARBOR DEEPENING PROJECT - 41' to 46' CHANNEL

Daniel Island Berthing Area for SPA

CHANNEL DEPTH	DISPOSAL SITE	QUANTITY CY	COST/CY	TOTAL COST	CONTINGENCY 15%	TOTAL COST INC. CONT.
41 Feet	Ocean	1,290,000	$2.47	$3,186,300	$477,945	$3,664,245
	Clouter Ck	1,290,000	$1.80	$2,322,000	$348,300	$2,670,300
42 Feet	Ocean	1,330,000	$2.47	$3,285,100	$492,765	$3,777,865
	Clouter Ck	1,330,000	$1.85	$2,460,500	$369,075	$2,829,575
43 Feet	Ocean	1,360,000	$2.47	$3,359,200	$503,880	$3,863,080
	Clouter Ck	1,360,000	$1.93	$2,624,800	$393,720	$3,018,520
44 Feet	Ocean	1,390,000	$2.46	$3,419,400	$512,910	$3.932,310
	Clouter Ck	1,390,000	$1.99	$2,766,100	$414,915	$3,181,015
45 Feet	Ocean	1,420,000	$2.46	$3,493,200	$523,980	$4,017,180
	Clouter Ck	1,420,000	$2.04	$2,896,800	$434,520	$3,331,320
46 Feet	Ocean	1,450,000	$2.46	$3,567,000	$535,050	$4,102,050
	Clouter Ck	1,450,000	$2.13	$3,088,500	$463,275	$3,551,775

Exhibit 8

Examples of Dredging Estimates

B DREDGING COST BID ITEM # 2

					REMARKS
1	GROSS YARDAGE			942,701 CY	FROM SHEET A, ITEM 6 G.
2	PRODUCTION RATE		/	388,080 CY/MO	FROM SHEET C, ITEM 8.
3	DREDGING TIME		=	2.43 MONTHS	833,801 Net Pay CY / 2.43 MO = 343,128 Pay CY/MO
4	TOTAL MONTHLY COST		x	$292,717	FROM SHEET D, ITEM 5.
	SUBTOTAL...........		=	$711,302	
5	FIXED COSTS		+	$0	FROM SHEET E, ITEM 15.
	SUBTOTAL.............		=	$711,302	
6	OVERHEAD	14.0%	+	$99,582	
	SUBTOTAL...........		=	$810,884	
7	PROFIT	10.0%	+	$81,088	
	SUBTOTAL.............		=	$891,972	
8	BOND	1.0%	+	$8,920	
9	GROSS PRODUCTION COSTS		=	$900,892	
10	NET PAY YARDAGE		/	833,801 CY	FROM SHEET A, ITEM 6 E.
11	UNIT COST		=	$1.08 /CY	
12	MAX PAY YARDAGE		x	877,361 CY	FROM SHEET A, ITEM 6 C.
13	DREDGING COST		=	$947,550	

GROSS PRODUCTION

C \ 1 BID ITEM # 2

OPERATING TIME

			REMARKS
1 SIZE OF DREDGE....PIPELINE.........>		18"	
2 POWER OUTPUT......MAIN PUMP........>		1,700 HP	
3 NUMBER OF BOOSTERS IN LINE		0	Each Booster is 1600 Horsepower.
4 PRODUCTION.........(BASED ON)......>		5,000 LF	FROM SHEET C \ 2, ITEM 13.
A. ADJUSTED CHART PRODUCTION		609 CY/HR	FROM SHEET C \ 2, ITEM 14.
B. MATERIAL FACTOR	x	1.15	FROM SHEET C \ 3, ITEM 1 B.
C. BANK FACTOR	x	1.10	FROM SHEET C \ 3, ITEM 2 D.
D. OTHER FACTOR	x	1.00	XXXXXXXXXXXXX
E. CLEANUP FACTOR	x	1.00	0% ADDITIONAL DREDGING TIME
F. GROSS PRODUCTION	=	770 CY/HR	

			REMARKS
5 OPERATING TIME:			
A. BOOSTER FACTOR		1.00	10% LOSS IN PUMPING TIME PER BOOSTER
B. TIME EFFICIENCY	x	69.0%	% OF EFFECTIVE WORKING TIME WITHOUT BOOSTERS
C. NET EFFICIENCY	=	69.0%	% OF EFFECTIVE WORKING TIME INCLUDING BOOSTER LOSSES
D. MAX DREDGE TIME	x	730 HRS/MO	
E. OPERATING TIME	=	504 HRS/MO	

* * *

MATERIAL FACTOR CALCULATION

C \ 3 BID ITEM # 2

BANK FACTOR CALCULATION

* * *

1 MATERIAL FACTOR COMPUTATION:

A. MATERIAL FACTOR CHART:

DESCRIPTION	INPLACE DENSITY		FACTOR	%	QUANTITIES
MUD & SILT	1200	GR/L	3	0%	0 c.y.
MUD & SILT	1300	GR/L	2.5	0%	0 c.y.
MUD & SILT	1400	GR/L	2	60%	565,621 c.y.
LOOSE SAND	1700	GR/L	1.1	0%	0 c.y.
LOOSE SAND	1900	GR/L	1	15%	141,405 c.y.
COMP. SAND	2000	GR/L	0.9	0%	0 c.y.
STIFF CLAY	2000	GR/L	0.6	25%	235,675 c.y.
COMP. SHELL	2300	GR/L	0.5	0%	0 c.y.
SOFT ROCK	2400	GR/L	0.4	0%	0 c.y.
BLAST. ROCK	2000	GR/L	0.25	0%	0 c.y.

* * *

B. MATERIAL FACTOR.................> 1.15 100% 942,701 c.y. (Computed from Chart)

* * *

REMARKS

2 BANK FACTOR COMPUTATION:

A. SIZE OF DREDGE....PIPELINE......> 18"

B. AVERAGE BANK HEIGHT.............> 8.7 FT

C. BANK FACTOR CHART:

BANK HEIGHT	1	2	3	4	5	6	7	8	9
FACTOR	NA	0.53	0.7	0.86	1.02	1.1	1.1	1.1	1.1

* * *

D. BANK FACTOR.....................> 1.10 Interpolated from chart

>

* * *

D \ 1 LABOR COSTS BID ITEM # 2

DREDGE SIZE 18"

SALARIED PERSONNEL:		RATE/MO	
CAPTAIN		$3,000	
CHIEF ENGR.		$2,800	
CIVIL ENGR.		$0	
FIELD OFFICE PERSONNEL		$1,800	
SUBTOTAL....		$7,600	
TAXES,INS.,FRINGES......	69.5%	$5,282	
SALARIED PAYROLL.......>		$12,882	/MO

Taxes, insurance and fringes on labor:
Latest Labor Rate Update -> Oct 93

Social Security		7.7%
Workman's Compensation		45.0%
State Unemployment Comp.		3.5%
Federal Unemployment Comp.		1.0%
Fringes...	$1.73 per hour	16.7%
(Not based	6 paid hol.	1.4%
on O.T.)	7.0%vacation	6.1%
TAXES,INS.,FRINGES......CREW...		81.5%
-(BENEFIT DIFFERENTIAL)		12.0%
TAXES,INS.,FRINGES......MANAGEMENT..		69.5%

CREW LABOR	NO.	RATE/HR	AMOUNT	
LEVERMAN	3	$10.63	$31.89	
WATCH ENGINEER	3	$10.17	$30.51	
DREDGE MATES	2	$9.35	$18.70	
TUG MASTERS	1	$10.17	$10.17	
LAUNCHMEN	3	$8.68	$26.04	
MAINTENANCE ENGINEERS	0	$0.00	$0.00	
EQUIPMENT OPERATORS	3	$9.20	$27.60	
WELDERS	1	$10.38	$10.38	
OILERS	1	$8.60	$8.60	
DECKHANDS	9	$8.24	$74.16	
ELECTRICIAN	1	$10.17	$10.17	
GENERAL DUMP FOREMAN	1	$9.35	$9.35	
DUMP FOREMAN	0	$0.00	$0.00	
YARD AND SHORE MEN	6	$8.29	$49.74	
ENGINEERS FOR BOOSTERS	0	$10.17	$0.00	
CREW TOTAL (3 SHIFTS)	34 MEN		$307.31	/HR

WAGES

WORK 56 HRS /WK			
PAY 64 HRS /WK @ 4.34WKS/wMO		$85,358	
TAXES,INS.,FRINGES......	81.5%	$69,567	
CREW PAYROLL..........>		$154,925	/MO

(ave. gross crew wage = $18.75 per manhour)

MONTHLY CREW PAYROLL	$154,925
+ MONTHLY SALARIED PAYROLL	$12,882
MONTHLY LABOR COSTS:	$167,807

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                         D \ 3       PIPELINE COSTS                         BID ITEM #          2
                                                                                        ------------
**************************************************************************************************************

PIPELINE SIZE:          18"          MATERIAL PUMPED:  SAND

                         |--------FLOATING PIPELINE---------|        |--SUBMERGED PIPELINE--|        |-SHOREPIPE-|

1a. Plant Description......   Pipeline      Joints    Pontoons          Pipeline      Joints           Pipeline
    Quantity.............>          60           1           2               400           1                 20
    Fixed Units Per Item..>         LF         Set        Each                LF         Set                 LF
    Unit Price...........>      $23.00   $4,500.00   $5,000.00            $23.00   $4,500.00             $25.00
1e. Plant Value:             $1,380.00   $4,500.00  $10,000.00         $9,200.00   $4,500.00            $500.00
1f. Acquis Year...........        1992        1992        1992              1992        1992               1992
1g. Pres Year.............        1995 - - - - ->- - - - - ->- - - - - - - - - - - - ->- - - - - ->- - - - - - - - - - - - ->
1h. Cost of Money Rate.....     6.500%- - - - ->- - - - - ->- - - - - - - - - - - - ->- - - - - ->- - - - - - - - - - - - ->
1i. Disc Money Rate:            5.200%- - - - ->- - - - - ->- - - - - - - - - - - - ->- - - - - ->- - - - - - - - - - - - ->
1j. Hrs Worked/Mo..........        504 - - - - ->- - - - - ->- - - - - - - - - - - - ->- - - - - ->- - - - - - - - - - - - ->
2a. LAF....................      0.840 - - - - ->- - - - - ->- - - - - - - - - - - - ->- - - - - ->- - - - - - - - - - - - ->
3a. Ec Index <for Acq Yr>..       4611        4611        4611              4611        4611               4611
3b. Ec Index <for 1995>....       5000 - - - - ->- - - - - ->- - - - - - - - - - - - ->- - - - - ->- - - - - - - - - - - - ->
4a. Mos Available/Year.....          9 - - - - ->- - - - - ->- - - - - - - - - - - - ->- - - - - ->- - - - - - - - - - - - ->
5a. Useful Life (in Yrs)...        1.0         3.0        12.0               1.0         3.0                1.5
5b. Physical Life (in Hrs).      4,500      12,000      60,000             4,500      12,000              6,000
5c. SLV Factor............        0.10        0.10        0.10              0.10        0.10               0.10
5g. RPR Factor............        0.05        0.30        0.05              0.05        0.30               0.05
6a. Depreciation:               90.00%      30.00%       7.50%            90.00%      30.00%             60.00%
6b. FCCM:                        5.20%       3.64%       3.06%             5.20%       3.64%              4.42%
6c. Total Ownership/Year:       95.20%      33.64%      10.56%            95.20%      33.64%             64.42%
7a. Yearly Ownership:        $1,313.76   $1,513.80   $1,056.00         $8,758.40   $1,513.80            $322.10
7b. Monthly Ownership:         $145.97     $168.20     $117.33           $973.16     $168.20             $35.79
8c. (1) EAF:                     1.084       1.084       1.084             1.084       1.084              1.084
8c. (2) Hrly Repair:             $0.01       $0.10       $0.01             $0.09       $0.10              $0.00
8e. Monthly Operating:           $5.04      $50.40       $5.04            $45.36      $50.40              $0.00
11. Monthly Rate (EA Item):    $151.01     $218.60     $122.37         $1,018.52     $218.60             $35.79
    Monthly Rate Per Section (Sum Of Items):           $491.98                     $1,237.12             $35.79
    / Section Length (In Linear Feet):                      60                           400                 20
                                                  ============                  ============       ============
MONTHLY RATES PER LF OF PIPELINE:                        $8.20                         $3.09              $1.79

5a. Useful Life (in Yrs)...        2.0         3.0        12.0               2.0         3.0                1.5
6a. Depreciation:               45.00%      30.00%       7.50%            45.00%      30.00%             30.00%
6b. FCCM:                        4.03%       3.64%       3.06%             4.03%       3.64%              3.64%
6c. Total Ownership/Year:       49.03%      33.64%      10.56%            49.03%      33.64%             33.64%
7a. Yearly Ownership:          $676.61   $1,513.80   $1,056.00         $4,510.76   $1,513.80            $168.20
7b. Monthly Ownership:          $75.18     $168.20     $117.33           $501.20     $168.20             $18.69
12a. HRLY STANDBY ALLOW:        $0.103      $0.230      $0.161            $0.687      $0.230             $0.026
    Hrly Standby Rate Per Section (Sum Of Items):       $0.494                        $0.917             $0.026
    / Section Length (In Linear Feet):                      60                           400                 20
                                                  ============                  ============       ============
HOURLY STANDBY RATES PER LF OF PIPELINE:                $0.008                        $0.002             $0.001
```

B DREDGING COST

BID ITEM # 2

				REMARKS
1 GROSS YARDAGE			223,245 CY	FROM SHEET A, ITEM 6 G.
2 PRODUCTION RATE		/	338,355 CY/MO	FROM SHEET C, ITEM 4.
3 DREDGING TIME		=	0.66 MONTHS	181,445 Net Pay CY / 0.66 MO = 274,917 Pay CY/MO
4 TOTAL MONTHLY COST		x	$628,627	FROM SHEET D, ITEM 5.
SUBTOTAL...........		=	$414,894	
5 FIXED COSTS		+	$0	FROM SHEET E, ITEM 15.
SUBTOTAL.............		=	$414,894	
6 OVERHEAD	14.0%	+	$58,085	
SUBTOTAL...........		=	$472,979	
7 PROFIT	10.0%	+	$47,298	
SUBTOTAL.............		=	$520,277	
8 BOND	1.0%	+	$5,203	
9 GROSS PRODUCTION COSTS		=	$525,480	
10 NET PAY YARDAGE		/	181,445 CY	FROM SHEET A, ITEM 6 E.
11 UNIT COST		=	$2.90 /CY	
12 MAX PAY YARDAGE		x	198,175 CY	FROM SHEET A, ITEM 6 C.
13 DREDGING COST		=	$574,708	

C \ 1A

EXCAVATION RATE
&
EXCAVATION TIME

BID ITEM # 2

1 MONTHLY EXCAVATION RATE:

			REMARKS
A. DREDGE PRODUCTION		701 CY/HR	FROM SHEET C \ 1B, ITEM 6.
B. EXCAVATION OPERATING TIME	x	621 HRS/MO	FROM SHEET C \ 1B, ITEM 7B.
C. EXCAVATION RATE	=	435,321 CY/MO	

2 EXCAVATION TIME:

			REMARKS
A. GROSS CUBIC YARDS		223,245 CY (GROSS)	FROM SHEET A, ITEM 6G.
B. EXCAVATION RATE	/	435,321 CY/MO	FROM ITEM 1C.
C. EXCAVATION TIME	=	0.51 MONTHS	

C \ 2A

HAULING RATE
&
HAULING TIME

BID ITEM # 2

1 MONTHLY HAULING RATE:

			REMARKS
A. HAULING PRODUCTION		515 CY/HR	FROM SHEET C \ 2B, ITEM 6.
B. HAULING OPERATING TIME	x	657 HRS/MO	FROM SHEET C \ 2B, ITEM 7B.
C. HAULING RATE	=	338,355 CY/MO	

2 HAULING TIME:

			REMARKS
A. GROSS CUBIC YARDS		223,245 CY (GROSS)	FROM SHEET A, ITEM 6G.
B. HAULING RATE	/	338,355 CY/MO	FROM ITEM 1C.
C. HAULING TIME	=	0.66 MONTHS	

C \ 2C

HAULING CYCLE TIME
&
TRIPS PER DAY

BID ITEM # 2

1 SIZE OF TUG 3000 HP Diesel--Twin Screw

2 CYCLE TIME PER TRIP:			REMARKS
A. PREPARE FOR SCOW TOW		15 MIN	
B. TO DISPOSAL AREA	+	147 MIN	17.2 miles / 7 miles per hr x 60 min
C. DUMPING OR PUMPOUT	+	5 MIN	
D. FROM DISPOSAL AREA	+	115 MIN	17.2 miles / 9 miles per hr x 60 min
E. DISENGAGE TOW RIGGING AND TIE UP SCOW	+	15 MIN	
3 AVERAGE CYCLE TIME	=	297 MIN/TRIP	
4 AVERAGE TRIPS PER TOWING VESSEL	=	4.85 /DAY	(1440 Minutes per Day divided by 297 Minutes per Trip)
5 NUMBER OF TOWING VESSELS	x	1	
6 AVERAGE TRIPS	=	4.85 /DAY	

D \ 1 LABOR COSTS BID ITEM # 2

DREDGE SIZE 26 CY Clamshell Dredge

SALARIED PERSONNEL:		RATE/MO	
CAPTAIN		$3,000	
CHIEF ENGR.		$2,800	
CIVIL ENGR.		$0	
FIELD OFFICE PERSONNEL		$1,800	
SUBTOTAL....		$7,600	
TAXES,INS.,FRINGES......	77.7%	$5,903	
SALARIED PAYROLL.......>		$13,503	/MO

CREW LABOR	NO.	RATE	AMOUNT	
OPERATOR (DREDGE)	3	$14.45	$43.35	
ENGINEER (DREDGE)	3	$13.46	$40.38	
MATE (DREDGE)	3	$12.15	$36.45	
LAUNCHMEN (DREDGE)	3	$10.12	$30.36	
DECKHANDS (DREDGE)	3	$9.63	$28.89	
MATE (DRAG BARGE)	1	$12.15	$12.15	
DECKHANDS (DRAG BARGE)	1	$9.63	$9.63	
COOK (QUARTERS)	1	$9.27	$9.27	
MESSMAN (QUARTERS)	1	$8.61	$8.61	
SCOWMAN (SCOWS)	6	$9.50	$57.00	
TUGMASTER (TOWING TUG)	1	$13.16	$13.16	
MATES (TOWING TUG)	2	$12.15	$24.30	
DECKHANDS (TOWING TUG)	3	$9.63	$28.89	
LAUNCHMEN (SURVEY BOAT)	0	$10.12	$0.00	
DECKHANDS (SURVEY BOAT)	0	$9.63	$0.00	
LAUNCHMEN (CREW BOAT)	0	$10.12	$0.00	
DECKHANDS (CREW BOAT)	0	$9.63	$0.00	
CREW TOTAL (3 SHIFTS)	31 MEN		$342.44	/HR

WAGES

WORK 56 HRS /WK			
PAY 64 HRS /WK @ 4.34WKS/wMO		$95,116	
TAXES,INS.,FRINGES......	89.7%	$85,291	
CREW PAYROLL..........>		$180,407	/MO

Taxes, insurance and fringes on labor:
Latest Labor Rate Update -> Oct 93

Social Security		7.7%
Workman's Compensation		45.0%
State Unemployment Comp.		3.5%
Federal Unemployment Comp.		1.0%
Fringes...	$3.01 per hour	23.8%
(Not based	7 paid hol.	1.7%
on O.T.)	8.0%vacation	7.0%
TAXES,INS.,FRINGES......CREW...		89.7%
-(BENEFIT DIFFERENTIAL)		12.0%
TAXES,INS.,FRINGES......MANAGEMENT..		77.7%

MONTHLY CREW PAYROLL	$180,407
+ MONTHLY SALARIED PAYROLL	$13,503
MONTHLY LABOR COSTS:	$193,910

(ave. gross crew wage = $23.94 per manhour)

D \ 3 EQUIPMENT COSTS - HAULING BID ITEM # 2

DREDGE SIZE 26 CY Clamshell Dredge

	TOWING VESSEL	DUMP SCOW
1a. Plant Description......	Twin Screw	4,000 CY CAPACITY
1b. Series & Model.........		Split Hull Scow
1c. Prime Eng HP...........	3,000	0
1d. Total 2nd Eng HP.......	300	250
1e. Plant Value............	$1,000,000	$1,310,000
1f. Acquis Year............	1982	1982
1g. Pres Year..............	1995	- - - - - - - - - - - - >
1h. Cost of Money Rate.....	6.500%	- - - - - - - - - - - - >
1i. Disc Money Rate:	5.200%	- - - - - - - - - - - - >
1j. Hrs Worked/Mo..........	657	730
2a. LAF....................	0.840	- - - - - - - - - - - - >
2b. Fuel Cost per Gal......	$0.79	- - - - - - - - - - - - >
3b. Ec Index <for 1995>....	5000	- - - - - - - - - - - - >
3a. Ec Index <for Acq Yr>..	3391	3391
4a. Mos Available/Year.....	10	- - - - - - - - - - - - >
5a. Useful Life (in Yrs)...	15	20
5b. Physical Life (in Hrs).	100,000	40,000
5c. SLV Factor.............	0.10	0.05
5d. Pr Eng Fuel Factor.....	0.045	0.011
5e. 2nd Eng Fuel Factor....	0.039	0.011
5f. WLS Factor.............	0.38	0.20
5g. RPR Factor.............	1.10	0.70
6a. Depreciation:	6.00%	4.75%
6b. FCCM:	3.02%	2.85%
6c. Total Ownership/Year:	9.02%	7.60%
7a. Yearly Ownership:	$90,200	$99,560
7b. Monthly Ownership:	$9,020	$9,956
8a. (1) Hrly Pr Eng Fuel:	$106.65	$0.00
8a. (2) Hrly 2nd Eng Fuel:	$9.24	$2.17
8b. (1) Hrly Pr Eng WLS:	$40.53	$0.00
8b. (2) Hrly 2nd Eng WLS:	$3.51	$0.43
8c. (1) EAF:	1.474	1.474
8c. (2) Hrly Repair:	$13.62	$28.38
8d. Total Hrly Operating:	$173.55	$30.98
8e. Monthly Operating:	$114,022	$22,615
11. MONTHLY RATE:	$123,042	$32,571
12a. HRLY STANDBY ALLOWANCE:	$12.36	$13.64

Exhibit 9

Cost Estimate for Contraction Dikes

This project consist of three contraction dikes. Two dikes, "A" and "B", are existing. They will be totally removed before the new dike is constructed in the same location. Dike "D" is the new dike. Each dike is constructed of sheet pile with a circular terminal cell. Every 13.5 feet there will be an anchor sheet pile driven along with a "H" batter pile. The batter piles will be attached to the sheet piles along with a waler on each side of the sheet pile. Dike "D" will have marl placed as bedding material, crushed stone as the foundation material, and new riprap placed against the sheet piles. All work must be performed by barge mounted equipment.

Estimated By:

James E Henderson Jr 28 NOV 95

James E. Henderson, Jr., PE DATE
CESAC-EN-C

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Tue 28 Nov 1995                                U.S. Army Corps of Engineers                                              TIME 08:41:40
Eff. Date  11/15/95        PROJECT SAC412:  Charleston Hbr Contraction Dikes - Cooper River, Charleston, S.C.
                                                 Preliminary Cost Estimate                                        SUMMARY PAGE    1
                                            ** PROJECT OWNER SUMMARY - Bid Item **

---------------------------------------------------------------------------------------------------------------------------------------
                                                              QUANTITY UOM    CONTRACT     OTHER  ESCALATN  OWN FURN  CONTINGN      SIOH  TOTAL COST UNIT COST
---------------------------------------------------------------------------------------------------------------------------------------

                              01  09. Channels (Dike "A") OLD        1.00 EA   1,006,781         0         0         0   151,017    69,468   1,227,266   1227266
                              02  09. Channels (Dike "B") OLD        1.00 EA     580,912         0         0         0    87,137    40,083     708,132 708131.76
                              03  09. Channels (Dike "D") NEW        1.00 EA   1,943,934         0         0         0   291,590   134,131   2,369,656   2369656
                              04  09. Channels (Mob & Demob)         1.00 EA      37,444         0         0         0     5,617     2,584      45,644  45644.39
                                                                          ----------- --------- --------- --------- --------- --------- -----------
                            TOTAL Charleston Hbr Contraction Dikes   1.00 EA   3,569,072         0         0         0   535,361   246,266   4,350,698   4350698



LABOR ID: CWR95A    EQUIP ID: NAT95A                   Currency in DOLLARS                          CREW ID: CWR95A   UPB ID: CWR95A
```

U.S. Army Corps of Engineers
PROJECT SAC412: Charleston Hbr Contraction Dikes - Cooper River, Charleston, S.C.
Preliminary Cost Estimate
** PROJECT INDIRECT SUMMARY - Bid Item **

	QUANTITY	UOM	DIRECT	OVERHEAD	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT COST
01 09. Channels (Dike "A") OLD	1.00	EA	782,452	93,894	30,672	89,795	9,968	1,006,781	1006781
02 09. Channels (Dike "B") OLD	1.00	EA	451,474	54,177	17,698	51,812	5,752	580,912	580912.02
03 09. Channels (Dike "D") NEW	1.00	EA	1,510,790	181,295	59,223	173,379	19,247	1,943,934	1943934
04 09. Channels (Mob & Demob)	1.00	EA	29,101	3,492	1,141	3,340	371	37,444	37444.13
TOTAL Charleston Hbr Contraction Dikes	1.00	EA	2,773,817	332,858	108,734	318,325	35,337	3,569,072	3569072
CONTINGN								535,361	
SUBTOTAL								4,104,432	
SIOH								246,266	
TOTAL INCL OWNER COSTS								4,350,698	

```
Tue 28 Nov 1995                                   U.S. Army Corps of Engineers                                            TIME 08:41:40
Eff. Date  11/15/95             PROJECT SAC412:   Charleston Hbr Contraction Dikes - Cooper River, Charleston, S.C.
                                                      Preliminary Cost Estimate                                           SUMMARY PAGE    5
                                                ** PROJECT DIRECT SUMMARY - Bid Item **

------------------------------------------------------------------------------------------------------------------------------------------------
                                                                                QUANTITY UOM  MANHRS      LABOR  EQUIPMNT  MATERIAL  TOTAL COST UNIT COST
------------------------------------------------------------------------------------------------------------------------------------------------

                                              01  09. Channels (Dike "A") OLD       1.00 EA   10,227    123,899   238,053   420,500     782,452 782451.97
                                              02  09. Channels (Dike "B") OLD       1.00 EA    6,002     70,779   139,039   241,656     451,474 451474.19
                                              03  09. Channels (Dike "D") NEW       1.00 EA   14,674    214,694   589,582   706,515   1,510,790   1510790
                                              04  09. Channels (Mob & Demob)        1.00 EA      440      3,837    25,264         0      29,101  29100.89
                                                                                              ------- --------- --------- --------- -----------
                                          TOTAL Charleston Hbr Contraction Dikes    1.00 EA   31,344    413,208   991,938 1,368,671   2,773,817   2773817

                                             OVERHEAD                                                                                  332,858
                                                                                                                                   -----------
                                               SUBTOTAL                                                                              3,106,675
                                             HOME OFC                                                                                  108,734
                                                                                                                                   -----------
                                               SUBTOTAL                                                                              3,215,409
                                             PROFIT                                                                                    318,325
                                                                                                                                   -----------
                                               SUBTOTAL                                                                              3,533,734
                                             BOND                                                                                       35,337
                                                                                                                                   -----------
                                               TOTAL INCL INDIRECTS                                                                  3,569,072
                                             CONTINGN                                                                                  535,361
                                                                                                                                   -----------
                                               SUBTOTAL                                                                              4,104,432
                                             SIOH                                                                                      246,266
                                                                                                                                   -----------
                                               TOTAL INCL OWNER COSTS                                                                4,350,698


LABOR ID: CWR95A    EQUIP ID: NAT95A                     Currency in DOLLARS                                    CREW ID: CWR95A   UPB ID: CWR95A
```

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------------------------------------------------------------------------------------------------------------------------------------
0101. 09_01. Channels                                                 QUANTY UOM CREW ID     MANHRS      LABOR  EQUIPMNT  MATERIAL  TOTAL COST
------------------------------------------------------------------------------------------------------------------------------------

  01. 09. Channels (Dike "A") OLD
     0101. 09_01. Channels

                         USR AA <02411 1005 > Steel Sheet Pile 27 LB/SF                          12.95     147.00    178.00    726.10     1051.10
                                                                      485.36 TN                   6,285     71,348    86,394   352,420     510,162

                         USR AA <02261 1006 > 10 Lb To 100 Lb Bedding                             1.00       9.25     11.25     26.50       47.00
                                                                      230.00 CY                     230      2,128     2,588     6,095      10,810

                         USR AA <02261 1007 > Rehandle Armor Stone 1500 Lb To                     0.71       7.93     22.98      0.00       30.90
                                                                     1600.00 CY  XXQHB            1,143     12,683    36,763         0      49,446

                       M MIL AA <02611 2001 > Graded Crushed Agg Rdwy Base Crs                    0.26       4.08      7.23     10.50       21.81
                                              This is for the resurfacing of  200.00 CY  XSABA       52        816     1,446     2,101       4,363
                                              the causeway.

                       B MIL AA <02315 1004 > 12 x 12 x 53#/Ft Stl H-Sect Pile                    0.13       2.82      2.36     14.33       19.51
                                              Rolled Steel                   3240.00 VLF CPIDC      421      9,137     7,646    46,433      63,216

                       B USR AA <02413 1001 > Walers, Connections & Struts                       50.00     735.00    890.00   1091.80     2716.80
                                              Includes Turnbuckle               12.32 TON           616      9,055    10,965    13,451      33,471

                         USR AA <02112 9001 > Demolition Of Old Goin System                       2.00      25.31     21.12      0.00       46.44
                                                                      740.00 LF  CPIDC            1,480     18,733    15,631         0      34,364

                         USR AA <01030 1001 > Barge Cost                                          0.00       0.00    127.70      0.00      127.70
                                                                      600.00 HR  MODEE                0          0    76,620         0      76,620
                                                                                             ------- --------- --------- --------- -----------
                                     TOTAL 09_01. Channels                                       10,227    123,899   238,053   420,500     782,452
                                                                                             ------- --------- --------- --------- -----------
                                     TOTAL 09. Channels (Dike "A") OLD                           10,227    123,899   238,053   420,500     782,452
```

```
--------------------------------------------------------------------------------------------------------------------------------------------
0301. 09_01. Channels                                                   QUANTY UOM CREW ID     MANHRS      LABOR  EQUIPMNT  MATERIAL  TOTAL COST
--------------------------------------------------------------------------------------------------------------------------------------------

   03. 09. Channels (Dike "D") NEW
      0301. 09_01. Channels

                                  USR AA <02411 1005 > Steel Sheet Pile 27 LB/SF                11.61     147.00    178.00    726.10     1051.10
                                                                            431.04 TN           5,004     63,363    76,725   312,978     453,066

                                M MIL AA <02611 2001 > Graded Crushed Agg Rdwy Base Crs          0.26       4.08      7.23     10.50       21.81
                                                       This is for the resurfacing of   400.00 CY  XSABA    104      1,632     2,892     4,202       8,726
                                                       the causeway.

                                B MIL AA <02315 1004 > 12 x 12 x 53#/Ft Stl H-Sect Pile          0.12       2.82      2.36     14.33       19.51
                                                       Rolled Steel                   3060.00 VLF CPIDC    367      8,629     7,222    43,853      59,704

                                L USR AA <02413 1001 > Walers, Connections & Struts             31.49     735.00    890.00   1091.80     2716.80
                                                       Includes Turnbuckle               11.36 TON             358      8,350    10,110    12,403      30,863

                                  USR AA <02261 1007 > Handle Armor Stone 1500 Lb To             0.35       9.25     11.25     26.50       47.00
                                                                           6500.00 CY           2,275     60,125    73,125   172,250     305,500

                                  USR AA <02261 1007 > Handle Marl Placement                     0.06       0.70      1.83      0.00        2.52
                                                                             75000 CY  XXQHB    4,688     52,365   136,905         0     189,270

                                  USR AA <02611 2001 > Graded Crushed Agg Foundation             0.13       1.40      3.65     11.13       16.18
                                                       Blanket(14,000) and terminal      14450 CY  XXQHB    1,879     20,230    52,743   160,829     233,801
                                                       cell(450).

                                  USR AA <01030 1001 > Barge Cost                                0.00       0.00    127.70      0.00      127.70
                                                                           1800.00 HR  MODEE        0          0   229,860         0     229,860
                                                                                              ------- ---------- --------- --------- -----------
                                          TOTAL 09_01. Channels                                14,674    214,694   589,582   706,515   1,510,790
                                                                                              ------- ---------- --------- --------- -----------
                                          TOTAL 09. Channels (Dike "D") NEW                    14,674    214,694   589,582   706,515   1,510,790
```

APPENDIX C

Cost Estimates

CONTENTS

EXHIBITS

APPENDIX C

COST ESTIMATES

Section 1: Computation Procedure

Cost Estimates were prepared for all project costs associated with dredging and dredged material disposal and construction of one new contraction dike and replacing two existing contraction dikes. The dredging estimates included 1 percent bond, 14 percent overhead, and 10 percent profit. Contingencies were calculated at 15 percent for all construction costs.

Dredging cost estimates were derived utilizing the latest version of the Corps of Engineers Dredge Estimating Program (CEDEP). Detailed and extensive data was collected and utilized for analysis and computation for the most reasonable cost for performing the work on each individual project plan.

Three examples of these cost estimates are provided in Exhibit 8 of this appendix. The first is a cost estimate for constructing the 45-foot channel at the Clouter Creek Reach and is typical for all estimates which required upland disposal. This estimate assumed utilizing an 18-inch hydraulic pipeline dredge to excavate all material and depositing the material into the Clouter Creek Disposal Area.

The second is a cost estimate for constructing the 45-foot channel at the Custom House Reach and is typical for all inner harbor estimates which require ocean disposal. This estimate assumed utilizing a 26 cubic yard clam shell dredge to excavate all material and placing the material into 4000 cubic yard scows to be towed by tugs and deposited into the Ocean Dredged Material Disposal Site (ODMDS) located 17.2 miles away.

The third is a cost estimate for constructing the 45-foot channel in the Charleston Harbor Entrance Channel and is typical for all shoals within the entrance channel. This estimate assumed utilizing a 30-inch hydraulic pipeline dredge to excavate all material and placing the material into 6000 cubic yard scows to be towed by tugs and deposited into the ODMDS.

All cost estimates considered all available information concerning material types which were derived from available boring logs and any other conditions present which would influence the production rates for performing the work. All cost estimates included the removal of the required quantities plus two-foot advanced maintenance plus two-foot allowable overdepth materials. All cost estimates assumed removing one-foot of non-pay yardage over the entire area to be dredged and assumed that 10 percent of the available overdepth material would not be removed. It should be noted that most of the quantities for new work required for any of these plans lies in the advanced

maintenance and allowable overdepth region of the dredge prism. Mobilization and demobilization costs were calculated and included in the summary sheets.

Estimates for projected maintenance dredging and upland disposal site diking were calculated based on historical practices and data combined with predicted increased shoaling quantities determined from the numerical sedimentation models and existing dredged material disposal practices. Upland dredged material disposal sites were utilized for placement of harbor maintenance material while entrance channel material was determined to be taken offshore to the ODMDS.

No associated project costs were included for the Navy's Degaussing pier. Future operation of the pier is uncertain as a result of the closure of the Naval Shipyard and presence of other degaussing facilities in Charleston harbor. Instrument cables from the degaussing pier are designated to be buried at -50 MLLW beneath the existing navigation channel. Data was unobtainable regarding costs associated with relocating the instrument cable. Further coordination of this issue will be pursued throughout the project.

The cost estimates for the contraction dikes were prepared using the Micro-Computer Aided Cost Engineering System (MCACES). The two existing contraction dikes along the west side of the channel will be demolished and replaced with new contraction dikes. The existing rip rap material will be utilized in the construction of the new replacement contraction dikes. The new contraction dike will be constructed on a newly placed underwater foundation dike constructed of placed excavated marl. New rip rap material will be placed around the new contraction dike to prevent scour. The new contraction dike will be connected to the existing bank by a newly constructed rip rap embankment. The construction of these contraction dikes will be by barge mounted equipment. The MCACES estimate is located in Exhibit 9 of this appendix.

The total first cost of the recommended project is $116,639,000. This includes the cost of deepening the channel, constructing the Daniel Island turning basin, and realigning the channel in the Shutes and Folly Reaches. This also includes the cost of widening the Daniel Island Reach, which is recommended in the interest of safety as a modification of the without-project condition. These costs, with the Federal and non-Federal shares and fully funded costs, are displayed in the Total Project Cost Summary Sheet [TPCS], which is included as Exhibit 1 of this appendix.

Exhibit 1

Total Project Cost Summary Sheet

	Main Channel Depth					
	41	42	43	44	45	46
Shared Costs						
Channel Deepening						
Entrance Channel	$21,188,745	$28,008,245	$29,554,476	$30,840,921	$31,687,768	$35,063,165
Main Channel	$17,140,658	$19,580,206	$22,968,577	$25,746,836	$28,737,613	$31,826,154
Columbus Street Channel	1,008,592	1,408,196	1,996,564	2,419,069	3,111,229	3,198,312
Wando River Channel	1,052,691	1,671,867	2,457,918	4,154,977	4,862,077	5,561,176
Shipyard River Channel	293,705	435,317	543,758	652,248	763,803	921,855
Mob/Demob, EC	1,100,000	1,100,000	1,100,000	2,200,000	2,200,000	3,300,000
Mob/Demob, Other	1,273,000	1,678,000	2,141,000	2,546,000	3,009,000	3,009,000
W/O Project Widening *	(8,964,000)	(8,964,000)	(8,964,000)	(8,964,000)	(8,964,000)	(8,964,000)
Subtotal	$34,093,390	$44,917,832	$51,798,293	$59,596,051	$65,407,489	$73,915,662
Contraction Dikes						
Dike A	$1,006,781	$1,006,781	$1,006,781	$1,006,781	$1,006,781	$1,006,781
Dike B	580,912	580,912	580,912	580,912	580,912	580,912
Dike C	1,943,934	1,943,934	1,943,934	1,943,934	1,943,934	1,943,934
Mob/Demob	37,444	37,444	37,444	37,444	37,444	37,444
Subtotal	$3,569,071	$3,569,071	$3,569,071	$3,569,071	$3,569,071	$3,569,071
Daniel Island Turning Basin	$6,388,349	$6,656,470	$6,950,043	$7,243,615	$7,482,139	$7,674,937
Shutes/Folly Realignment	$5,348,376	$4,820,057	$4,706,280	$4,787,679	$4,088,854	$3,839,941
Mitigation	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000
Subtotal	$49,419,187	$59,983,430	$67,043,686	$75,216,416	$80,567,553	$89,019,611
Contingencies, 15 Percent	$7,412,878	$8,997,514	$10,056,553	$11,282,462	$12,085,133	$13,352,942
Subtotal	$56,832,065	$68,980,944	$77,100,239	$86,498,879	$92,652,686	$102,372,553
Monitoring of ODMDS	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000
PED	$2,620,000	$2,620,000	$2,620,000	$2,620,000	$2,620,000	$2,620,000
Construction Management	$1,600,000	$1,600,000	$2,000,000	$2,000,000	$2,000,000	$2,400,000
Total Shared Costs	**$61,552,065**	**$73,700,944**	**$82,220,239**	**$91,618,879**	**$97,772,686**	**$107,892,553**
Federal Costs						
Aids to Navigation	**$78,000**	**$78,000**	**$78,000**	**$78,000**	**$78,000**	**$78,000**
Non-Federal Costs						
Berthing Areas	$4,290,136	$4,504,927	$4,679,253	$4,697,577	$5,228,507	$5,404,838
Disposal Diking	$582,846	$939,044	$1,321,950	$1,719,999	$2,129,521	$2,548,602
Real Estate	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000
Subtotal	$4,887,982	$5,458,971	$6,016,202	$6,432,576	$7,373,028	$7,968,440
Contingencies, 15 Percent	$733,197	$818,846	$902,430	$964,886	$1,105,954	$1,195,266
Total Non-Fed. Costs	**$5,621,179**	**$6,277,816**	**$6,918,633**	**$7,397,463**	**$8,478,982**	**$9,163,706**
Total First Costs	**$67,251,244**	**$80,056,760**	**$89,216,872**	**$99,094,342**	**$106,329,668**	**$117,134,259**
Interest During Construction	$11,134,252	$13,712,379	$14,637,626	$16,471,009	$17,543,645	$18,822,556
Total Investment Cost	$78,385,496	$93,769,139	$103,854,498	$115,565,351	$123,873,313	$135,956,815
Average Annual Cost						
Interest	$5,976,894	$7,149,897	$7,918,905	$8,811,858	$9,445,340	$10,366,707
Amortization	$155,589	$186,124	$206,143	$229,388	$245,878	$269,863
Annual O&M	$202,000	$404,000	$606,000	$808,000	$1,010,000	$1,212,000
Total AAC	$6,334,483	$7,740,021	$8,731,048	$9,849,246	$10,701,218	$11,848,570

* See Exhibit 5, Dredging Cost Summary Sheet for Daniel Island Channel Widening.

Exhibit 3

Dredging Cost Summary Sheets for Inner Harbor

CHARLESTON HARBOR DEEPENING PROJECT - 41' CHANNEL, INNER HARBOR

SHOAL	DISPOSAL SITE	QUANTITY CY	COST/CY	TOTAL COST	CONTINGENCY 15%	TOTAL COST INC. CONT.
Mount Pleasant Range	Ocean	28,850	$8.76	$252,726	$37,909	$290,635
Rebellion/Folly Reach	Ocean	313,380	$5.46	$1,711,055	$256,658	$1,967,713
Horse/Shutes Reach	Ocean	202,334	$3.21	$649,492	$97,424	$746,916
Hog Island Reach	Ocean	224,539	$6.69	$1,502,166	$225,325	$1,727,491
Drum Island Bend	Ocean	16,221	$18.82	$305,279	$45,792	$351,071
Drum Island Reach	Ocean	127,499	$3.52	$448,796	$67,319	$516,116
Daniel Island Reach	Clouter Creek	160,577	$1.83	$293,856	$44,078	$337,934
Daniel Island Bend	Clouter Creek	140,682	$3.65	$513,489	$77,023	$590,513
Daniel I. Widening	Ocean	3,800,000	$2.49	$9,462,000	$1,419,300	$10,881,300
Clouter Creek Reach	Clouter Creek	200,992	$2.23	$448,212	$67,232	$515,444
Navy Yard Reach - Lower	Clouter Creek	40,273	$1.11	$44,703	$6,705	$51,408
Navy Yard Reach - Upper	Clouter Creek	141,993	$0.99	$140,573	$21,086	$161,659
North Charleston Reach	Clouter Creek	162,381	$1.19	$193,233	$28,985	$222,218
Filbin Creek Reach	Clouter Creek	147,365	$2.87	$422,938	$63,441	$486,378
Port Terminal Reach	Clouter Creek	97,356	$3.18	$309,592	$46,439	$356,031
Ordinance Reach	Clouter Creek	80,846	$3.91	$316,108	$47,416	$363,524
Ordinance Turning Basin	Clouter Creek	44,996	$2.81	$126,439	$18,966	$145,405
Main Channel Subtotal		5,930,284		$17,140,658	$2,571,099	$19,711,756
Custom House Reach	Ocean	30,873	$3.73	$115,156	$17,273	$132,430
Tidewater - Upper Reach	Ocean	37,139	$6.26	$232,490	$34,874	$267,364
Lower Towncreek - Lower	Ocean	126,256	$3.87	$488,611	$73,292	$561,902
Turning Basin	Ocean	45,471	$3.79	$172,335	$25,850	$198,185
Columbus Street Subtotal		239,739		$1,008,592	$151,289	$1,159,881
Shipyard River	Clouter Creek	122,377	$2.40	$293,705	$44,056	$337,761
Wando Reach	Ocean	80,601	$4.40	$354,644	$53,197	$407,841
Wando Terminal	Ocean	67,047	$6.37	$427,089	$64,063	$491,153
Wando Extension	Ocean	62,004	$4.37	$270,957	$40,644	$311,601
Wando River Subtotal		209,652		$1,052,691	$157,904	$1,210,595
Custom House Berth	Ocean	125,930	$2.59	$326,159	$48,924	$375,083
N. Charleston Berth	Clouter Creek	163,200	$1.64	$267,648	$40,147	$307,795
Allied Berth	Clouter Creek	27,780	$3.92	$108,898	$16,335	$125,232
Hess Berth	Clouter Creek	80,560	$1.70	$136,952	$20,543	$157,495
Shipyard Berth	Clouter Creek	7,640	$17.00	$129,880	$19,482	$149,362
Wando Berth	Ocean	34,260	$3.92	$134,299	$20,145	$154,444
Daniel I. Berth	Ocean	1,290,000	$2.47	$3,186,300	$477,945	$3,664,245
Berthing Area Subtotal		1,729,370		$4,290,136	$643,520	$4,933,656
Daniel I. Turning Basin	Ocean	2,545,159	$2.51	$6,388,349	$958,252	$7,346,601
Shutes/Folly Realignment	Ocean	3,116,826		$5,348,376	$802,256	$6,150,633
TOTALS		**13,893,407**		**$35,522,507**	**$5,328,376**	**$40,850,883**

CHARLESTON HARBOR DEEPENING PROJECT - 42' CHANNEL, INNER HARBOR

SHOAL	DISPOSAL SITE	QUANTITY CY	COST/CY	TOTAL COST	CONTINGENCY 15%	TOTAL COST INC. CONT.
Mount Pleasant Range	Ocean	55,781	$4.69	$261,613	$39,242	$300,855
Rebellion/Folly Reach	Ocean	630,483	$3.77	$2,376,921	$356,538	$2,733,459
Horse/Shutes Reach	Ocean	317,353	$2.83	$898,109	$134,716	$1,032,825
Hog Island Reach	Ocean	407,963	$4.02	$1,640,011	$246,002	$1,886,013
Drum Island Bend	Ocean	29,792	$9.90	$294,941	$44,241	$339,182
Drum Island Reach	Ocean	238,569	$2.80	$667,993	$100,199	$768,192
Daniel Island Reach	Clouter Creek	269,394	$1.76	$474,133	$71,120	$545,253
Daniel Island Bend	Clouter Creek	230,996	$2.50	$577,490	$86,624	$664,114
Daniel I. Widening	Ocean	4,000,000	$2.48	$9,920,000	$1,488,000	$11,408,000
Clouter Creek Reach	Clouter Creek	361,311	$1.45	$523,901	$78,585	$602,486
Navy Yard Reach - Lower	Clouter Creek	80,447	$0.96	$77,229	$11,584	$88,813
Navy Yard Reach - Upper	Clouter Creek	230,385	$0.98	$225,777	$33,867	$259,644
North Charleston Reach	Clouter Creek	278,109	$1.13	$314,263	$47,139	$361,403
Filbin Creek Reach	Clouter Creek	239,440	$1.94	$464,514	$69,677	$534,191
Port Terminal Reach	Clouter Creek	175,727	$2.05	$360,240	$54,036	$414,276
Ordinance Reach	Clouter Creek	161,001	$2.24	$360,642	$54,096	$414,739
Ordinance Turning Basin	Clouter Creek	74,962	$1.90	$142,428	$21,364	$163,792
Main Channel Subtotal		7,781,713		$19,580,206	$2,937,031	$22,517,237
Custom House Reach	Ocean	64,607	$2.49	$160,871	$24,131	$185,002
Tidewater - Upper Reach	Ocean	71,537	$3.63	$259,679	$38,952	$298,631
Lower Towncreek - Lower	Ocean	204,421	$3.17	$648,015	$97,202	$745,217
Turning Basin	Ocean	95,941	$3.54	$339,631	$50,945	$390,576
Columbus Street Subtotal		436,506		$1,408,196	$211,229	$1,619,426
Shipyard River	Clouter Creek	186,033	$2.34	$435,317	$65,298	$500,615
Wando Reach	Ocean	212,881	$2.82	$600,324	$90,049	$690,373
Wando Terminal	Ocean	164,155	$3.99	$654,978	$98,247	$753,225
Wando Extension	Ocean	104,141	$4.00	$416,564	$62,485	$479,049
Wando River Subtotal		481,177		$1,671,867	$250,780	$1,922,647
Custom House Berth	Ocean	140,740	$2.49	$350,443	$52,566	$403,009
N. Charleston Berth	Clouter Creek	179,410	$1.61	$288,850	$43,328	$332,178
Allied Berth	Clouter Creek	33,340	$3.74	$124,692	$18,704	$143,395
Hess Berth	Clouter Creek	97,710	$1.55	$151,451	$22,718	$174,168
Shipyard Berth	Clouter Creek	10,190	$13.33	$135,833	$20,375	$156,208
Wando Berth	Ocean	51,390	$3.28	$168,559	$25,284	$193,843
Daniel I. Berth	Ocean	1,330,000	$2.47	$3,285,100	$492,765	$3,777,865
Berthing Area Subtotal		1,842,780		$4,504,927	$675,739	$5,180,666
Daniel I. Turning Basin	Ocean	2,662,588	$2.50	$6,656,470	$998,471	$7,654,941
Shutes/Folly Realignment	Ocean	2,830,694		$4,820,057	$723,009	$5,543,066
TOTALS		**16,221,491**		**$39,077,040**	**$5,861,556**	**$44,938,596**

CHARLESTON HARBOR DEEPENING PROJECT - 43' CHANNEL, INNER HARBOR

SHOAL	DISPOSAL SITE	QUANTITY CY	COST/CY	TOTAL COST	CONTINGENCY 15%	TOTAL COST INC. CONT.
Mount Pleasant Range	Ocean	81508	$3.42	$278,757	$41,814	$320,571
Rebellion/Folly Reach	Ocean	992727	$3.03	$3,007,963	$451,194	$3,459,157
Horse/Shutes Reach	Ocean	443073	$2.63	$1,165,282	$174,792	$1,340,074
Hog Island Reach	Ocean	599,754	$3.23	$1,937,205	$290,581	$2,227,786
Drum Island Bend	Ocean	45,771	$6.80	$311,243	$46,686	$357,929
Drum Island Reach	Ocean	362,704	$2.60	$943,030	$141,455	$1,084,485
Daniel Island Reach	Clouter Creek	381,487	$2.35	$896,494	$134,474	$1,030,969
Daniel Island Bend	Clouter Creek	327,840	$1.94	$636,010	$95,401	$731,411
Daniel I. Widening	Ocean	4,200,000	$2.48	$10,416,000	$1,562,400	$11,978,400
Clouter Creek Reach	Clouter Creek	528,936	$1.12	$592,408	$88,861	$681,270
Navy Yard Reach - Lower	Clouter Creek	131,034	$1.88	$246,344	$36,952	$283,296
Navy Yard Reach - Upper	Clouter Creek	322,736	$1.22	$393,738	$59,061	$452,799
North Charleston Reach	Clouter Creek	398,317	$1.69	$673,156	$100,973	$774,129
Filbin Creek Reach	Clouter Creek	335,017	$1.52	$509,226	$76,384	$585,610
Port Terminal Reach	Clouter Creek	257,492	$1.54	$396,538	$59,481	$456,018
Ordinance Reach	Clouter Creek	244,931	$1.66	$406,585	$60,988	$467,573
Ordinance Turning Basin	Clouter Creek	106,441	$1.49	$158,597	$23,790	$182,387
Main Channel Subtotal		9,759,768		$22,968,577	$3,445,287	$26,413,863
Custom House Reach	Ocean	106,866	$2.26	$241,517	$36,228	$277,745
Tidewater - Upper Reach	Ocean	111,785	$2.84	$317,468	$47,620	$365,088
Lower Towncreek - Lower	Ocean	289,174	$3.06	$884,872	$132,731	$1,017,603
Turning Basin	Ocean	156,574	$3.53	$552,706	$82,906	$635,612
Columbus Street Subtotal		664,399		$1,996,564	$299,485	$2,296,048
Shipyard River	Clouter Creek	261,422	$2.08	$543,758	$81,564	$625,321
Wando Reach	Ocean	373,516	$2.56	$956,201	$143,430	$1,099,631
Wando Terminal	Ocean	298,544	$3.40	$1,015,050	$152,257	$1,167,307
Wando Extension	Ocean	148,828	$3.27	$486,668	$73,000	$559,668
Wando River Subtotal		820,888		$2,457,918	$368,688	$2,826,606
Custom House Berth	Ocean	155,560	$2.41	$374,900	$56,235	$431,135
N. Charleston Berth	Clouter Creek	209,970	$1.58	$331,753	$49,763	$381,515
Allied Berth	Clouter Creek	38,890	$3.60	$140,004	$21,001	$161,005
Hess Berth	Clouter Creek	114,830	$1.50	$172,245	$25,837	$198,082
Shipyard Berth	Clouter Creek	12,740	$8.31	$105,869	$15,880	$121,750
Wando Berth	Ocean	68,520	$2.85	$195,282	$29,292	$224,574
Daniel I. Berth	Ocean	1,360,000	$2.47	$3,359,200	$503,880	$3,863,080
Berthing Area Subtotal		1,960,510		$4,679,253	$701,888	$5,381,140
Daniel I. Turning Basin	Ocean	2,780,017	$2.50	$6,950,043	$1,042,506	$7,992,549
Shutes/Folly Realignment	Ocean	2,488,705		$4,706,280	$705,942	$5,412,222
TOTALS		**18,735,709**		**$44,302,391**	**$6,645,359**	**$50,947,750**

CHARLESTON HARBOR DEEPENING PROJECT - 44' CHANNEL, INNER HARBOR

SHOAL	DISPOSAL SITE	QUANTITY CY	COST/CY	TOTAL COST	CONTINGENCY 15%	TOTAL COST INC. CONT.
Mount Pleasant Range	Ocean	108,353	$2.54	$275,217	$41,282	$316,499
Rebellion/Folly Reach	Ocean	1,373,396	$2.49	$3,419,756	$512,963	$3,932,719
Horse/Shutes Reach	Ocean	576,617	$2.43	$1,401,179	$210,177	$1,611,356
Hog Island Reach	Ocean	797,185	$3.07	$2,447,358	$367,104	$2,814,462
Drum Island Bend	Ocean	64,004	$4.91	$314,260	$47,139	$361,399
Drum Island Reach	Ocean	491,429	$3.23	$1,587,316	$238,097	$1,825,413
Daniel Island Reach	Clouter Creek	496,359	$2.25	$1,116,808	$167,521	$1,284,329
Daniel Island Bend	Clouter Creek	429,625	$1.59	$683,104	$102,466	$785,569
Daniel I. Widening	Ocean	4,300,000	$2.49	$10,707,000	$1,606,050	$12,313,050
Clouter Creek Reach	Clouter Creek	700,996	$1.07	$750,066	$112,510	$862,576
Navy Yard Reach - Lower	Clouter Creek	188,490	$1.42	$267,656	$40,148	$307,804
Navy Yard Reach - Upper	Clouter Creek	417,492	$1.05	$438,367	$65,755	$504,122
North Charleston Reach	Clouter Creek	524,448	$1.37	$718,494	$107,774	$826,268
Filbin Creek Reach	Clouter Creek	433,636	$1.32	$572,400	$85,860	$658,259
Port Terminal Reach	Clouter Creek	341,321	$1.26	$430,064	$64,510	$494,574
Ordinance Reach	Clouter Creek	329,810	$1.34	$441,945	$66,292	$508,237
Ordinance Turning Basin	Clouter Creek	139,562	$1.26	$175,848	$26,377	$202,225
Main Channel Subtotal		11,712,723		$25,746,836	$3,862,025	$29,608,862
Custom House Reach	Ocean	152,316	$2.23	$339,665	$50,950	$390,614
Tidewater - Upper Reach	Ocean	153,632	$2.47	$379,471	$56,921	$436,392
Lower Towncreek - Lower	Ocean	376,071	$2.78	$1,045,477	$156,822	$1,202,299
Turning Basin	Ocean	221,100	$2.96	$654,456	$98,168	$752,624
Columbus Street Subtotal		903,119		$2,419,069	$362,860	$2,781,929
Shipyard River	Clouter Creek	341,491	$1.91	$652,248	$97,837	$750,085
Wando Reach	Ocean	545,626	$3.33	$1,816,935	$272,540	$2,089,475
Wando Terminal	Ocean	440,983	$3.99	$1,759,522	$263,928	$2,023,450
Wando Extension	Ocean	194,788	$2.97	$578,520	$86,778	$665,298
Wando River Subtotal		1,181,397		$4,154,977	$623,247	$4,778,224
Custom House Berth	Ocean	170,370	$2.38	$405,481	$60,822	$466,303
N. Charleston Berth	Clouter Creek	240,525	$1.56	$375,219	$56,283	$431,502
Allied Berth	Clouter Creek	44,450	$3.50	$155,575	$23,336	$178,911
Hess Pier	Clouter Creek	131,970	$1.49	$196,635	$29,495	$226,131
Shiyard Berth	Clouter Creek	17,600	$8.31	$146,256	$21,938	$168,194
Wando Berth	Ocean	85,650	$2.71	$232,112	$34,817	$266,928
Daniel I. Berth	Ocean	1,290,000	$2.47	$3,186,300	$477,945	$3,664,245
Berthing Area Subtotal		1,980,565		$4,697,577	$704,637	$5,402,214
Daniel I. Turning Basin	Ocean	2,897,446	$2.50	$7,243,615	$1,086,542	$8,330,157
Shutes/Folly Realignment	Ocean	2,120,462		$4,787,679	$718,152	$5,505,831
TOTALS		**21,137,203**		**$49,702,002**	**$7,455,300**	**$57,157,302**

CHARLESTON HARBOR DEEPENING PROJECT - 45' CHANNEL, INNER HARBOR

SHOAL	DISPOSAL SITE	QUANTITY CY	COST/CY	TOTAL COST	CONTINGENCY 15%	TOTAL COST INC. CONT.
Mount Pleasant Range	Ocean	135,589	$2.23	$302,363	$45,355	$347,718
Rebellion/Folly Reach	Ocean	1,764,842	$2.32	$4,094,433	$614,165	$4,708,598
Horse/Shutes Reach	Ocean	715,660	$2.42	$1,731,897	$259,785	$1,991,682
Hog Island Reach	Ocean	1,000,377	$2.85	$2,851,074	$427,661	$3,278,736
Drum Island Bend	Ocean	84,262	$3.82	$321,881	$48,282	$370,163
Drum Island Reach	Ocean	623,031	$2.90	$1,806,790	$271,018	$2,077,808
Daniel Island Reach	Clouter Creek	614,031	$1.91	$1,172,799	$175,920	$1,348,719
Daniel Island Bend	Clouter Creek	534,515	$1.53	$817,808	$122,671	$940,479
Daniel I. Widening	Ocean	4,500,000	$2.47	$11,115,000	$1,667,250	$12,782,250
Clouter Creek Reach	Clouter Creek	877,361	$1.08	$947,550	$142,132	$1,089,682
Navy Yard Reach - Lower	Clouter Creek	249,896	$1.20	$299,875	$44,981	$344,856
Navy Yard Reach - Upper	Clouter Creek	514,573	$1.09	$560,885	$84,133	$645,017
North Charleston Reach	Clouter Creek	656,204	$1.25	$820,255	$123,038	$943,293
Filbin Creek Reach	Clouter Creek	534,223	$1.27	$678,463	$101,769	$780,233
Port Terminal Reach	Clouter Creek	427,733	$1.20	$513,280	$76,992	$590,272
Ordinance Reach	Clouter Creek	415,606	$1.21	$502,883	$75,432	$578,316
Ordinance Turning Basin	Clouter Creek	174,240	$1.15	$200,376	$30,056	$230,432
Main Channel Subtotal		13,822,143		$28,737,613	$4,310,642	$33,048,255
Custom House Reach	Ocean	198,175	$2.90	$574,708	$86,206	$660,914
Tidewater - Upper Reach	Ocean	196,152	$2.61	$511,957	$76,794	$588,750
Lower Towncreek - Lower	Ocean	464,070	$2.64	$1,225,145	$183,772	$1,408,917
Turning Basin	Ocean	287,561	$2.78	$799,420	$119,913	$919,333
Columbus Street Subtotal		1,145,958		$3,111,229	$466,684	$3,577,913
Shipyard River	Clouter Creek	424,335	$1.80	$763,803	$114,570	$878,373
Wando Reach	Ocean	727,219	$3.00	$2,181,657	$327,249	$2,508,906
Wando Terminal	Ocean	585,001	$3.44	$2,012,403	$301,861	$2,314,264
Wando Extension	Ocean	242,035	$2.76	$668,017	$100,202	$768,219
Wando River Subtotal		1,554,255		$4,862,077	$729,312	$5,591,389
Custom House Berth	Ocean	185,190	$2.37	$438,900	$65,835	$504,735
N. Charleston Berth	Clouter Creek	271,070	$1.53	$414,737	$62,211	$476,948
Allied Pier	Clouter Creek	50,000	$3.53	$176,500	$26,475	$202,975
Hess Pier	Clouter Creek	149,090	$1.46	$217,671	$32,651	$250,322
Shipyard Berth	Clouter Creek	22,460	$6.97	$156,546	$23,482	$180,028
Wando Berth	Ocean	102,780	$3.22	$330,952	$49,643	$380,594
Daniel I. Berth	Ocean	1,420,000	$2.46	$3,493,200	$523,980	$4,017,180
Berthing Area Subtotal		2,200,590		$5,228,507	$784,276	$6,012,783
Daniel I. Turning Basin	Ocean	3,004,875	$2.49	$7,482,139	$1,122,321	$8,604,460
Shutes/Folly Realignment	Ocean	1,736,208		$4,088,854	$613,328	$4,702,183
TOTALS		**23,888,364**		**$54,274,222**	**$8,141,133**	**$62,415,355**

CHARLESTON HARBOR DEEPENING PROJECT - 46' CHANNEL, INNER HARBOR

SHOAL	DISPOSAL SITE	QUANTITY CY	COST/CY	TOTAL COST	CONTINGENCY 15%	TOTAL COST INC. CONT.
Mount Pleasant Range	Ocean	162,825	$2.03	$330,535	$49,580	$380,115
Rebellion/Folly Reach	Ocean	2,164,121	$2.17	$4,696,143	$704,421	$5,400,564
Horse/Shutes Reach	Ocean	859,382	$2.32	$1,993,766	$299,065	$2,292,831
Hog Island Reach	Ocean	1,208,422	$2.63	$3,178,150	$476,722	$3,654,872
Drum Island Bend	Ocean	106,208	$3.35	$355,797	$53,370	$409,166
Drum Island Reach	Ocean	757,001	$2.68	$2,028,763	$304,314	$2,333,077
Daniel Island Reach	Clouter Creek	734,730	$1.86	$1,366,598	$204,990	$1,571,587
Daniel Island Bend	Clouter Creek	641,332	$1.55	$994,065	$149,110	$1,143,174
Daniel I. Widening	Ocean	4,600,000	$2.47	$11,362,000	$1,704,300	$13,066,300
Clouter Creek Reach	Clouter Creek	1,057,801	$1.10	$1,163,581	$174,537	$1,338,118
Navy Yard Reach - Lower	Clouter Creek	313,959	$1.12	$351,634	$52,745	$404,379
Navy Yard Reach - Upper	Clouter Creek	613,753	$1.12	$687,403	$103,111	$790,514
North Charleston Reach	Clouter Creek	793,542	$1.28	$1,015,734	$152,360	$1,168,094
Filbin Creek Reach	Clouter Creek	636,374	$1.28	$814,559	$122,184	$936,743
Port Terminal Reach	Clouter Creek	515,459	$1.21	$623,705	$93,556	$717,261
Ordinance Reach	Clouter Creek	502,350	$1.23	$617,891	$92,684	$710,574
Ordinance Turning Basin	Clouter Creek	210,113	$1.17	$245,832	$36,875	$282,707
Main Channel Subtotal		15,877,372		$31,826,154	$4,773,923	$36,600,078
Custom House Reach	Ocean	245,680	$2.61	$641,225	$96,184	$737,409
Tidewater - Upper Reach	Ocean	119,614	$2.38	$284,681	$42,702	$327,384
Lower Towncreek - Lower	Ocean	553,138	$2.47	$1,366,251	$204,938	$1,571,188
Turning Basin	Ocean	355,355	$2.55	$906,155	$135,923	$1,042,079
Columbus Street Subtotal		1,273,787		$3,198,312	$479,747	$3,678,059
Shipyard River	Clouter Creek	509,312	$1.81	$921,855	$138,278	$1,060,133
Wando Reach	Ocean	915,091	$2.74	$2,507,349	$376,102	$2,883,452
Wando Terminal	Ocean	730,153	$3.11	$2,270,776	$340,616	$2,611,392
Wando Extension	Ocean	290,019	$2.70	$783,051	$117,458	$900,509
Wando River Subtotal		1,935,263		$5,561,176	$834,176	$6,395,353
Custom House Berth	Ocean	200,000	$2.37	$474,000	$71,100	$545,100
N. Charleston Berth	Clouter Creek	301,625	$1.52	$458,470	$68,771	$527,241
Allied Berth	Clouter Creek	55,560	$3.46	$192,238	$28,836	$221,073
Hess Berth	Clouter Creek	166,220	$1.44	$239,357	$35,904	$275,260
Shipyard Berth	Clouter Creek	27,320	$5.93	$162,008	$24,301	$186,309
Wando Berth	Ocean	119,910	$2.60	$311,766	$46,765	$358,531
Daniel I. Berth	Ocean	1,450,000	$2.46	$3,567,000	$535,050	$4,102,050
Berthing Area Subtotal		2320635		$5,404,838	$810,726	$6,215,564
Daniel I. Turning Basin	Ocean	3,082,304	$2.49	$7,674,937	$1,151,241	$8,826,178
Shutes/Folly Realignment	Ocean	1,591,215		$3,839,941	$575,991	$4,415,932
TOTALS		**26,589,888**		**$58,427,214**	**$8,764,082**	**$67,191,296**

Exhibit 4

Dredging Cost Summary Sheets for Entrance Channel

CHARLESTON HARBOR DEEPENING PROJECT
ENTRANCE CHANNEL

AUTHORIZED PROJECT DEPTH	DISPOSAL SITE	QUANTITY CY	COST/CY	TOTAL COST	15 PERCENT CONTINGENCY	TOTAL COST
41 Feet	Ocean	4,927,615	$4.30	$21,188,745	$3,178,312	$24,367,056
42 Feet	Ocean	7,163,234	$3.91	$28,008,245	$4,201,237	$32,209,482
43 Feet	Ocean	9,207,002	$3.21	$29,554,476	$4,433,171	$33,987,648
44 Feet	Ocean	11,338,574	$2.72	$30,840,921	$4,626,138	$35,467,059
45 Feet	Ocean	13,541,781	$2.34	$31,687,768	$4,753,165	$36,440,933
46 Feet	Ocean	15,378,581	$2.28	$35,063,165	$5,259,475	$40,322,639

Exhibit 5

Dredging Cost Summary Sheets for Daniel Island Widening

CHARLESTON HARBOR DEEPENING PROJECT - Daniel Island Widening

CHANNEL DEPTH	DISPOSAL SITE	QUANTITY CY	COST/CY	TOTAL COST	CONTINGENCY 15%	TOTAL COST INC. CONT.
40 Feet	Ocean	3,600,000	$2.49	$8,964,000	$1,344,600	$10,308,600
41 Feet	Ocean	3,800,000	$2.49	$9,462,000	$1,419,300	$10,881,300
42 Feet	Ocean	4,000,000	$2.48	$9,920,000	$1,488,000	$11,408,000
43 Feet	Ocean	4,200,000	$2.48	$10,416,000	$1,562,400	$11,978,400
44 Feet	Ocean	4,300,000	$2.48	$10,664,000	$2,666,000	$13,330,000
45 Feet	Ocean	4,500,000	$2.47	$11,115,000	$1,667,250	$12,782,250
46 Feet	Ocean	4,600,000	$2.47	$11,362,000	$1,704,300	$13,066,300

Exhibit 6

Dredging Cost Summary Sheets for Daniel Island Turning Basin

CHARLESTON HARBOR DEEPENING PROJECT - 41' to 46' CHANNEL

Daniel Island Turning Basin

CHANNEL DEPTH	DISPOSAL SITE	QUANTITY CY	COST/CY	TOTAL COST	CONTINGENCY 15%	TOTAL COST INC. CONT.
41 Feet	Ocean	2,545,159	$2.51	$6,388,349	$958,252	$7,346,601
	Clouter Ck	2,545,159	$1.59	$4,046,803	$607,020	$4,653,823
42 Feet	Ocean	2,662,588	$2.50	$6,656,470	$998,471	$7,654,941
	Clouter Ck	2,662,588	$1.63	$4,340,018	$651,003	$4,991,021
43 Feet	Ocean	2,780,017	$2.50	$6,950,043	$1,042,506	$7,992,549
	Clouter Ck	2,780,017	$1.70	$4,726,029	$708,904	$5,434,933
44 Feet	Ocean	2,897,446	$2.50	$7,243,615	$1,086,542	$8,330,157
	Clouter Ck	2,897,446	$1.75	$5,070,531	$760,580	$5,831,110
45 Feet	Ocean	3,004,875	$2.49	$7,482,139	$1,122,321	$8,604,460
	Clouter Ck	3,004,875	$1.80	$5,408,775	$811,316	$6,220,091
46 Feet	Ocean	3,082,304	$2.49	$7,674,937	$1,151,241	$8,826,178
	Clouter Ck	3,082,304	$1.88	$5,794,732	$869,210	$6,663,941

Exhibit 7

Dredging Cost Summary Sheets for Daniel Island Berthing Area

CHARLESTON HARBOR DEEPENING PROJECT - 41' to 46' CHANNEL

Daniel Island Berthing Area for SPA

CHANNEL DEPTH	DISPOSAL SITE	QUANTITY CY	COST/CY	TOTAL COST	CONTINGENCY 15%	TOTAL COST INC. CONT.
41 Feet	Ocean	1,290,000	$2.47	$3,186,300	$477,945	$3,664,245
	Clouter Ck	1,290,000	$1.80	$2,322,000	$348,300	$2,670,300
42 Feet	Ocean	1,330,000	$2.47	$3,285,100	$492,765	$3,777,865
	Clouter Ck	1,330,000	$1.85	$2,460,500	$369,075	$2,829,575
43 Feet	Ocean	1,360,000	$2.47	$3,359,200	$503,880	$3,863,080
	Clouter Ck	1,360,000	$1.93	$2,624,800	$393,720	$3,018,520
44 Feet	Ocean	1,390,000	$2.46	$3,419,400	$512,910	$3.932,310
	Clouter Ck	1,390,000	$1.99	$2,766,100	$414,915	$3,181,015
45 Feet	Ocean	1,420,000	$2.46	$3,493,200	$523,980	$4,017,180
	Clouter Ck	1,420,000	$2.04	$2,896,800	$434,520	$3,331,320
46 Feet	Ocean	1,450,000	$2.46	$3,567,000	$535,050	$4,102,050
	Clouter Ck	1,450,000	$2.13	$3,088,500	$463,275	$3,551,775

Exhibit 8

Examples of Dredging Estimates

A DESCRIPTION AND QUANTITY SUMMARY

1 PROJECT CHARLESTON HARBOR DEEPENING DATE OF ESTIMATE JUNE 1995

2 LOCATION Clouter Creek Reach - 45' w/Clouter Crk DA INVIT. OR CONTR. NO. DACW60-9?-B-00??

3 ESTIMATED BY HENDERSON CHECKED BY

4 TYPE OF DREDGE 18" Cutter-Suction Dredge TYPE OF ESTIMATE Planning Estimate

5 DESCRIPTION OF WORK WORK CONSISTS OF UTILIZING AN 18" PIPELINE DREDGE TO EXCAVATE ALL MATERIAL AND DEPOSITING IT INTO THE CLOUTER CREEK DISPOSAL AREA. NO BOOSTER WILL BE REQUIRED TO ACCOMPLISH THE WORK. THE REQUIRED DEPTH IS 45' +2'OD + 2' ADV. MAINT.

6 EXCAVATION

			REMARKS
A. REQUIRED		441,761 CY	2,940,000 s.f. of Dredging Area
B. PAY OVERDEPTH	+	435,600 CY	
C. MAX. PAY YARDAGE	=	877,361 CY	(YARDAGE USED ON BID FORM)
D. O.D. NOT DREDGED	-	43,560 CY	
E. NET PAY YARDAGE	=	833,801 CY	(YARDAGE USED TO FIGURE UNIT PRICE PER C.Y.)
F. NON-PAY YARDAGE	+	108,900 CY	1.0 Feet Average Overdigging Outside of Prism
G. GROSS YARDAGE	=	942,701 CY	(YARDAGE USED TO FIGURE PRODUCTION TIME & COST)

B DREDGING COST BID ITEM # 2

					REMARKS
1	GROSS YARDAGE			942,701 CY	FROM SHEET A, ITEM 6 G.
2	PRODUCTION RATE		/	388,080 CY/MO	FROM SHEET C, ITEM 8.
3	DREDGING TIME		=	2.43 MONTHS	833,801 Net Pay CY / 2.43 MO = 343,128 Pay CY/MO
4	TOTAL MONTHLY COST		x	$292,717	FROM SHEET D, ITEM 5.
	SUBTOTAL...........=			$711,302	
5	FIXED COSTS		+	$0	FROM SHEET E, ITEM 15.
	SUBTOTAL.............=			$711,302	
6	OVERHEAD	14.0%	+	$99,582	
	SUBTOTAL...........=			$810,884	
7	PROFIT	10.0%	+	$81,088	
	SUBTOTAL.............=			$891,972	
8	BOND	1.0%	+	$8,920	
9	GROSS PRODUCTION COSTS		=	$900,892	
10	NET PAY YARDAGE		/	833,801 CY	FROM SHEET A, ITEM 6 E.
11	UNIT COST		=	$1.08 /CY	
12	MAX PAY YARDAGE		x	877,361 CY	FROM SHEET A, ITEM 6 C.
13	DREDGING COST		=	$947,550	

C MONTHLY PRODUCTION SUMMARY BID ITEM # 2

			REMARKS
1	SIZE OF DREDGE....PIPELINE.........>	18"	
2	POWER OUTPUT......MAIN PUMP........>	1,700 HP	
3	NUMBER OF BOOSTERS IN LINE.........>	0	
4	POWER OUTPUT......EACH BOOSTER.....>	1,600 HP	
5	PUMPING DISTANCES		
	A. MAXIMUM PIPELINE NEEDED.........>	6,000 LF	
	B. AVERAGE PIPELINE................>	3,000 LF	
	C. EQUIVALENT ADDITIONAL PIPELINE +	2,000 LF	
	D. PRODUCTION BASED ON =	5,000 LF	
6	GROSS PRODUCTION	770 CY/HR	SEE SHEET C \ 1, ITEM 4 F.
7	OPERATING TIME x	504 HRS/MO	SEE SHEET C \ 1, ITEM 5 E.
			(504 Operating Hrs per Mo / 730 Hrs per Mo of Dredging =
			69.0% Effective Time)
8	PRODUCTION RATE =	388,080 CY/MO	

GROSS PRODUCTION
C \ 1
OPERATING TIME

BID ITEM # 2

			REMARKS
1 SIZE OF DREDGE....PIPELINE........>		18"	
2 POWER OUTPUT......MAIN PUMP........>		1,700 HP	
3 NUMBER OF BOOSTERS IN LINE		0	Each Booster is 1600 Horsepower.
4 PRODUCTION.........(BASED ON)......>		5,000 LF	FROM SHEET C \ 2, ITEM 13.
A. ADJUSTED CHART PRODUCTION		609 CY/HR	FROM SHEET C \ 2, ITEM 14.
B. MATERIAL FACTOR	x	1.15	FROM SHEET C \ 3, ITEM 1 B.
C. BANK FACTOR	x	1.10	FROM SHEET C \ 3, ITEM 2 D.
D. OTHER FACTOR	x	1.00	XXXXXXXXXXXXX
E. CLEANUP FACTOR	x	1.00	0% ADDITIONAL DREDGING TIME
F. GROSS PRODUCTION	=	770 CY/HR	

			REMARKS
5 OPERATING TIME:			
A. BOOSTER FACTOR		1.00	10% LOSS IN PUMPING TIME PER BOOSTER
B. TIME EFFICIENCY	x	69.0%	% OF EFFECTIVE WORKING TIME WITHOUT BOOSTERS
C. NET EFFICIENCY	=	69.0%	% OF EFFECTIVE WORKING TIME INCLUDING BOOSTER LOSSES
D. MAX DREDGE TIME	x	730 HRS/MO	
E. OPERATING TIME	=	504 HRS/MO	

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**************************************************************************************************

                    C \ 2      ADJUSTED CHART PRODUCTION                BID ITEM #        2
                                                                                     ------------
**************************************************************************************************

                                                                   REMARKS

 1 SIZE OF DREDGE....PIPELINE........>         18"
                                         ------------          ------------------------------------------------
 2 CHART HORSEPOWER..................>      1,700 HP
                                         ------------          ------------------------------------------------
 3 STANDARD PRODUCTION CHART:
                                                               ------------------------------------------------
   STANDARD DREDGE PRODUCTION BASED ON CHART HORSEPOWER
   ----------------------------------------------------        ------------------------------------------------
   UP TO             4,240 L.F. OF PIPE       650 CY/HR
   AT                8,480 L.F. OF PIPE       420 CY/HR        ------------------------------------------------
   AT               11,660 L.F. OF PIPE       180 CY/HR
                                                               ------------------------------------------------
 4 POWER OUTPUT....USED FOR DREDGE....>     1,700 HP          Chart Adjustment Factor = (Available Dredge Horsepower +
                                         ------------          ------------------------------------------------
 5 NUMBER OF BOOSTERS USED...........>          0                      Number of Boosters x Booster H.P.) / Chart H.P.
                                         ------------          ------------------------------------------------
 6 POWER OUTPUT......EACH BOOSTER.....>     1,600 HP
                                         ------------          ------------------------------------------------
 7 TOTAL POWER APPLIED TO PIPELINE....>     1,700 HP          = (1700 H.P. + 0 Booster(s) x 1600 HP/Booster)
                                         ------------          ------------------------------------------------
 8 CHART ADJUSTMENT FACTOR (C.A.F)....>       1.00                      ERR
                                         ------------          ------------------------------------------------
 9 ADJUSTED PRODUCTION CHART:
                                                               ------------------------------------------------
   ADJUSTED DREDGE PRODUCTION CHART BASED ON C.A.F.
   ------------------------------------------------            ------------------------------------------------
   UP TO             4,240 L.F. OF PIPE       650 CY/HR
   AT                8,480 L.F. OF PIPE       420 CY/HR        ------------------------------------------------
   AT               11,660 L.F. OF PIPE       180 CY/HR
                                                               ------------------------------------------------

10 MAXIMUM LINE LENGTH...............>      6,000 LF
                                         ------------          ------------------------------------------------
11 AVERAGE LINE LENGTH...............>      3,000 LF          Actual Pipeline
                                         ------------          ------------------------------------------------
12 EQUIVALENT ADDITIONAL PIPELINE    +      2,000 LF          Assume 80 LF / VLF of dike @ 25'= 2000'
                              ------------------------         ------------------------------------------------
13 PIPE USED FOR PRODUCTION          =      5,000 LF          Actual Pipeline + Equivalent Feet of Pipe
                                         ------------          ------------------------------------------------
14 ADJUSTED CHART PRODUCTION                  609 CY/HR       Interpolated from Chart
                                         ------------          ------------------------------------------------
```

MATERIAL FACTOR CALCULATION

C \ 3 BID ITEM # 2

BANK FACTOR CALCULATION

1 MATERIAL FACTOR COMPUTATION:

A. MATERIAL FACTOR CHART:

DESCRIPTION	INPLACE DENSITY		FACTOR	%	QUANTITIES
MUD & SILT	1200	GR/L	3	0%	0 c.y.
MUD & SILT	1300	GR/L	2.5	0%	0 c.y.
MUD & SILT	1400	GR/L	2	60%	565,621 c.y.
LOOSE SAND	1700	GR/L	1.1	0%	0 c.y.
LOOSE SAND	1900	GR/L	1	15%	141,405 c.y.
COMP. SAND	2000	GR/L	0.9	0%	0 c.y.
STIFF CLAY	2000	GR/L	0.6	25%	235,675 c.y.
COMP. SHELL	2300	GR/L	0.5	0%	0 c.y.
SOFT ROCK	2400	GR/L	0.4	0%	0 c.y.
BLAST. ROCK	2000	GR/L	0.25	0%	0 c.y.

B. MATERIAL FACTOR................> 1.15 100% 942,701 c.y. (Computed from Chart)

REMARKS

2 BANK FACTOR COMPUTATION:

A. SIZE OF DREDGE....PIPELINE......> 18"

B. AVERAGE BANK HEIGHT............> 8.7 FT

C. BANK FACTOR CHART:

BANK HEIGHT	1	2	3	4	5	6	7	8	9
FACTOR	NA	0.53	0.7	0.86	1.02	1.1	1.1	1.1	1.1

D. BANK FACTOR....................> 1.10 Interpolated from chart

>

D MONTHLY COST SUMMARY BID ITEM # 2

DREDGE SIZE 18"

			REMARKS		
1 LABOR COSTS		$167,807 /MO	FROM SHEET D \ 1		
2 EQUIPMENT COSTS			FROM SHEET D \ 2		
A. DREDGE	+	$80,117 /MO	1 EA	@	$80,117 /MO
B. WORK TUG(S)	+	$13,662 /MO	2 EA	@	$6,831 /MO
C. CREW/SURVEY TUG	+	$3,907 /MO	1 EA	@	$3,907 /MO
D. DERRICK(S)	+	$6,064 /MO	2 EA	@	$3,032 /MO
E. FUEL/WATER BARGE	+	$1,271 /MO	1 EA	@	$1,271 /MO
F. WORK BARGE	+	$1,608 /MO	2 EA	@	$804 /MO
H. BOOSTER(S)	+	$0 /MO	0 EA	@	$47,213 /MO
G. ***Unused***	+	$0 /MO	0 EA	@	$0 /MO
3 PIPELINE COSTS BASED ON PUMPING SAND			6,000 LF (ON JOB) - RATES TAKEN FROM SHEET D \ 3		
A. (1) FLOATING PIPE (AVERAGE)	+	$8,200 /MO	1,000 LF	@	$8.20 /MO
(2) FLOATING PIPE (REMAINING)	+	$0 /MO	0 LF	@	$0.008 /HR X 730 HRS/MO
B. (1) SUBMERGED PIPE (AVERAGE)	+	$5,562 /MO	1,800 LF	@	$3.09 /MO
(2) SUBMERGED PIPE (REMAINING)	+	$3,942 /MO	2,700 LF	@	$0.002 /HR X 730 HRS/MO
C. (1) SHORE PIPE (AVERAGE)	+	$358 /MO	200 LF	@	$1.79 /MO
(2) SHORE PIPE (REMAINING)	+	$219 /MO	300 LF	@	$0.001 /HR X 730 HRS/MO
4 OTHER MONTHLY COSTS	+	$0 /MO	FROM SHEET D \ 4		
5 TOTAL MONTHLY COST	=	$292,717			

D \ 1 LABOR COSTS BID ITEM # 2

DREDGE SIZE 18"

SALARIED PERSONNEL:		RATE/MO
CAPTAIN		$3,000
CHIEF ENGR.		$2,800
CIVIL ENGR.		$0
FIELD OFFICE PERSONNEL		$1,800
SUBTOTAL....		$7,600
TAXES,INS.,FRINGES......	69.5%	$5,282
SALARIED PAYROLL.......>		$12,882 /MO

Taxes, insurance and fringes on labor:
Latest Labor Rate Update -> Oct. 93

Social Security		7.7%
Workman's Compensation		45.0%
State Unemployment Comp.		3.5%
Federal Unemployment Comp.		1.0%
Fringes...	$1.73 per hour	16.7%
(Not based	6 paid hol.	1.4%
on O.T.)	7.0%vacation	6.1%
TAXES,INS.,FRINGES......CREW...		81.5%
-(BENEFIT DIFFERENTIAL)		12.0%
TAXES,INS.,FRINGES......MANAGEMENT..		69.5%

CREW LABOR	NO.	RATE/HR	AMOUNT
LEVERMAN	3	$10.63	$31.89
WATCH ENGINEER	3	$10.17	$30.51
DREDGE MATES	2	$9.35	$18.70
TUG MASTERS	1	$10.17	$10.17
LAUNCHMEN	3	$8.68	$26.04
MAINTENANCE ENGINEERS	0	$0.00	$0.00
EQUIPMENT OPERATORS	3	$9.20	$27.60
WELDERS	1	$10.38	$10.38
OILERS	1	$8.60	$8.60
DECKHANDS	9	$8.24	$74.16
ELECTRICIAN	1	$10.17	$10.17
GENERAL DUMP FOREMAN	1	$9.35	$9.35
DUMP FOREMAN	0	$0.00	$0.00
YARD AND SHORE MEN	6	$8.29	$49.74
ENGINEERS FOR BOOSTERS	0	$10.17	$0.00
CREW TOTAL (3 SHIFTS)	34 MEN		$307.31 /HR

WAGES

WORK 56 HRS /WK		
PAY 64 HRS /WK @ 4.34WKS/wMO		$85,358
TAXES,INS.,FRINGES......	81.5%	$69,567
CREW PAYROLL..........>		$154,925 /MO

(ave. gross crew wage = $18.75 per manhour)

MONTHLY CREW PAYROLL	$154,925
+ MONTHLY SALARIED PAYROLL	$12,882
MONTHLY LABOR COSTS:	$167,807

****

D \ 2 EQUIPMENT COSTS BID ITEM # 2

****

DREDGE SIZE 18"

	--DREDGE--	----TUGS & TENDERS-----		--------------BARGES----------------			--BOOSTER--	---OTHER---
1a. Plant Description......	HYDRAULIC	WORK TUG	CREW/SURVEY	DERRICK	FUEL/WATER	WORK	FLOATING	***Unused***
1c. Prime Eng HP...........	1,700	150	100	150	0	0	1,600	0
1d. (1) Dredge El Gen HP...	280	--	--	--	--	--	--	--
1d. Total 2nd Eng HP.......	1,100	25	40	25	10	0	100	0
1e. Plant Value............	$1,766,000	$178,000	$42,000	$158,000	$95,000	$63,000	$810,000	$0
1f. Acquis Year............	1981	1982	1987	1980	1980	1980	1982	0
1g. Pres Year..............	1995	- - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->
1h. Cost of Money Rate.....	6.500%	- - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->
1i. Disc Money Rate:	5.200%	- - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->
1j. Hrs Worked/Mo..........	504	- - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->
2a. LAF....................	0.840	- - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->
2b. Fuel Cost per Gal......	$0.79	- - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->
3a. Ec Index <for Acq Yr>..	3239	3391	3886	2922	2922	2922	3391	0
3b. Ec Index <for 1995>....	5000	- - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->
4a. Mos Available/Year.....	9	- - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->	- - - - - ->
5a. Useful Life (in Yrs)...	25	20	20	20	20	20	25	0
5b. Physical Life (in Hrs).	125,000	100,000	100,000	100,000	100,000	100,000	125,000	0
5c. SLV Factor.............	0.10	0.10	0.10	0.10	0.05	0.05	0.10	0.00
5d. Pr Eng Fuel Factor.....	0.045	0.045	0.045	0.011	0.011	0.011	0.045	0
5e. 2nd Eng Fuel Factor....	0.039	0.039	0.039	0.011	0.011	0.011	0.039	0
5f. WLS Factor.............	0.24	0.38	0.38	0.20	0.20	0.20	0.22	0.00
5g. RPR Factor.............	0.90	1.00	1.00	0.70	0.60	0.60	1.10	0.00
6a. Depreciation:	3.60%	4.50%	4.50%	4.50%	4.75%	4.75%	3.60%	0.00%
6b. FCCM:	2.95%	2.98%	2.98%	2.98%	2.85%	2.85%	2.95%	0.00%
6c. Total Ownership/Year:	6.55%	7.48%	7.48%	7.48%	7.60%	7.60%	6.55%	0.00%
7a. Yearly Ownership:	$115,673	$13,314	$3,142	$11,818	$7,220	$4,788	$53,055	$0
7b. Monthly Ownership:	$12,853	$1,479	$349	$1,313	$802	$532	$5,895	$0
8a. (1) Hrly Pr Eng Fuel:	$60.44	$5.33	$3.56	$1.30	$0.00	$0.00	$56.88	$0.00
8a. (2) Hrly 2nd Eng Fuel:	$33.89	$0.77	$1.23	$0.22	$0.09	$0.00	$3.08	$0.00
8b. (1) Hrly Pr Eng WLS:	$14.51	$2.03	$1.35	$0.26	$0.00	$0.00	$12.51	$0.00
8b. (2) Hrly 2nd Eng WLS:	$8.13	$0.29	$0.47	$0.04	$0.02	$0.00	$0.68	$0.00
8c. (1) EAF:	1.544	1.474	1.287	1.711	1.711	1.711	1.474	0.000
8c. (2) Hrly Repair:	$16.49	$2.20	$0.45	$1.59	$0.82	$0.54	$8.83	$0.00
8d. Total Hrly Operating:	$133.46	$10.62	$7.06	$3.41	$0.93	$0.54	$81.98	$0.00
8e. Monthly Operating:	$67,264	$5,352	$3,558	$1,719	$469	$272	$41,318	$0
11. MONTHLY RATE:	$80,117	$6,831	$3,907	$3,032	$1,271	$804	$47,213	$0
12a. HRLY STANDBY ALLOW:	$17.61	$2.03	$0.48	$1.80	$1.10	$0.73	$8.08	$0.00
12b. Gener Fuel Allowance:	$8.63	--	--	--	--	--	--	--
12c. DREDGE HOURLY STANDBY:	$26.24	--	--	--	--	--	--	--

0401. 09_01. Channels	QUANTY	UOM	CREW ID	MANHRS	LABOR	EQUIPMNT	MATERIAL	TOTAL COST
04. 09. Channels (Mob & Demob)								
0401. 09_01. Channels								
USR AA <01030 1001 > Mob & Demob by Land				7.00	55.50	400.84	0.00	456.34
	40.00	HR	MODEL	280	2,220	16,034	0	18,254
USR AA <01030 1001 > Mob & Demob by Water				4.00	40.41	230.77	0.00	271.18
	40.00	HR	MODEG	160	1,616	9,231	0	10,847
TOTAL 09_01. Channels				440	3,837	25,264	0	29,101
TOTAL 09. Channels (Mob & Demob)				440	3,837	25,264	0	29,101
TOTAL Charleston Hbr Contraction Dikes				31,344	413,208	991,938	1,368,671	2,773,817

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0301. 09_01. Channels                                                   QUANTY UOM CREW ID     MANHRS      LABOR  EQUIPMNT  MATERIAL  TOTAL COST
------------------------------------------------------------------------------------------------------------------------------------------------------

   03. 09. Channels (Dike "D") NEW
       0301. 09_01. Channels

                              USR AA <02411 1005 > Steel Sheet Pile 27 LB/SF                       11.61     147.00    178.00    726.10     1051.10
                                                                           431.04 TN               5,004     63,363    76,725   312,978     453,066

                            M MIL AA <02611 2001 > Graded Crushed Agg Rdwy Base Crs                 0.26       4.08      7.23     10.50       21.81
                                                   This is for the resurfacing of   400.00 CY  XSABA    104      1,632     2,892     4,202       8,726
                                                   the causeway.

                            B MIL AA <02315 1004 > 12 x 12 x 53#/Ft Stl H-Sect Pile                 0.12       2.82      2.36     14.33       19.51
                                                   Rolled Steel                    3060.00 VLF CPIDC    367      8,629     7,222    43,853      59,704

                            L USR AA <02413 1001 > Walers, Connections & Struts                    31.49     735.00    890.00   1091.80     2716.80
                                                   Includes Turnbuckle               11.36 TON          358      8,350    10,110    12,403      30,863

                              USR AA <02261 1007 > Handle Armor Stone 1500 Lb To                    0.35       9.25     11.25     26.50       47.00
                                                                          6500.00 CY               2,275     60,125    73,125   172,250     305,500

                              USR AA <02261 1007 > Handle Marl Placement                            0.06       0.70      1.83      0.00        2.52
                                                                            75000 CY   XXQHB       4,688     52,365   136,905         0     189,270

                              USR AA <02611 2001 > Graded Crushed Agg Foundation                    0.13       1.40      3.65     11.13       16.18
                                                   Blanket(14,000) and terminal      14450 CY   XXQHB       1,879     20,230    52,743   160,829     233,801
                                                   cell(450).

                              USR AA <01030 1001 > Barge Cost                                       0.00       0.00    127.70      0.00      127.70
                                                                          1800.00 HR   MODEE           0          0   229,860         0     229,860
                                                                                                 ------- ---------- --------- --------- -----------
                                         TOTAL 09_01. Channels                                    14,674    214,694   589,582   706,515   1,510,790
                                                                                                 ------- ---------- --------- --------- -----------
                                         TOTAL 09. Channels (Dike "D") NEW                        14,674    214,694   589,582   706,515   1,510,790
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0201. 09_01. Channels                                                              QUANTY UOM CREW ID     MANHRS     LABOR  EQUIPMNT  MATERIAL  TOTAL COST
---------------------------------------------------------------------------------------------------------------------------------------

   02. 09. Channels (Dike "B") OLD
      0201. 09_01. Channels

                                   USR AA <02411 1005 > Steel Sheet Pile 27 LB/SF                    12.95    147.00    178.00    726.10     1051.10
                                                                              277.36 TN             3,592    40,772    49,370   201,391     291,533

                                   USR AA <02261 1006 > 10 Lb To 100 Lb Bedding                       1.00      9.25     11.25     26.50       47.00
                                                                              185.00 CY               185     1,711     2,081     4,903       8,695

                                   USR AA <02261 1007 > Rehandle Armor Stone 1500 Lb To               0.71      7.93     22.98      0.00       30.90
                                                                              900.00 CY  XXQHB        643     7,134    20,679         0      27,813

                                 M MIL AA <02611 2001 > Graded Crushed Agg Rdwy Base Crs              0.26      4.08      7.23     10.50       21.81
                                                        This is for the resurfacing of  350.00 CY  XSABA         91     1,428     2,531     3,677       7,635
                                                        the causeway.

                                 B MIL AA <02315 1004 > 12 x 12 x 53#/Ft Stl H-Sect Pile              0.12      2.82      2.36     14.33       19.51
                                                        Rolled Steel                   1680.00 VLF CPIDC       202     4,738     3,965    24,076      32,779

                                 B USR AA <02413 1001 > Walers, Connections & Struts                 73.17    735.00    890.00   1091.80     2716.80
                                                        Includes Turnbuckle               6.97 TON              510     5,123     6,203     7,610      18,936

                                   USR AA <02112 9001 > Demolition Of Old Goin System                 2.00     25.31     21.12      0.00       46.44
                                                                              390.00 LF  CPIDC        780     9,873     8,238         0      18,111

                                   USR AA <01030 1001 > Barge Cost                                    0.00      0.00    127.70      0.00      127.70
                                                                              360.00 HR  MODEE          0         0    45,972         0      45,972
                                                                                                  ------- --------- --------- --------- -----------
                                              TOTAL 09_01. Channels                               6,002    70,779   139,039   241,656     451,474
                                                                                                  ------- --------- --------- --------- -----------
                                              TOTAL 09. Channels (Dike "B") OLD                   6,002    70,779   139,039   241,656     451,474
```

0101. 09_01. Channels	QUANTY	UOM	CREW ID	MANHRS	LABOR	EQUIPMNT	MATERIAL	TOTAL COST
01. 09. Channels (Dike "A") OLD								
0101. 09_01. Channels								
USR AA <02411 1005 > Steel Sheet Pile 27 LB/SF				12.95	147.00	178.00	726.10	1051.10
	485.36	TN		6,285	71,348	86,394	352,420	510,162
USR AA <02261 1006 > 10 Lb To 100 Lb Bedding				1.00	9.25	11.25	26.50	47.00
	230.00	CY		230	2,128	2,588	6,095	10,810
USR AA <02261 1007 > Rehandle Armor Stone 1500 Lb To				0.71	7.93	22.98	0.00	30.90
	1600.00	CY	XXQHB	1,143	12,683	36,763	0	49,446
M MIL AA <02611 2001 > Graded Crushed Agg Rdwy Base Crs				0.26	4.08	7.23	10.50	21.81
This is for the resurfacing of the causeway.	200.00	CY	XSABA	52	816	1,446	2,101	4,363
B MIL AA <02315 1004 > 12 x 12 x 53#/Ft Stl H-Sect Pile				0.13	2.82	2.36	14.33	19.51
Rolled Steel	3240.00	VLF	CPIDC	421	9,137	7,646	46,433	63,216
B USR AA <02413 1001 > Walers, Connections & Struts				50.00	735.00	890.00	1091.80	2716.80
Includes Turnbuckle	12.32	TON		616	9,055	10,965	13,451	33,471
USR AA <02112 9001 > Demolition Of Old Goin System				2.00	25.31	21.12	0.00	46.44
	740.00	LF	CPIDC	1,480	18,733	15,631	0	34,364
USR AA <01030 1001 > Barge Cost				0.00	0.00	127.70	0.00	127.70
	600.00	HR	MODEE	0	0	76,620	0	76,620
TOTAL 09_01. Channels				10,227	123,899	238,053	420,500	782,452
TOTAL 09. Channels (Dike "A") OLD				10,227	123,899	238,053	420,500	782,452

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                                                                              QUANTITY UOM  MANHRS     LABOR  EQUIPMNT  MATERIAL  TOTAL COST UNIT COST
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                                              01  09. Channels (Dike "A") OLD

                                              0101  09_01. Channels               1.00 EA  10,227   123,899   238,053   420,500     782,452 782451.97
                                                                                           ------- --------- --------- --------- -----------
                                              TOTAL 09. Channels (Dike "A") OLD   1.00 EA  10,227   123,899   238,053   420,500     782,452 782451.97


                                              02  09. Channels (Dike "B") OLD

                                              0201  09_01. Channels               1.00 EA   6,002    70,779   139,039   241,656     451,474 451474.19
                                                                                           ------- --------- --------- --------- -----------
                                              TOTAL 09. Channels (Dike "B") OLD   1.00 EA   6,002    70,779   139,039   241,656     451,474 451474.19


                                              03  09. Channels (Dike "D") NEW

                                              0301  09_01. Channels               1.00 EA  14,674   214,694   589,582   706,515   1,510,790   1510790
                                                                                           ------- --------- --------- --------- -----------
                                              TOTAL 09. Channels (Dike "D") NEW   1.00 EA  14,674   214,694   589,582   706,515   1,510,790   1510790


                                              04  09. Channels (Mob & Demob)

                                              0401  09_01. Channels               1.00 EA     440     3,837    25,264         0      29,101  29100.89
                                                                                           ------- --------- --------- --------- -----------
                                              TOTAL 09. Channels (Mob & Demob)    1.00 EA     440     3,837    25,264         0      29,101  29100.89
                                                                                           ------- --------- --------- --------- -----------
                                              TOTAL Charleston Hbr Contraction Dikes 1.00 EA  31,344   413,208   991,938 1,368,671   2,773,817   2773817

                                                OVERHEAD                                                                  332,858
                                                                                                                      -----------
                                                  SUBTOTAL                                                              3,106,675
                                                HOME OFC                                                                  108,734
                                                                                                                      -----------
                                                  SUBTOTAL                                                              3,215,409
                                                PROFIT                                                                    318,325
                                                                                                                      -----------
                                                  SUBTOTAL                                                              3,533,734
                                                BOND                                                                       35,337
                                                                                                                      -----------
                                                  TOTAL INCL INDIRECTS                                                  3,569,072
                                                CONTINGN                                                                  535,361
                                                                                                                      -----------
                                                  SUBTOTAL                                                              4,104,432
                                                SIOH                                                                      246,266
                                                                                                                      -----------
                                                  TOTAL INCL OWNER COSTS                                                4,350,698
```

** PROJECT DIRECT SUMMARY - Bid Item **

	QUANTITY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
01 09. Channels (Dike "A") OLD	1.00	EA	10,227	123,899	238,053	420,500	782,452	782451.97
02 09. Channels (Dike "B") OLD	1.00	EA	6,002	70,779	139,039	241,656	451,474	451474.19
03 09. Channels (Dike "D") NEW	1.00	EA	14,674	214,694	589,582	706,515	1,510,790	1510790
04 09. Channels (Mob & Demob)	1.00	EA	440	3,837	25,264	0	29,101	29100.89
TOTAL Charleston Hbr Contraction Dikes	1.00	EA	31,344	413,208	991,938	1,368,671	2,773,817	2773817
OVERHEAD							332,858	
SUBTOTAL							3,106,675	
HOME OFC							108,734	
SUBTOTAL							3,215,409	
PROFIT							318,325	
SUBTOTAL							3,533,734	
BOND							35,337	
TOTAL INCL INDIRECTS							3,569,072	
CONTINGN							535,361	
SUBTOTAL							4,104,432	
SIOH							246,266	
TOTAL INCL OWNER COSTS							4,350,698	

** PROJECT INDIRECT SUMMARY - Facility **

	QUANTITY	UOM	DIRECT	OVERHEAD	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT COST
01 09. Channels (Dike "A") OLD									
0101 09_01. Channels	1.00	EA	782,452	93,894	30,672	89,795	9,968	1,006,781	1006781
TOTAL 09. Channels (Dike "A") OLD	1.00	EA	782,452	93,894	30,672	89,795	9,968	1,006,781	1006781
02 09. Channels (Dike "B") OLD									
0201 09_01. Channels	1.00	EA	451,474	54,177	17,698	51,812	5,752	580,912	580912.02
TOTAL 09. Channels (Dike "B") OLD	1.00	EA	451,474	54,177	17,698	51,812	5,752	580,912	580912.02
03 09. Channels (Dike "D") NEW									
0301 09_01. Channels	1.00	EA	1,510,790	181,295	59,223	173,379	19,247	1,943,934	1943934
TOTAL 09. Channels (Dike "D") NEW	1.00	EA	1,510,790	181,295	59,223	173,379	19,247	1,943,934	1943934
04 09. Channels (Mob & Demob)									
0401 09_01. Channels	1.00	EA	29,101	3,492	1,141	3,340	371	37,444	37444.13
TOTAL 09. Channels (Mob & Demob)	1.00	EA	29,101	3,492	1,141	3,340	371	37,444	37444.13
TOTAL Charleston Hbr Contraction Dikes	1.00	EA	2,773,817	332,858	108,734	318,325	35,337	3,569,072	3569072
CONTINGN								535,361	
SUBTOTAL								4,104,432	
SIOH								246,266	
TOTAL INCL OWNER COSTS								4,350,698	

U.S. Army Corps of Engineers
PROJECT SAC412: Charleston Hbr Contraction Dikes - Cooper River, Charleston, S.C.
Preliminary Cost Estimate
** PROJECT INDIRECT SUMMARY - Bid Item **

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                                                                              QUANTITY UOM      DIRECT  OVERHEAD  HOME OFC    PROFIT      BOND  TOTAL COST UNIT COST
--------------------------------------------------------------------------------------------------------------------------------------------------------------------

                                               01  09. Channels (Dike "A") OLD         1.00 EA     782,452    93,894    30,672    89,795     9,968   1,006,781   1006781
                                               02  09. Channels (Dike "B") OLD         1.00 EA     451,474    54,177    17,698    51,812     5,752     580,912 580912.02
                                               03  09. Channels (Dike "D") NEW         1.00 EA   1,510,790   181,295    59,223   173,379    19,247   1,943,934   1943934
                                               04  09. Channels (Mob & Demob)          1.00 EA      29,101     3,492     1,141     3,340       371      37,444  37444.13
                                                                                               ----------- --------- --------- --------- --------- -----------
                                             TOTAL Charleston Hbr Contraction Dikes    1.00 EA   2,773,817   332,858   108,734   318,325    35,337   3,569,072   3569072

                                                 CONTINGN                                                                                              535,361
                                                                                                                                                   -----------
                                                   SUBTOTAL                                                                                          4,104,432
                                                 SIOH                                                                                                  246,266
                                                                                                                                                   -----------
                                                   TOTAL INCL OWNER COSTS                                                                            4,350,698
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U.S. Army Corps of Engineers
PROJECT SAC412: Charleston Hbr Contraction Dikes - Cooper River, Charleston, S.C.
Preliminary Cost Estimate
** PROJECT OWNER SUMMARY - Facility **

	QUANTITY	UOM	CONTRACT	OTHER	ESCALATN	OWN FURN	CONTINGN	SIOH	TOTAL COST	UNIT COST
01 09. Channels (Dike "A") OLD										
0101 09_01. Channels	1.00	EA	1,006,781	0	0	0	151,017	69,468	1,227,266	1227266
TOTAL 09. Channels (Dike "A") OLD	1.00	EA	1,006,781	0	0	0	151,017	69,468	1,227,266	1227266
02 09. Channels (Dike "B") OLD										
0201 09_01. Channels	1.00	EA	580,912	0	0	0	87,137	40,083	708,132	708131.76
TOTAL 09. Channels (Dike "B") OLD	1.00	EA	580,912	0	0	0	87,137	40,083	708,132	708131.76
03 09. Channels (Dike "D") NEW										
0301 09_01. Channels	1.00	EA	1,943,934	0	0	0	291,590	134,131	2,369,656	2369656
TOTAL 09. Channels (Dike "D") NEW	1.00	EA	1,943,934	0	0	0	291,590	134,131	2,369,656	2369656
04 09. Channels (Mob & Demob)										
0401 09_01. Channels	1.00	EA	37,444	0	0	0	5,617	2,584	45,644	45644.39
TOTAL 09. Channels (Mob & Demob)	1.00	EA	37,444	0	0	0	5,617	2,584	45,644	45644.39
TOTAL Charleston Hbr Contraction Dikes	1.00	EA	3,569,072	0	0	0	535,361	246,266	4,350,698	4350698

U.S. Army Corps of Engineers
PROJECT SAC412: Charleston Hbr Contraction Dikes - Cooper River, Charleston, S.C.
Preliminary Cost Estimate
** PROJECT OWNER SUMMARY - Bid Item **

	QUANTITY	UOM	CONTRACT	OTHER	ESCALATN	OWN FURN	CONTINGN	SIOH	TOTAL COST	UNIT COST
01 09. Channels (Dike "A") OLD	1.00	EA	1,006,781	0	0	0	151,017	69,468	1,227,266	1227266
02 09. Channels (Dike "B") OLD	1.00	EA	580,912	0	0	0	87,137	40,083	708,132	708131.76
03 09. Channels (Dike "D") NEW	1.00	EA	1,943,934	0	0	0	291,590	134,131	2,369,656	2369656
04 09. Channels (Mob & Demob)	1.00	EA	37,444	0	0	0	5,617	2,584	45,644	45644.39
TOTAL Charleston Hbr Contraction Dikes	1.00	EA	3,569,072	0	0	0	535,361	246,266	4,350,698	4350698

SUMMARY REPORTS .... SUMMARY PAGE

DETAILED ESTIMATE .... DETAIL PAGE

No Backup Reports...

* * * END TABLE OF CONTENTS * * *

This project consist of three contraction dikes. Two dikes, "A" and "B", are existing. They will be totally removed before the new dike is constructed in the same location. Dike "D" is the new dike. Each dike is constructed of sheet pile with a circular terminal cell. Every 13.5 feet there will be an anchor sheet pile driven along with a "H" batter pile. The batter piles will be attached to the sheet piles along with a waler on each side of the sheet pile. Dike "D" will have marl placed as bedding material, crushed stone as the foundation material, and new riprap placed against the sheet piles. All work must be performed by barge mounted equipment.

Estimated By:

28 NOV 95

James E. Henderson, Jr., PE
CESAC-EN-C

DATE

Charleston Hbr Contraction Dikes
Cooper River, Charleston, S.C.

Designed By: U.S. Army Corps Of Engineers
Estimated By: James E. Henderson, Jr.,PE

Prepared By:
CESAC-EN-C

Preparation Date: 11/15/95
Effective Date of Pricing: 11/15/95
Est Construction Time: 270 Days

Sales Tax: 6.00%

MCACES GOLD EDITION
Composer GOLD Software Copyright (c) 1985-1994
by Building Systems Design, Inc.
Release 5.30A

LABOR ID: CWR95A EQUIP ID: NAT95A Currency in DOLLARS CREW ID: CWR95A UPB ID: CWR95A

Exhibit 9

Cost Estimate for Contraction Dikes

D \ 3 EQUIPMENT COSTS - HAULING BID ITEM # 2

DREDGE SIZE 26 CY Clamshell Dredge

	TOWING VESSEL	DUMP SCOW
1a. Plant Description......	Twin Screw	4,000 CY CAPACITY
1b. Series & Model.........		Split Hull Scow
1c. Prime Eng HP...........	3,000	0
1d. Total 2nd Eng HP.......	300	250
1e. Plant Value............	$1,000,000	$1,310,000
1f. Acquis Year............	1982	1982
1g. Pres Year..............	1995	- - - - - - - - - - - >
1h. Cost of Money Rate.....	6.500%	- - - - - - - - - - - >
1i. Disc Money Rate:	5.200%	- - - - - - - - - - - >
1j. Hrs Worked/Mo..........	657	730
2a. LAF....................	0.840	- - - - - - - - - - - >
2b. Fuel Cost per Gal......	$0.79	- - - - - - - - - - - >
3b. Ec Index <for 1995>....	5000	- - - - - - - - - - - >
3a. Ec Index <for Acq Yr>..	3391	3391
4a. Mos Available/Year.....	10	- - - - - - - - - - - >
5a. Useful Life (in Yrs)...	15	20
5b. Physical Life (in Hrs).	100,000	40,000
5c. SLV Factor.............	0.10	0.05
5d. Pr Eng Fuel Factor.....	0.045	0.011
5e. 2nd Eng Fuel Factor....	0.039	0.011
5f. WLS Factor.............	0.38	0.20
5g. RPR Factor.............	1.10	0.70
6a. Depreciation:	6.00%	4.75%
6b. FCCM:	3.02%	2.85%
6c. Total Ownership/Year:	9.02%	7.60%
7a. Yearly Ownership:	$90,200	$99,560
7b. Monthly Ownership:	$9,020	$9,956
8a. (1) Hrly Pr Eng Fuel:	$106.65	$0.00
8a. (2) Hrly 2nd Eng Fuel:	$9.24	$2.17
8b. (1) Hrly Pr Eng WLS:	$40.53	$0.00
8b. (2) Hrly 2nd Eng WLS:	$3.51	$0.43
8c. (1) EAF:	1.474	1.474
8c. (2) Hrly Repair:	$13.62	$28.38
8d. Total Hrly Operating:	$173.55	$30.98
8e. Monthly Operating:	$114,022	$22,615
11. MONTHLY RATE:	$123,042	$32,571
12a. HRLY STANDBY ALLOWANCE:	$12.36	$13.64

D \ 2 EQUIPMENT COSTS - EXCAVATION BID ITEM # 2

DREDGE SIZE 26 CY Clamshell Dredge

	DREDGE	TUGS & TENDERS		BARGES			OTHER	
1a. Plant Description......	CLAMSHELL	WORK TUG	CREW/SURVEY	DERRICK	FUEL/WATER	WORK	**Unused**	**Unused**
1c. Prime Eng HP...........	5,000	250	100	200	0	0	0	0
1d. (1) Dredge El Gen HP...	830	--	--	--	--	--	--	--
1d. Total 2nd Eng HP.......	3,310	50	40	40	10	0	0	0
1e. Plant Value............	$4,431,000	$250,000	$42,000	$190,000	$95,000	$63,000	$0	$0
1f. Acquis Year............	1980	1982	1987	1980	1980	1980	0	0
1g. Pres Year..............	1995	->	->	->	->	->	->	->
1h. Cost of Money Rate.....	6.500%	->	->	->	->	->	->	->
1i. Disc Money Rate:	5.200%	->	->	->	->	->	->	->
1j. Hrs Worked/Mo..........	483	->	->	->	->	->	->	->
2a. LAF....................	0.840	->	->	->	->	->	->	->
2b. Fuel Cost per Gal......	$0.79	->	->	->	->	->	->	->
3a. Ec Index <for Acq Yr>..	2922	3391	3886	2922	2922	2922	0	0
3b. Ec Index <for 1995>....	5000	->	->	->	->	->	->	->
4a. Mos Available/Year.....	10	->	->	->	->	->	->	->
5a. Useful Life (in Yrs)...	25	20	20	20	20	20	0	0
5b. Physical Life (in Hrs).	125,000	100,000	100,000	100,000	100,000	100,000	0	0
5c. SLV Factor.............	0.05	0.10	0.10	0.10	0.05	0.05	0.00	0.00
5d. Pr Eng Fuel Factor.....	0.045	0.045	0.045	0.011	0.011	0.011	0	0
5e. 2nd Eng Fuel Factor....	0.039	0.039	0.039	0.011	0.011	0.011	0	0
5f. WLS Factor.............	0.24	0.38	0.38	0.20	0.20	0.20	0.00	0.00
5g. RPR Factor.............	1.20	1.00	2.00	0.70	0.60	0.60	0.00	0.00
6a. Depreciation:	3.80%	4.50%	4.50%	4.50%	4.75%	4.75%	0.00%	0.00%
6b. FCCM:	2.83%	2.98%	2.98%	2.98%	2.85%	2.85%	0.00%	0.00%
6c. Total Ownership/Year:	6.63%	7.48%	7.48%	7.48%	7.60%	7.60%	0.00%	0.00%
7a. Yearly Ownership:	$293,775	$18,700	$3,142	$14,212	$7,220	$4,788	$0	$0
7b. Monthly Ownership:	$29,378	$1,870	$314	$1,421	$722	$479	$0	$0
8a. (1) Hrly Pr Eng Fuel:	$177.75	$8.89	$3.56	$1.74	$0.00	$0.00	$0.00	$0.00
8a. (2) Hrly 2nd Eng Fuel:	$101.98	$1.54	$1.23	$0.35	$0.09	$0.00	$0.00	$0.00
8b. (1) Hrly Pr Eng WLS:	$42.66	$3.38	$1.35	$0.35	$0.00	$0.00	$0.00	$0.00
8b. (2) Hrly 2nd Eng WLS:	$24.48	$0.59	$0.47	$0.07	$0.02	$0.00	$0.00	$0.00
8c. (1) EAF:	1.711	1.474	1.287	1.711	1.711	1.711	0.000	0.000
8c. (2) Hrly Repair:	$61.14	$3.10	$0.91	$1.91	$0.82	$0.54	$0.00	$0.00
8d. Total Hrly Operating:	$408.01	$17.50	$7.52	$4.42	$0.93	$0.54	$0.00	$0.00
8e. Monthly Operating:	$197,069	$8,453	$3,632	$2,135	$449	$261	$0	$0
11. MONTHLY RATE:	$226,447	$10,323	$3,946	$3,556	$1,171	$740	$0	$0
12a. HRLY STANDBY ALLOW:	$40.24	$2.56	$0.43	$1.95	$0.99	$0.66	$0.00	$0.00
12b. Gener Fuel Allowance:	$25.57	--	--	--	--	--	--	--
12c. DREDGE HOURLY STANDBY	$65.81	--	--	--	--	--	--	--

D \ 1 LABOR COSTS BID ITEM # 2

DREDGE SIZE 26 CY Clamshell Dredge

SALARIED PERSONNEL:		RATE/MO
CAPTAIN		$3,000
CHIEF ENGR.		$2,800
CIVIL ENGR.		$0
FIELD OFFICE PERSONNEL		$1,800
SUBTOTAL....		$7,600
TAXES,INS.,FRINGES......	77.7%	$5,903
SALARIED PAYROLL.......>		$13,503 /MO

Taxes, insurance and fringes on labor:
Latest Labor Rate Update -> Oct 93

Social Security		7.7%
Workman's Compensation		45.0%
State Unemployment Comp.		3.5%
Federal Unemployment Comp.		1.0%
Fringes...	$3.01 per hour	23.8%
(Not based	7 paid hol.	1.7%
on O.T.)	8.0%vacation	7.0%
TAXES,INS.,FRINGES......CREW...		89.7%
-(BENEFIT DIFFERENTIAL)		12.0%
TAXES,INS.,FRINGES......MANAGEMENT..		77.7%

CREW LABOR		NO.	RATE	AMOUNT
OPERATOR	(DREDGE)	3	$14.45	$43.35
ENGINEER	(DREDGE)	3	$13.46	$40.38
MATE	(DREDGE)	3	$12.15	$36.45
LAUNCHMEN	(DREDGE)	3	$10.12	$30.36
DECKHANDS	(DREDGE)	3	$9.63	$28.89
MATE	(DRAG BARGE)	1	$12.15	$12.15
DECKHANDS	(DRAG BARGE)	1	$9.63	$9.63
COOK	(QUARTERS)	1	$9.27	$9.27
MESSMAN	(QUARTERS)	1	$8.61	$8.61
SCOWMAN	(SCOWS)	6	$9.50	$57.00
TUGMASTER	(TOWING TUG)	1	$13.16	$13.16
MATES	(TOWING TUG)	2	$12.15	$24.30
DECKHANDS	(TOWING TUG)	3	$9.63	$28.89
LAUNCHMEN	(SURVEY BOAT)	0	$10.12	$0.00
DECKHANDS	(SURVEY BOAT)	0	$9.63	$0.00
LAUNCHMEN	(CREW BOAT)	0	$10.12	$0.00
DECKHANDS	(CREW BOAT)	0	$9.63	$0.00
CREW TOTAL	(3 SHIFTS)	31 MEN		$342.44 /HR

MONTHLY CREW PAYROLL	$180,407
+ MONTHLY SALARIED PAYROLL	$13,503

****

MONTHLY LABOR COSTS: $193,910

****

WAGES		
WORK 56 HRS /WK		
PAY 64 HRS /WK @ 4.34WKS/wMO		$95,116
TAXES,INS.,FRINGES......	89.7%	$85,291
CREW PAYROLL..........>		$180,407 /MO

(ave. gross crew wage = $23.94 per manhour)

D MONTHLY COST SUMMARY BID ITEM # 2

DREDGE SIZE 26 CY Clamshell Dredge

			REMARKS			
1 LABOR COSTS		$193,910 /MO	FROM SHEET D \ 1			
2 EXCAVATION			FROM SHEET D \ 2			
A. DREDGE(S)	+	$226,447 /MO	1 EA	@	$226,447 /MO	
B. WORK TUG(S)	+	$10,323 /MO	1 EA	@	$10,323 /MO	
C. CREW/SURVEY TUG	+	$0 /MO	0 EA	@	$3,946 /MO	
D. DERRICK(S)	+	$7,112 /MO	2 EA	@	$3,556 /MO	
E. FUEL/WATER BARGE	+	$1,171 /MO	1 EA	@	$1,171 /MO	
F. WORK BARGE(S)	+	$1,480 /MO	2 EA	@	$740 /MO	
H. **Unused**	+	$0 /MO	0 EA	@	$0 /MO	
I. **Unused**	+	$0 /MO	0 EA	@	$0 /MO	
3 HAULING			FROM SHEET D \ 3			
A. TOWING VESSEL(S)	+	$123,042 /MO	1 EA	@	$123,042 /MO	
B. SCOW(S)	+	$65,142 /MO	2 EA	@	$32,571 /MO	
4 OTHER MONTHLY COSTS	+	$0 /MO	FROM SHEET D \ 4			
5 TOTAL MONTHLY COST	=	$628,627				

C \ 2C

HAULING CYCLE TIME
&
TRIPS PER DAY

BID ITEM # 2

1 SIZE OF TUG		3000 HP Diesel--Twin Screw	
2 CYCLE TIME PER TRIP:			REMARKS
A. PREPARE FOR SCOW TOW		15 MIN	
B. TO DISPOSAL AREA	+	147 MIN	17.2 miles / 7 miles per hr x 60 min
C. DUMPING OR PUMPOUT	+	5 MIN	
D. FROM DISPOSAL AREA	+	115 MIN	17.2 miles / 9 miles per hr x 60 min
E. DISENGAGE TOW RIGGING AND TIE UP SCOW	+	15 MIN	
3 AVERAGE CYCLE TIME	=	297 MIN/TRIP	
4 AVERAGE TRIPS PER TOWING VESSEL	=	4.85 /DAY	(1440 Minutes per Day divided by 297 Minutes per Trip)
5 NUMBER OF TOWING VESSELS	x	1	
6 AVERAGE TRIPS	=	4.85 /DAY	

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******************************************************************************************
                                   HAULING PRODUCTION
                         C \ 2B    &                                   BID ITEM #       2
                                   HAULING OPERATING TIME                          ------------
******************************************************************************************

                                                                         REMARKS

 1 SIZE OF SCOW                          4,000 CY
                                   ------------      ------------------------------------------------------------
   A. CAPACITY               x             85%
                         ------------------------    ------------------------------------------------------------
   B. USEABLE VOLUME         =           3,400 CY
                                   ------------      ------------------------------------------------------------
   C. SLURRY DENSITY           x           75%
                         ------------------------    ------------------------------------------------------------
 2 AVERAGE VOLUME HAULED                 2,550 CY/SCOW
                                   ------------      ------------------------------------------------------------
 3 SCOWS PER TOWING VESSEL     x             1
                         ------------------------
 4 AVERAGE VOLUME HAULED                 2,550 CY/TRIP
                                   ------------      ------------------------------------------------------------
 5 TRIP FREQUENCY            x            4.85 /DAY     FROM SHEET C \ 2C, ITEM 6.
                         ------------------------    ------------------------------------------------------------
                             =          12,368 CY/DAY
                                   ------------      ------------------------------------------------------------
                               /            24 HRS/DAY
                         ------------------------    ------------------------------------------------------------
  ****************************************************************************************

 6 HAULING PRODUCTION          =           515 CY/HR
                                   ------------      ------------------------------------------------------------

  ****************************************************************************************


 7 HAULING OPERATING TIME:                                               REMARKS

                                                     ------------------------------------------------------------
   A. TIME EFFICIENCY                    90.0%        % OF EFFECTIVE WORKING TIME WITHOUT WAITING FOR DREDGE(S)
                                   ------------      ------------------------------------------------------------
                               x           730 HRS/MO
                         ------------------------    ------------------------------------------------------------
  ****************************************************************************************

   B. HAULING OPERATING TIME   =           657 HRS/MO
                                   ------------      ------------------------------------------------------------

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C \ 2A

HAULING RATE
&
HAULING TIME

BID ITEM # 2

1 MONTHLY HAULING RATE:

			REMARKS
A. HAULING PRODUCTION		515 CY/HR	FROM SHEET C \ 2B, ITEM 6.
B. HAULING OPERATING TIME	x	657 HRS/MO	FROM SHEET C \ 2B, ITEM 7B.
C. HAULING RATE	=	338,355 CY/MO	

2 HAULING TIME:

			REMARKS
A. GROSS CUBIC YARDS		223,245 CY (GROSS)	FROM SHEET A, ITEM 6G.
B. HAULING RATE	/	338,355 CY/MO	FROM ITEM 1C.
C. HAULING TIME	=	0.66 MONTHS	

C \ 1B

DREDGE PRODUCTION
&
EXCAVATION OPERATING TIME

BID ITEM # 2

1 SIZE OF DREDGE		26 CY Clamshell Dredge	REMARKS
2 CYCLE RATE		1.20 BUCKETS/MIN	(60 SECONDS PER MINUTE / 50 SECONDS PER CYCLE)
	x	60 MIN/HR	
3 BUCKET SIZE	x	21 CY	
A. BUCKET FILL FACTOR	x	0.70	(WORKING CAPACITY = 14.70 CY/BUCKET)
B. BANK FACTOR	x	0.66	(based on 5.3 Ft of Bank Height)
C. OTHER FACTOR	x	1.00	>
D. CLEANUP FACTOR	x	1.00	0.0% ADDITIONAL TIME
4 PRODUCTION PER DREDGE		701 CY/HR	
5 NUMBER OF DREDGES	x	1	
6 GROSS PRODUCTION	=	701 CY/HR	

7 EXCAVATION OPERATING TIME:			REMARKS
A. TIME EFFICIENCY		85.0%	% OF EFFECTIVE WORKING TIME WITHOUT MAJOR WAITS FOR SCOWS
	x	730 HRS/MO	
B. EXCAVATION OPERATING TIME	=	621 HRS/MO	

C \ 1A

EXCAVATION RATE
&
EXCAVATION TIME

BID ITEM # 2

REMARKS

1 MONTHLY EXCAVATION RATE:

A. DREDGE PRODUCTION		701 CY/HR	FROM SHEET C \ 1B, ITEM 6.
B. EXCAVATION OPERATING TIME	x	621 HRS/MO	FROM SHEET C \ 1B, ITEM 7B.
C. EXCAVATION RATE	=	435,321 CY/MO	

REMARKS

2 EXCAVATION TIME:

A. GROSS CUBIC YARDS		223,245 CY (GROSS)	FROM SHEET A, ITEM 6G.
B. EXCAVATION RATE	/	435,321 CY/MO	FROM ITEM 1C.
C. EXCAVATION TIME	=	0.51 MONTHS	

MONTHLY PRODUCTION SUMMARY
C &
ADJUSTED OPERATING HOURS

BID ITEM # 2

			REMARKS
1 EXCAVATION TIME	0.51 MONTHS	435,321 CY/MO	FROM SHEET C \ 1A
2 HAULING TIME	0.66 MONTHS	338,355 CY/MO	FROM SHEET C \ 2A
3 DREDGING TIME....................>	0.66 MONTHS		[Greater of Excavation Time or Hauling Time]
4 PRODUCTION RATE..................>	338,355 CY/MO		
5 PRODUCTION RATE..................>	338,355 CY/MO		FROM ITEM 4.
6 GROSS PRODUCTION (DREDGE) /	701 CY/HR		FROM SHEET C \ 1B, ITEM 6.
7 ADJUSTED OPERATING HOURS (DREDGE) =	483 HR/MO		DIVIDED BY 730 HOURS = 66.2% OF EWT
8 PRODUCTION RATE..................>	338,355 CY/MO		FROM ITEM 4.
9 GROSS PRODUCTION (HAULING) /	515 CY/HR		FROM SHEET C \ 2B, ITEM 6.
10 ADJUSTED OPERATING HRS (HAULING) =	657 HR/MO		DIVIDED BY 730 HOURS = 90.0% OF EWT

B DREDGING COST BID ITEM # 2

				REMARKS
1 GROSS YARDAGE			223,245 CY	FROM SHEET A, ITEM 6 G.
2 PRODUCTION RATE		/	338,355 CY/MO	FROM SHEET C, ITEM 4.
3 DREDGING TIME		=	0.66 MONTHS	181,445 Net Pay CY / 0.66 MO = 274,917 Pay CY/MO
4 TOTAL MONTHLY COST		x	$628,627	FROM SHEET D, ITEM 5.
SUBTOTAL............		=	$414,894	
5 FIXED COSTS		+	$0	FROM SHEET E, ITEM 15.
SUBTOTAL..............		=	$414,894	
6 OVERHEAD	14.0%	+	$58,085	
SUBTOTAL............		=	$472,979	
7 PROFIT	10.0%	+	$47,298	
SUBTOTAL..............		=	$520,277	
8 BOND	1.0%	+	$5,203	
9 GROSS PRODUCTION COSTS		=	$525,480	
10 NET PAY YARDAGE		/	181,445 CY	FROM SHEET A, ITEM 6 E.
11 UNIT COST		=	$2.90 /CY	
12 MAX PAY YARDAGE		x	198,175 CY	FROM SHEET A, ITEM 6 C.
13 DREDGING COST		=	$574,708	

A DESCRIPTION AND QUANTITY SUMMARY

1 PROJECT	CHARLESTON HARBOR DEEPENING	DATE OF ESTIMATE	JUNE 1995
2 LOCATION	Custom House Reach - 45 Ft Project	INVIT. OR CONTR. NO.	DACW60-9?-B-00??
3 ESTIMATED BY	HENDERSON	CHECKED BY	
4 TYPE OF DREDGE	26 CY Clamshell Dredge	TYPE OF ESTIMATE	Planning Estimate

5 DESCRIPTION OF WORK WORK CONSISTS OF UTILIZING A 26 CY CLAM SHELL DREDGE TO EXCAVATE ALL MATERIAL
AND PLACING INTO 4000 CY SCOWS TO BE DEPOSITED IN THE OCEAN DISPOSAL AREA.
ONE WAY AVG. DISTANCE IS 17.2 MILES. PROJECT DEPTH IS 45 FT + 2' OD + 2' ADV. MAINT.

6 EXCAVATION

		REMARKS
A. REQUIRED	30,875 CY	1,129,500 s.f. of Dredging Area
B. PAY OVERDEPTH	+ 167,300 CY	
C. MAX. PAY YARDAGE	= 198,175 CY	(YARDAGE USED ON BID FORM)
D. O.D. NOT DREDGED	- 16,730 CY	
E. NET PAY YARDAGE	= 181,445 CY	(YARDAGE USED TO FIGURE UNIT PRICE PER C.Y.)
F. NON-PAY YARDAGE	+ 41,800 CY	1.0 Feet Average Overdigging Outside of Prism
G. GROSS YARDAGE	= 223,245 CY	(YARDAGE USED TO FIGURE PRODUCTION TIME & COST)

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D \ 3 PIPELINE COSTS BID ITEM # 2

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PIPELINE SIZE: 18" MATERIAL PUMPED: SAND

	FLOATING PIPELINE			SUBMERGED PIPELINE		SHOREPIPE
1a. Plant Description......	Pipeline	Joints	Pontoons	Pipeline	Joints	Pipeline
Quantity.............>	60	1	2	400	1	20
Fixed Units Per Item..>	LF	Set	Each	LF	Set	LF
Unit Price...........>	$23.00	$4,500.00	$5,000.00	$23.00	$4,500.00	$25.00
1e. Plant Value:	$1,380.00	$4,500.00	$10,000.00	$9,200.00	$4,500.00	$500.00
1f. Acquis Year...........	1992	1992	1992	1992	1992	1992
1g. Pres Year.............	1995	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->
1h. Cost of Money Rate.....	6.500%	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->
1i. Disc Money Rate:	5.200%	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->
1j. Hrs Worked/Mo.........	504	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->
2a. LAF...................	0.840	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->
3a. Ec Index <for Acq Yr>..	4611	4611	4611	4611	4611	4611
3b. Ec Index <for 1995>....	5000	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->
4a. Mos Available/Year.....	9	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->
5a. Useful Life (in Yrs)...	1.0	3.0	12.0	1.0	3.0	1.5
5b. Physical Life (in Hrs).	4,500	12,000	60,000	4,500	12,000	6,000
5c. SLV Factor............	0.10	0.10	0.10	0.10	0.10	0.10
5g. RPR Factor............	0.05	0.30	0.05	0.05	0.30	0.05
6a. Depreciation:	90.00%	30.00%	7.50%	90.00%	30.00%	60.00%
6b. FCCM:	5.20%	3.64%	3.06%	5.20%	3.64%	4.42%
6c. Total Ownership/Year:	95.20%	33.64%	10.56%	95.20%	33.64%	64.42%
7a. Yearly Ownership:	$1,313.76	$1,513.80	$1,056.00	$8,758.40	$1,513.80	$322.10
7b. Monthly Ownership:	$145.97	$168.20	$117.33	$973.16	$168.20	$35.79
8c. (1) EAF:	1.084	1.084	1.084	1.084	1.084	1.084
8c. (2) Hrly Repair:	$0.01	$0.10	$0.01	$0.09	$0.10	$0.00
8e. Monthly Operating:	$5.04	$50.40	$5.04	$45.36	$50.40	$0.00
11. Monthly Rate (EA Item):	$151.01	$218.60	$122.37	$1,018.52	$218.60	$35.79
Monthly Rate Per Section (Sum Of Items):			$491.98		$1,237.12	$35.79
/ Section Length (In Linear Feet):			60		400	20
			============		============	============
MONTHLY RATES PER LF OF PIPELINE:			$8.20		$3.09	$1.79
5a. Useful Life (in Yrs)...	2.0	3.0	12.0	2.0	3.0	1.5
6a. Depreciation:	45.00%	30.00%	7.50%	45.00%	30.00%	30.00%
6b. FCCM:	4.03%	3.64%	3.06%	4.03%	3.64%	3.64%
6c. Total Ownership/Year:	49.03%	33.64%	10.56%	49.03%	33.64%	33.64%
7a. Yearly Ownership:	$676.61	$1,513.80	$1,056.00	$4,510.76	$1,513.80	$168.20
7b. Monthly Ownership:	$75.18	$168.20	$117.33	$501.20	$168.20	$18.69
12a. HRLY STANDBY ALLOW:	$0.103	$0.230	$0.161	$0.687	$0.230	$0.026
Hrly Standby Rate Per Section (Sum Of Items):			$0.494		$0.917	$0.026
/ Section Length (In Linear Feet):			60		400	20
			============		============	============
HOURLY STANDBY RATES PER LF OF PIPELINE:			$0.008		$0.002	$0.001

APPENDIX D

Real Estate

REAL ESTATE SECTION
FOR
FEASIBILITY REPORT

CHARLESTON HARBOR DEEPENING

CHARLESTON, SOUTH CAROLINA

Prepared By: JAMES THOMAS JR., CESAS-RE-AP, (912) 652-5892
Revised By: LYNN HARRISON, CESAS-RE-AP, (912) 652-5453
Study Manager: AMY DENN, CESAC-EN-P, (803) 727-4626

Date: 30 October 1995
Revised: 30 January 1996

REAL ESTATE SECTION
FOR
FEASIBILITY STUDY
CHARLESTON HARBOR (DEEPENING), SOUTH CAROLINA

1. REAL ESTATE SECTION.

The Charleston Harbor is a natural tidal estuary formed by the confluence of the Cooper, Ashley and Wando Rivers and is approximately midway of the South Carolina coastline. It is 140 miles southwest of the entrance to Cape Fear River, North Carolina, and 75 statute miles northeast of the Savannah River. (See Area Map, Exhibit "A").

2. PROJECT DESCRIPTION AND REAL ESTATE ISSUES.

a. The existing Charleston Harbor Project provides for a 40-foot navigational channel, 26.97 miles in length, from the 42-foot ocean contour to North Charleston Terminal on the Cooper River; a 2.08 mile long 40-foot deep channel in the Wando River extending from the Cooper River to the Wando Terminal; a 38-foot channel in Shipyard River Entrance Channel; and a 40-foot channel in Town Creek (part of the Cooper River system that loops around Drum Island). (See Project Map, Exhibit "B"). The Charleston Harbor's drawback to increased shipping is the lack of sufficient depth. With the large increase in containerized cargo over the last ten years and the development of a coal terminal, larger vessels are utilizing Charleston Harbor. Increased channel depths are required to facilitate these larger vessels. In the future, a lack of depth in the navigation channel may cause an increase in shipping costs due to the larger ships having to carry lighter loads to enter the harbor. These lighter loads would increase shipping costs, that would be passed on to the consumer of the shipped goods.

b. The Charleston Harbor Deepening/Widening Study, was authorized by resolutions adopted on 27 March 1990 and 1 August 1990, respectively, by the Senate Committee on Environment and Public Works and the House Committee on Public Works and Transportation. The information in this report is tentative in nature and is to be used for planning purposes only. The author of this report has inspected the Project area. This report contains information from Planning Division, Charleston District. The Project Sponsor (PS) is the South Carolina State Ports Authority (SCSPA).

The proposed Charleston Harbor Deepening Project consists of deepening the navigational channel from existing depths of 38 to 40 feet to design depth of 45 feet. The decision to dredge to this depth was based on economic and technical reasons. The total length of the Project is approximately 29 miles. It includes portions of the Wando, Cooper and Shipyard Rivers. (See Project Map, Exhibit "B").

c. The Project is expected to generate approximately 26.5 million cubic yards of dredged material from both operation and maintenance and initial construction. The majority of the dredged material (approximately 70%) taken from the Daniel Island Turning Basin, the widening of Daniel Island Reach, and the berthing areas at the Daniel Island Terminal will be placed offshore in an Environmental Protection Agency's (EPA) approved Ocean Dredged Material Dumping Site (ODMDS). The ODMDS is approximately three square miles in size and controlled by the EPA. The site is located in federal waters approximately 9 miles southeast of the Charleston Harbor. In addition, suitable material (as determined by EPA standards) taken from the entrance channel to Drum Island Reach and the turning basins at the Custom House and Wando Terminal will be placed in the ODMDS. Only material found suitable can be placed in the ODMDS. All remaining materials will be placed in the approved existing upland disposal sites, (Clouter Creek, Drum Island, and Morris Island). Approximately 20% of the dredged material will be deposited in the Clouter Creek disposal area. The southern end of the Clouter Creek disposal area (approximately 1,397 acres) is owned in fee by the federal government and is under jurisdiction of the U.S. Navy. Based on our segment map, 1,021 acres of Clouter Island are owned by the SCSPA of which the Corps of Engineers has a perpetual disposal easement over 618 acres. A request to transfer the portion of Clouter Island under the jurisdiction of the Navy to the Department of the Army has been submitted for approval. The transfer is expected to be completed before the start of this Project. There may be costs for the PS associated with the storage of dredged materials on lands owned by the federal government. This issue is explained in detail in the next paragraph. (See Exhibit "C"). The remaining 10% of dredged material from the Project will be deposited in the Morris Island and Drum Island disposal areas. Morris Island disposal area contains approximately 703 acres and is owned in fee by the SCSPA. The Corps of Engineers has an easement through the year 2017 for disposal of dredged material on Morris Island for operations and maintenance of the harbor. The Drum Island disposal area is owned by the SCSPA and contains approximately 300 acres. The United States has a disposal easement over approximately 152 acres on the north side of Drum Island for harbor operations and maintenance which expires in 2012. The remaining disposal sites in the area either had limited capacity at the time of Project construction or were found to be uneconomically acceptable. This eliminated Naval Weapons Station and Yellowhouse Creek Disposal and Daniel Island.

The Clouter Creek Disposal site is in the process of being transferred from the Department of Navy to the Department of Army as part of the Base Realignment and Closure (BRAC). The transfer is continuing and problems are not anticipated in the conclusion of this action. After the approval has been received from higher authority, a DD Form 1354 is prepared to transfer the accountability from the Department of the Navy to the Department of Army. This is handled at the District (local) level. If for some reason this transfer cannot be accomplished the Yellowhouse Creek Disposal Site and the Naval Weapons Station would have to be utilized thus increasing the disposal costs. Additionally, there may be costs for the PS associated with the storage of dredged materials on lands owned by the federal government. These costs of storage and diking to the PS will depend on the particular disposal area and the amount of dredged material deposited in the upland sites. (See Exhibit "C"). It is estimated that with 5.9 million cubic yards, at $0.50 per yard, the cost will be $2,950,000.00 for the use of Clouter Island.

d. The inner harbor width varies from 500 to 875 feet. The entrance channel width varies from 800 to 1000 feet. Modeling studies conducted by the Waterways Experiment Station (WES) indicate that there will be no sloughing along banks of the channel due to dredging. All dredging will be conducted within the navigational servitude of the United States. No lands above Mean High Water (MHW) will be required for dredging purposes.

e. There are three contraction dikes required for this Project which are located in what is known as North Charleston. These dikes are needed to reduce shoaling in the harbor. Two of these dikes are existing and will require renovation and one new dike will be constructed. One of the existing dikes is located on federally owned lands controlled by the Department of the Navy and the other is on lands owned by the State of South Carolina. (See Exhibit "E"). The new dike to be constructed on lands currently under federal jurisdiction (Navy lands) are scheduled to be a part of BRAC in the year 2000. The Department of the Navy could issue a license to the sponsor for the construction of the new dike, but a license will not transfer with the land under BRAC. Since it is imperative to ensure the capability of long term use of the contraction dike, the land should be transferred to the Department of the Army. Approximately 1/4 acre of land above MHW will be required to place the rubble abutments for each of the dikes. The PS will make available for the Project, all lands required to construct the contraction dike on state property.

f. All construction will be accomplished from barges on the river, therefore, temporary construction and road easements are not required. The appraised value of the property is included as Exhibit "F". There are administrative costs for both the federal and PS in the preparation, coordination, negotiation, and review of the PCA.

3. **GOVERNMENT OWNED LAND WITHIN PROJECT AREA**.

At this time the Corps of Engineers and the Navy are in the process of transferring the Clouter Creek Disposal Area, currently owned by the Department of the Navy, to the Department of the Army. The material that is suitable will be placed offshore in the ODMDS. All other material will be placed in the Clouter Creek Disposal Site. The remaining inner harbor disposal sites are not the most economically feasible choices but can and would be used if the Clouter Creek transfer does not occur as expected.

Other lands owned by the Department of Navy are necessary for the contraction dikes required for shoaling purposes. This area is known as North Charleston and is adjacent to Shipyard Creek. Currently one contraction dike is already in place and a new one is scheduled for construction in 1998. This is further discussed above. A third dike is already in place on privately owned lands of the PS.

4. PROJECT SPONSOR.

The Project Sponsor (PS) is the South Carolina State Ports Authority (SCSPA).

5. OTHER LANDS WITHIN THE PROJECT AREA.

The state of South Carolina owns lands in the Project area through the SCSPA. Most of the lands are utilized for disposal of dredged material in the operation and maintenance of the Charleston Harbor.

6. P.L. 91-646 RELOCATIONS.

None

7. MINERAL ACTIVITY.

There is no mineral activity within the Project or disposal areas.

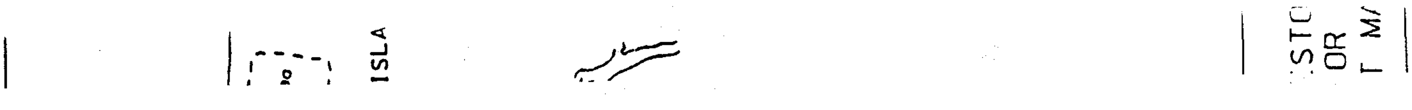
8. REAL ESTATE INTERESTS TO BE ACQUIRED.

The real estate interests to be acquired for the Project are the lands from the Navy which will be transferred to the Army. Lands may be required for mitigation purposes but this has not yet been determined. It is anticipated that between two to four acres will be required. The PS will acquire appropriate interests in other lands if required.

9. RELOCATION OF FACILITIES, UTILITIES.

There are no relocations of facilities or utilities within the Project area.

10. REAL ESTATE COST ESTIMATE.



APPENDIX E

Economic Analysis

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Introduction

The purpose of this appendix is to provide a detailed description of the economic evaluation of plans to improve the efficiency of shipping and to provide safe navigation for vessels in Charleston Harbor.

Charleston Harbor is the largest and most important seaport in South Carolina and is the second largest container port on the east coast of the United States. In 1994, more than 10 million short tons of waterborne commerce was moved through the harbor. The most important products shipped from Charleston include coal, chemicals, paper, grains, wood pulp, cement, textiles and lumber. Petroleum products, chemicals, bauxite and non-ferrous ores are the most important commodities shipped into Charleston. Two-thirds of this traffic was containerized cargo.

Many of the vessels that currently call on Charleston must light-load and/or wait on tidal advantage in order to enter or leave the harbor. The depth of the harbor also impedes the introduction of larger vessels into the fleet that calls on Charleston despite the efficiency gains that can be realized with larger vessels.

The design of the existing channel was based on a vessel length of 810 feet-- the length of the largest vessels that were then expected to use the harbor. Vessels that are 950 feet long are now calling on Charleston and the frequency of such calls is increasing.

Most of the largest vessels that call on Charleston are containerships. Charleston's container traffic has grown dramatically since its introduction in the mid-1960's and is projected to experience substantial growth in the future. Containership terminals are located on the Wando River, Columbus Street in downtown Charleston, and in North Charleston.

The local port authority has purchased land on Daniel Island to be used in the construction of a fourth container port. This construction will be completed in several stages, as capacity is needed. When completed, the new Daniel Island Terminal will provide an estimated 25 million tons of capacity.

Major inputs to the economic analysis-- commodity traffic projections, fleet projections, and estimates of vessel operating cost-- are described in the first three sections of this appendix. Evaluations of transportation savings and NED benefit-cost analysis are presented in Sections 4 and 5, respectively. Section 6 summarizes the results of sensitivity/risk studies and Section 7 contains the multiport analysis.

Section 1. Historical and Projected Traffic

Five major commodity groups will be affected by the deepening of Charleston Harbor: petroleum products, grains, coal, iron carbide, and containerized cargo. For each commodity group, three key factors are evaluated. First, the historical levels of traffic are examined to identify trends and important discontinuities, such as the sudden decline in residual fuel oil tonnage that occurred when industrial users shifted to natural gas. Second, relevant supply and end-use markets are examined to determine the major influences upon future traffic. Third, the methods and results of commodity projections are described. Figure E-1 shows Charleston Harbor and the location of major terminals.

Two features of the forecasting methodology should be addressed at this point, since they apply to all the traffic projections described in this section. First, variance in historical traffic levels makes it difficult to develop meaningful measures of change. Growth rates based on historical data can vary widely, depending on the choice of beginning and ending years. For this reason, regression analysis was used to fit a trendline to the historical data and historical growth rates were developed based on the trendline.

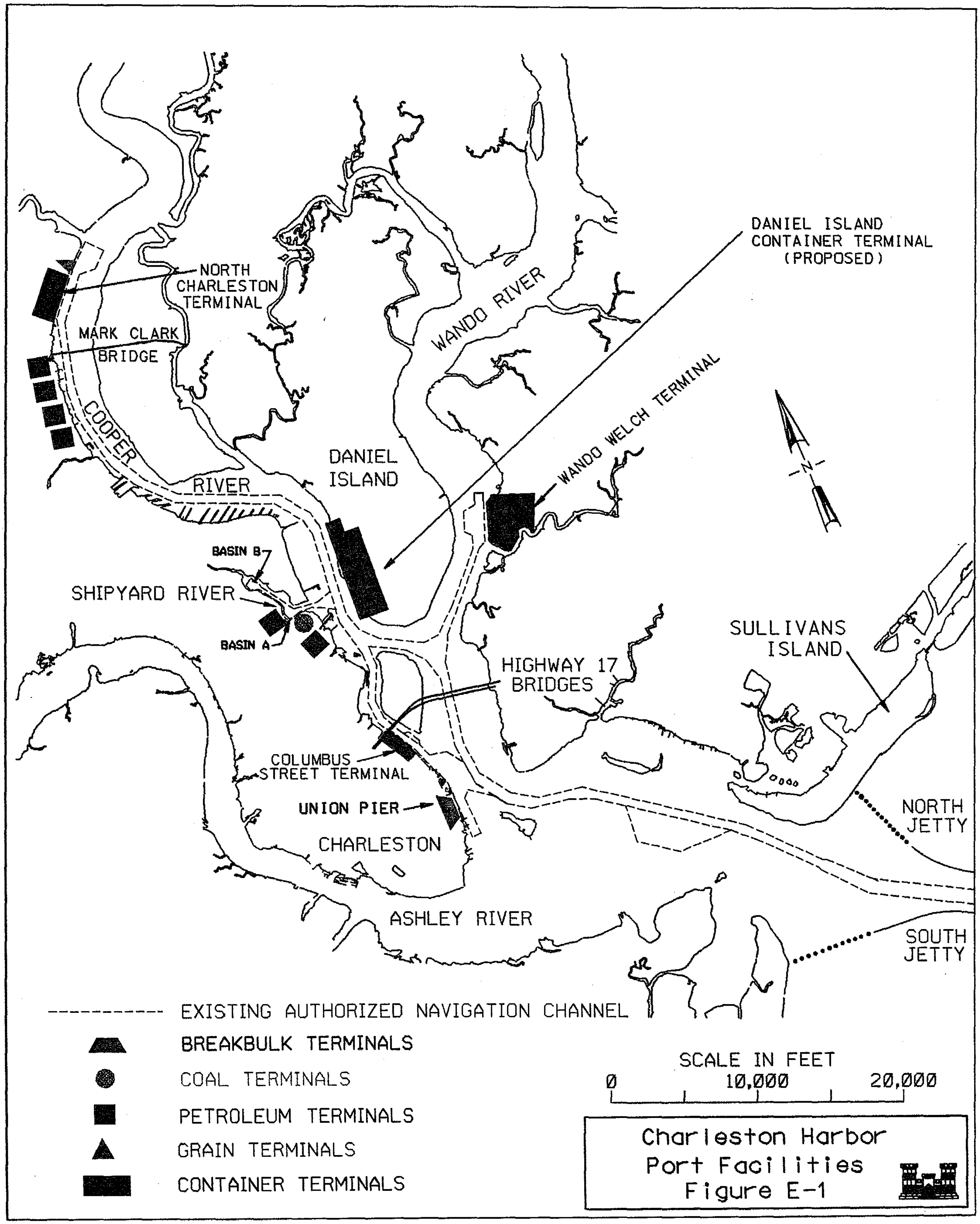
Second, trendlines were also used to calculate normalized traffic levels for use in projecting future traffic. The base year for the traffic projections described below is 1992, but actual 1992 tonnage levels were not used as starting points for the projections. Instead, a trendline was developed for each commodity group from recent traffic data, and projections were based on the 1992 trendline value. In that way, the effects of unusually high or low base-year traffic levels are minimized.

I. Petroleum Products.

A. General. In 1992, more than 2 million tons of petroleum fuels and lubricants were received at the Port of Charleston for inland distribution. There are no petroleum product pipelines serving the coastal regions of South Carolina. The nearest ports importing significant volumes of petroleum products are Wilmington and Savannah.

The primary market for the petroleum products received at Charleston consists of nine counties in southeastern South Carolina: Bamberg, Berkeley, Charleston, Clarendon, Colleton, Dorchester, Georgetown, Orangeburg, and Williamsburg Counties. These counties, with a combined 1990 population of about 750,000, depend almost exclusively upon the Port of Charleston for gasoline and other petroleum products.

Petroleum products received at Charleston are distributed outside the primary market area into markets shared with the ports of Savannah and Wilmington or served by



Charleston Harbor
Port Facilities
Figure E-1

pipelines located in North Carolina and western South Carolina. This secondary market area includes the entire coastal portion of South Carolina, up to 100-miles inland.

B. Gasoline.

1. General. Gasoline is received at two terminals located near the confluence of the Shipyard and Cooper Rivers, and at four other terminals located on the Cooper River just downstream from the North Charleston Terminal.

Gasoline is received from three major sources: the Gulf Coast, the Virgin Islands, and Jacksonville, Florida. More than half of the gasoline originates from various points along the gulf coast, most importantly, Corpus Christi, TX and Garyville, LA. The remainder originates from the Virgin Islands, Jacksonville, and various domestic sources; imports of gasoline are insignificant.

2. Historical Traffic. In 1992, gasoline receipts at Charleston Harbor totaled 1.2 million tons, about the same as in 1980 [see Table E-1]. However, this does not reflect unchanging demands for gasoline, but the interaction of several offsetting factors.

The demand for automobile transportation grew steadily in the Charleston area throughout the study period. Automobile registration increased from 1.5 million in 1980 to 1.9 million in 1992. This increase, which normally would have translated into increased consumption and receipts of gasoline, was offset by improvements in the fuel efficiency of new cars and by temporary changes in gasoline distribution patterns in the Charleston area.

Receipts of gasoline at the Port of Charleston actually declined during the late 1970's and the early 1980's. This was largely the result of higher gasoline prices and the Corporate Average Fuel Economy Standards that were established under the Energy Conservation Act of 1975, as new cars with improved fuel efficiency helped to reduce the demand for gasoline.

The rate of improvement in the fuel efficiency of new cars slowed in the 1980's and receipts of gasoline began to increase. Declines of gasoline tonnage in 1988 and 1989 were the result of temporary changes in local distribution patterns, primarily by a single distributor.

Table E-1
Charleston Harbor Study
Historical & Projected Bulk Commodity Traffic, 1980 - 2052
[Thousands of Tons]

Year	Gasoline	Distillate Fuel Oil	Residual Fuel Oil	Lubricating Oil	Grains	Coal	Iron Carbide	Total Bulk
1980	1,368.2	459.4	1,179.2	272.7	397.7	0.3	0.0	3,677.4
1981	1,145.1	379.9	888.2	189.0	600.1	52.4	0.0	3,254.7
1982	1,151.0	364.2	492.8	176.3	524.1	0.3	0.0	2,708.8
1983	1,168.1	388.4	611.5	149.7	336.2	284.6	0.0	2,938.4
1984	1,011.2	407.3	422.9	281.0	525.0	838.5	0.0	3,485.9
1985	1,014.8	389.3	423.1	257.9	501.0	1,050.2	0.0	3,636.4
1986	1,100.6	365.6	407.3	353.3	186.7	1,037.8	0.0	3,451.3
1987	1,087.1	425.5	324.1	298.1	211.1	568.6	0.0	2,914.5
1988	903.7	308.6	806.0	300.9	233.0	844.8	0.0	3,397.0
1989	866.2	240.5	396.7	279.7	408.0	834.5	0.0	3,025.7
1990	1,229.0	319.0	410.0	272.0	266.0	1,116.0	0.0	3,612.0
1991	1,241.0	323.0	312.0	227.0	201.0	1,159.0	0.0	3,463.0
1992	1,221.0	388.0	261.0	274.0	310.0	782.0	0.0	3,236.0
2002	1,388.6	457.0	291.4	310.6	382.4	1,425.4	400.0	4,655.5
2012	1,530.4	558.0	291.4	340.9	405.5	1,662.0	440.1	5,228.3
2022	1,671.2	609.3	291.4	368.6	430.1	1,891.2	476.6	5,738.3
2032	1,824.9	665.3	291.4	398.5	456.1	2,151.9	516.1	6,304.3
2042	1,992.8	726.5	291.4	430.9	483.7	2,448.6	558.9	6,932.8
2052	2,176.1	793.4	291.4	465.9	513.0	2,786.2	605.3	7,631.3

Source: Waterborne Commerce of the United States, Part I, US Army Corps of Engineers, Waterborne Commerce Statistical Center; [1980 - 1989, and advance copies, 1990 - 1992; computations by Charleston District.

3. Projected Traffic. Projections of gasoline receipts through 2010 are based on the Department of Energy's projections of consumption of gasoline in the South Atlantic states[1]. In the South Atlantic states, gasoline consumption is projected to grow at an annual rate of 1.0 percent between 1990 and 2010. This growth rate was applied to a normalized 1992 tonnage level of 1,257,000 tons to project growth of gasoline receipts through 2010.

Projections of gasoline receipts after 2010 are based on the projected growth of total earnings within the nine-county primary market area described above. Total earnings is a good indicator of gasoline consumption, reflecting changes in population as well as affluence. For comparison, in the nine-county primary market area, the annual growth rate projected for total earnings from 1995 to 2010 in the 1990 OBERS Regional Projections[2] is identical to the DOE's projections of gasoline consumption over the same period.

Total earnings within the nine-county area are projected to grow at an annual rate of about 0.9 percent from 2010 to 2040. This growth rate was used to project gasoline receipts in Charleston after 2010. Projected gasoline traffic in the Port of Charleston is shown in Table E-1.

C. Distillate Fuel Oil.

1. General. About four-fifths of Charleston's distillate fuel oil is received at terminals located just upstream from the Navy Shipyard on the Cooper River. This traffic primarily consists of receipts of diesel fuel for use in trucks, railroad locomotive engines, and city buses, including both No. 1 and No. 2 diesel fuel oils.

About half of this traffic originates along the Gulf Coast, in Texas and Louisiana. The remainder originates in the Virgin Islands, Jacksonville, and at various other domestic sources; imports of distillate fuel oil are insignificant.

2. Historical Traffic. Receipts of distillate fuel oil declined in the late 1980's, but have rebounded in recent years. Historical highs in the late 1970's approached 700,000 tons. Traffic declined through the 1980's to a low of just over 240,000 tons in 1989. Since then, traffic levels have increased to nearly 400,000 tons in 1992.

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[1] Supplement to the Annual Energy Outlook 1994, "Energy Consumption by End-Use Sector and Source, South Atlantic Census Division," pp. 88-89.

[2] US Department of Commerce, Bureau of Economic Analysis.

3. Projected Traffic. Near-term projections of distillate fuel tonnage are based on the Department of Energy's projections of consumption of distillate fuel oil in the South Atlantic states. Distillate fuel oil consumption in this region is projected to grow at rate of 2.3 percent annually through 2010. This growth rate was applied to a normalized 1992 tonnage level of 364,000 tons to project growth of gasoline receipts through 2010. After 2010, distillate fuel oil tonnage is projected to grow at an annual rate of 0.9 percent, based on OBERS projections for total earnings in the nine-county primary market area. Projected residual fuel tonnage is shown in Table E-1.

D. Residual Fuel Oil.

1. General. Charleston receives residual fuel oil for use in industrial processes and commercial and industrial heating. Residual fuel oil is the heavy oil that remains after other fuels have been removed from crude petroleum in the refinery processes as well as crude oil that is burned as fuel.

About 90 percent of the residual fuel oil originates from various domestic origins, including the Virgin Islands. The remainder originates from overseas origins.

2. Historical Traffic. Receipts of residual fuel oil declined sharply in the early 1980's as many industrial users in the area shifted from residual fuel oil to natural gas. Charleston's receipts of residual fuel oil fell from over 3 million tons in the late 1970's to 492,800 tons in 1982. Since 1982, receipts of residual fuel oil have leveled off at about 300,000 tons annually. Historical receipts of residual fuel oil are shown in Table E-1.

3. Projected Traffic. The Department of Energy projects growth in the Nation's consumption of residual fuel oil at an annual rate of 1.2 percent through 2010. However, local terminal operators do not expect a reversal of Charleston's declining trend in residual oil tonnage. For this reason, residual oil traffic has been held constant at the normalized 1992 tonnage level of 291,400 tons. Projected residual fuel tonnage is shown in Table E-1.

E. Lubricating Oil.

1. General. Charleston Harbor receives lubricating oil for use in manufacturing in the Charleston area and the surrounding region. Nearly all of the lubricating oil originates at sources along the Gulf Coast.

2. Historical Traffic. Historical traffic patterns have been erratic, rising from about 150,000 tons in 1970 to nearly 300,000 tons in the late 1970's; falling to just over

150,000 tons in 1983; rising sharply to 320,000 tons in 1986; and leveling off at about 270,000 tons through 1992. Despite the wide swings in tonnage levels, the general trend has been upward, with an average annual growth rate of 2.8 percent from 1970-1992.

3. Projected Traffic. The primary use of lubricating oil is as an input to manufacturing and other industrial processes. For that reason, projections of lubricating oil traffic through 2040 are based on OBERS projections of manufacturing earnings in the nine-county primary market area described above. Through 1995, lubricating oil tonnage is projected to grow at a rate 1.9 percent annually from a normalized 1992 base traffic level of 274,000 tons. Between 1995 and 2010, the growth rate is projected to be 1.0 percent annually, and 0.8 percent annually thereafter. Projected lubricating oil tonnage is shown in Table E-1.

F. Available Capacity. By 2052, petroleum product tonnage levels are projected to reach 3.7 million tons. This does not exceed maximum historical levels of petroleum product traffic. Thus, existing terminal facilities have adequate capacity to accommodate projected growth.

II. Grains

A. General. With the devastating effects of the boll weevil outbreak that began in the 1960's, farmers in South Carolina began to search for cash crops to serve as a substitute for cotton. Farmers throughout South Carolina began growing increased volumes of corn, soybeans, wheat, and other grains for export, and by the mid-1970's, grain exports from the Port of Charleston exceeded 500,000 tons.

High levels of grain production and exports have persisted despite a resurgence of cotton production. In the mid-1980's, the US Department of Agriculture started a campaign to exterminate boll weevils in South Carolina, and by 1992 the USDA had eradicated boll weevils in the state. The production of grains in South Carolina continued to grow through the early 1990's even though the state's production of cotton increased by about 50 percent during that period.

B. Historical Traffic. Annual shipments of grains from the Port of Charleston commonly exceeded 500,000 through the mid-1980's. Grain shipments declined sharply in 1986, but have followed an upward trend since then. In 1992, 310,000 tons of grains were shipped from the Port of Charleston. The primary markets for grains shipped from Charleston are Europe and the Mideast.

Both the composition and the total volume of grain exports from Charleston Harbor have fluctuated widely, reflecting the cyclical nature of the world grain market. Wheat has accounted for more than half of all the grain exported from Charleston Harbor since 1970. Soybeans have accounted for one-fourth of that total and corn for over 10 percent.

C. Projected Traffic. Projections of grain exports through 2001 are based on the WEFA Group's most recent projections of US wheat exports[3] and normalized 1992 base traffic levels of 300,000 tons. Beyond 2001, grain exports are projected to grow at the same rate as OBERS projected earnings in the farm and agricultural services sectors in the State of South Carolina.

From 1986 to 1992, the trendline in grain exports increased at a rate of over 5 percent annually. The WEFA-based projections of grain shipments grow at a rate of 2.7 percent annually through 2001. Beyond 2001, OBERS-based projections of grain shipments grow at an annual rate of 0.6 percent. Projected grain tonnage is shown in Table E-1.

Grain shipments are projected to grow from 310,000 tons in 1992 to more than 500,000 tons in 2052. Since the Port of Charleston has already demonstrated the ability to ship over 600,000 tons of grains annually with existing facilities, no capacity constraints are anticipate over the study period.

III. Coal

A. General. Coal has been exported from the Shipyard River Coal Terminal [SRCT] in Charleston since the coal terminal became operational in 1983. Currently, coal exports consist entirely of blended coal that is shipped to industrial users in Europe and Latin America. Most of the coal comes from mines in Virginia, the remainder originating in Kentucky, Tennessee and West Virginia. The coal is shipped by rail to SRCT where it is blended and loaded onto oceangoing vessels. SRCT is served by CSX and NS railroads, and is the only deep-draft facility on the east coast that is served by two major railroads and that has on-site blending capabilities.

B. Historical Traffic. Coal exports from the Port of Charleston have followed a cyclical pattern since 1983, as is typical of coal exports in general. Most of Charleston's coal traffic consists of specialty blends of coal sold on the spot market and, because of the absence of long-term contracts, a greater degree of variance is to be expected here than in coal exports in general.

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[3] US Agriculture and World Trade Long-Term Projections, The WEFA Group, No. 2, November 1992, Table 7-1, pp 6.40-6.41.

Charleston's coal traffic has in fact varied widely since 1983, with pronounced peaks and troughs. Most recently, coal exports have declined from a peak of 1.2 million tons in 1991 to 782,000 tons in 1992. However, this trough was short-lived, and preliminary data indicate that coal exports in 1994 totaled about 1 million tons. The smoothed trendline shows that coal exports have increased at a rate of about 5 percent annually from 1983 to 1992.

C. Projected Traffic. WEFA projections of total US coal exports[4] are very similar to those projected by the Department of Energy[5], projecting coal exports to grow at a rate of 3.8 percent annually through 2003, and at a rate of 1.3 percent annually from 2003 to 2013. The WEFA growth rates were applied to a normalized 1992 base traffic level of 982,000 tons to project coal exports from Charleston Harbor. Projected coal tonnage is shown in Table E-1. Coal exports are projected to increase from 1.0 million tons in 1993 to 1.5 million tons in 2005, and 2.8 million tons in 2052. Existing facilities can handle up to 4 million tons of coal annually[6].

IV. Other Bulk Commodities

Gypsum, gravel, and asphalt are also received at the SRCT for use in local construction. The gypsum that is received is used in the production of cement. In 1992, about 300,000 tons of these commodities were received at the SRCT. However, these commodities are shipped using a dedicated fleet, none of which would benefit from deepening the channel. For this reason, no further evaluation of this traffic will be conducted.

Early in 1995, NUCOR Steel announced plans to construct a mini-mill on the Cooper River about 9 miles upstream from the federally maintained channel. Initially, this mill is expected to produce 1.8 million tons of flat-rolled steel, using 1.6 million tons of scrap and 400,000 tons of iron carbide.

Projections of iron carbide tonnage are based on OBERS projections of earnings in durable manufacturing in South Carolina. Iron carbide receipts are projected to grow at an annual rate of 1.0 percent through 2010, and 0.8 percent annually thereafter. Projected iron carbide tonnage is shown in Table E-1.

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[4] US Long-Term Economic Outlook, Volume 1, Trend/Moderate Growth Scenario, 3rd Quarter 1994, The WEFA Group.

[5] 1994 Annual Energy Outlook, US Department of Energy, Table B-15.

[6] Lloyd's Ports of the World: 1994, Lloyd's of London Press.

The scrap will be shipped on ocean barges and will not benefit from the deeper channel. NUCOR is presently shipping iron carbide from Trinidad to its mills along the Mississippi and Ohio Rivers using 42' draft self-unloading vessels, and transloading the cargo to river barges in New Orleans. NUCOR is considering the use of these same 42' draft vessels to transport iron carbide to Charleston, transloading the cargo to ocean barges at the upper limits of the federally maintained project.

V. Containerized Cargo

A. General. Charleston Harbor is a modern intermodal transportation hub, shipping and receiving containerized cargo from around the world. Measured in TEU's of throughput, Charleston Harbor is the second largest container cargo port on the East and Gulf coasts-- New York/New Jersey is the largest-- and the sixth largest in the nation. The average net crane production is second only to Yokohama among container ports worldwide[7].

A wide variety of commodities are shipped in containers. Charleston's most important containerized exports, by tonnage, are chemical products, plastics, clays and refractory materials, textiles, machinery, paper products, wood pulp, and rough wood. The most important containerized imports, by tonnage, are chemicals, machinery and textiles. In 1992, Charleston Harbor handled 6.3 million tons of containerized cargo, about 65 percent of which was export traffic. With the completion of additional berthing space and landside facilities in 1995, Charleston has the capacity to handle about 12 million tons of containerized cargo annually.

Containerized cargo is handled at three terminals: North Charleston Terminal, Columbus Street Terminal and Wando Terminal. These terminals provide about 1.5 miles of berthing space, 18 container cranes, 7 traveling bridge cranes, and 36 top-lift cranes. The North Charleston and Columbus Street terminals have rail and truck access; the Wando Terminal has truck access only. All three terminals are served by 40' navigation channels.

The South Carolina State Ports Authority (SCSPA) has purchased land on Daniel Island to develop a fourth container terminal, to be constructed in several phases, with a total annual capacity of 25 million tons. The 800-acre site was acquired in 1992 at a cost of about $12 million and provides 20,000 feet of waterfront. The initial phase of construction will provide facilities that are roughly equivalent in capacity to the North Charleston Terminal. The SCSPA plans to construct about 2,000 linear feet of berthing

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[7] "Production Values," Port Development International, October 1995, pp. 45-47.

space, to be served by six post-Panamax cranes. Plans also include a container marshaling area of about 100 acres in size, a multi-lane gate complex, and a container freight station to pack and unpack containers. The new terminal will have both rail and truck access. If a turning basin is economically justified, it will be constructed at the same time as the berthing areas. Constructing the turning basin at the same time as the berthing areas will cut mob/demob costs in half; any potential gains of deferred construction will be more than offset by the additional mob/demob costs.

The initial utilization of these facilities will be fairly high. Contract negotiations with prospective users will be conducted during construction to facilitate immediate occupancy upon the completion of the terminal. A similar process enabled shippers to move into the new facilities at the Wando Terminal a few days after construction was completed. The initial phase of construction is scheduled to be operational by 2003. The total project is scheduled to be completed over a 15 to 20-year period and will provide 8,000 feet of continuous berthing space.

The Columbus Street Terminal is located on the east side of Charleston's peninsula, just below Drum Island, on the right bank of the Cooper River. The North Charleston Terminal is located on the right bank of the Cooper River, immediately downstream from Goose Creek. The Wando Terminal is located on the left bank of the Wando River, about one mile above its confluence with the Cooper River. The site for the new Daniel Island Terminal is located on the left bank of the Cooper River just upstream from Shipyard River. Figure E-1 shows Charleston Harbor and the location of major terminals.

Domestic cargo moving on US flag vessels accounts for a small part of Charleston's containerized traffic. No benefits were claimed for this traffic, which moves on small vessels whose use is not constrained by the current depth of Charleston Harbor. Import/export tonnage is about evenly split between Pacific and European trade routes. Containerized cargo vessels are Charleston Harbor's only significant users of the Panama Canal.

B. Historical Traffic. Containerized cargo was first shipped from Charleston Harbor in the late 1960's. Container tonnage grew dramatically, from less than 100,000 tons in 1968 to 600,000 tons in 1972, 1.8 million tons in 1980, and 6.3 million tons in 1992. Between 1982 and 1989, containerized tonnage grew at an annual rate of almost 19 percent. As can be seen in Table E-2, the annual tonnage of containerized cargo grew very little between 1989 and 1992. Slow growth of containerized traffic, which continued through 1993, was the result of a variety of factors. However, since 1993, rapid growth of container traffic has resumed. Container traffic increased about 15 percent to about 7.5 million tons in 1994 and preliminary data indicate that container traffic continues to grow rapidly in 1995.

This rapid growth has been facilitated by an aggressive program of construction and marketing by the SCSPA. The recent completion of the Wando Terminal extension added nearly 1,400 feet of berthing space and 66 acres of marshaling area. Existing shippers moved from the Columbus Street Terminal to the newly completed facilities at the Wando Terminal in April 1995. A new shipping consortium began using the Columbus Street Terminal that same month.

Plans are underway to construct a fourth container cargo terminal. The SCSPA has purchased approximately 800 acres on Daniel Island for use in developing a large container terminal. Construction of the new Daniel Island Terminal will be completed in several phases, as capacity is needed. The final phases of the project are expected to be complete by the year 2015, adding a total annual capacity of 25 million tons.

Table E-2
Charleston Harbor Study
Historical and Projected
Containerized Cargo Traffic, 1980 - 2050
[Thousands of Tons]

Historical		Projected	
Year	1,000 Tons	Year	1,000 Tons
1980	1,819.2	1997	8,951.7
1981	1,669.8	2002	11,368.7
1982	1,869.9	2012	17,527.4
1983	2,038.2	2022	21,607.6
1984	2,781.7	2032	24,295.5
1985	3,092.8	2042	27,323.8
1986	3,687.7	2052	30,735.9
1987	4,510.1		
1988	5,611.9		
1989	6,190.5		
1990	6,373.9		
1991	6,232.7		
1992	6,310.8		

Source: South Carolina State Ports Authority and computations by the Charleston District, US Army Corps of Engineers.

C. Projected Traffic. In recent studies by DRI/McGraw-Hill, container cargo in the South Atlantic is projected to grow at a rate of 5.3 percent annually through 2010, and 2.4 percent annually from 2010 to 2050.[8] In the 1993 World Sea Trade Service (WSTS) report, DRI/McGraw-Hill projects growth of 5.1 percent annually through 2010 for Charleston Harbor's containerized cargo.[9]

In this analysis, projections of containerized tonnage through 2010 are based on an application of the WSTS growth rate (5.1 percent) to normalized 1992 tonnage levels of 6,675,000 tons. Tonnage levels from 2010 to 2020 are based on the DRI/McGraw Hill projected growth rate for 2010 to 2050 (2.4 percent). Beyond 2020, containerized cargo is projected to grow at a rate of 1.2 percent annually-- half that projected by DRI/McGraw-Hill. This lower growth rate was used so that future tonnage levels do not exceed the capacity of existing and currently planned terminal facilities. Projected growth through 2052 is equivalent to an average annual growth rate of 2.7 percent from 1992 to 2052.

These growth rates indicate continued substantial growth in container cargo into the near future. Containerized cargo is projected to reach 10 million tons by the year 2000 and 15 million tons by the year 2008. However, historical growth rates from 1982 to 1992 (13 percent annually) greatly exceed projected growth rates. In 1994, the actual tonnage of containerized cargo exceeded projected tonnage levels. Sharp growth is expected in 1995 as Sea-Land moves to the newly constructed facilities at the Wando Terminal and a new shipping consortium moves into Sea-Land's space at the Columbus Street Terminal.

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[8] The Future Market for Containership Traffic in the South Atlantic Region of the United States; US Army Corps of Engineers and the US Department of Transportation, MARAD; June 1993.

[9] From Charleston Navy Base Reuse Plan, Final Technical Report; Vickerman, Zachary, and Miller Consultants; June 1994.

VI. Summary and Conclusions

The volume of containerized cargo shipped and received in Charleston Harbor is projected to grow substantially over the period of analysis, while more modest growth is projected in bulk cargo. Containerized cargo is projected to grow at an average annual rate of 2.7 percent from 1992 and 2052; bulk traffic is projected to grow at an average annual rate of 1.4 percent over the same period.

Containerized cargo grew at an annual rate of about 19 percent from 1982 to 1989. After four years of slow growth in the early 1990's, rapid growth of traffic has resumed. Container traffic increased about 15 percent to about 7.5 million tons (about 800,000 TEU's) in 1994 and preliminary data indicate that container traffic continues to grow rapidly into 1995. The development of a the new terminal on Daniel Island will accommodate all projected future growth of containerized cargo. Projected growth of container traffic through 2052 is equivalent to an average annual growth rate of 2.7 percent from 1992 to 2052.

Recent growth in total bulk traffic has been slow and erratic, largely due to two important historical phenomena. Most important was the shift by many industrial users of residual fuel oil to natural gas that began in the late 1970's. Shipments of residual fuel oil declined dramatically, from over 1 million tons in 1980 to current levels ranging from 250,000 to 400,000 tons. A second important influence was the increased efficiency of automobiles, which depressed the growth of gasoline and other fuels. Total bulk traffic declined in the late 1970's and early 1980's. Since 1982, total bulk traffic has ranged from 2.7 million tons to 3.6 million tons.

Regression analysis was used to develop a trendline for comparison with historical and projected traffic levels. Tonnages for residual fuel oil and iron carbide were excluded from this comparison because no growth is projected for residual fuel oil and iron carbide is a new commodity that is not represented in the historical time-series data. The resulting trendline is a simple linear model of the form:

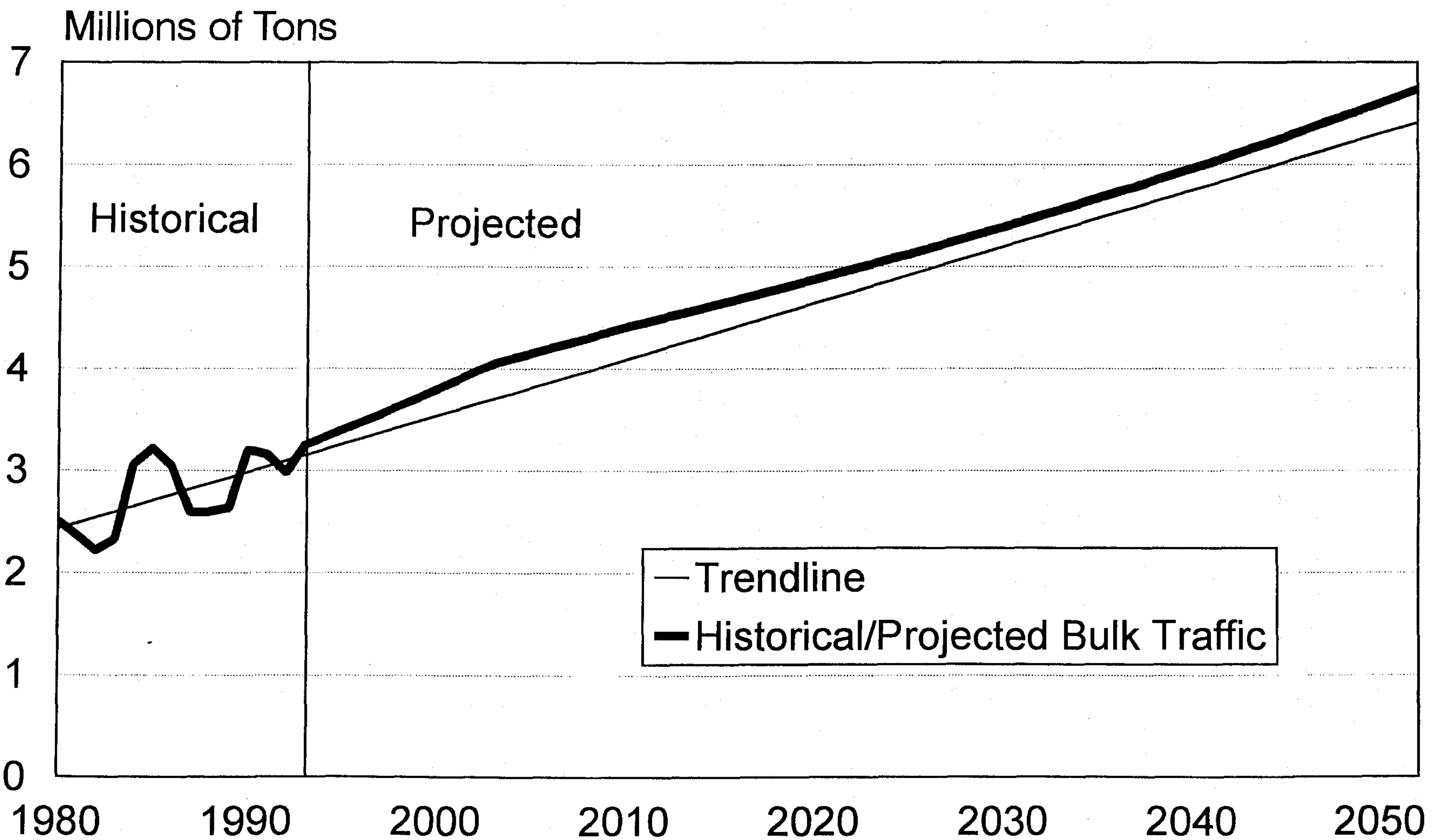
$$y = mx + b,$$

where y = annual tonnage,
x = year,
$m = 55{,}308$, and
$b = -1.1 \times 10^{8}$.

Historical bulk traffic totals are shown in Figure E-2, with the projected growth and the trendline.

Figure E-2

Charleston Harbor Study
Historical and Projected Bulk Traffic



Excludes Residual Fuel Oil and Iron Carbide Tonnage

The projections of bulk traffic levels described at the beginning of this section are about 250,000 tons higher than the trendline throughout the period of analysis. This slight difference is not unreasonable since traffic growth shown in the historical time-series was depressed by efficiency gains in the use of gasoline and other fuels, while further efficiency gains of this magnitude are not likely.

Section 2. Historical and Projected Fleets

I. Petroleum Tankers

Descriptions of petroleum tankers calling on Charleston Harbor were obtained from pilots' logs and Lloyd's Register of Ships. The design drafts of petroleum tankers calling on Charleston ranged from 31 feet to 44 feet, as shown in Table E-3. About 40 percent of the vessels had design drafts of 35 feet to 37 feet. Nearly half had design drafts in excess of 37 feet, with more than a fourth of all vessels at 42 feet. This distribution is not projected to change over the planning horizon without increases in channel depth.

Increases in channel depth are not projected to affect vessels with a design drafts less than 38 feet because most of these vessels originate from ports on the Gulf Coast whose depth will not allow the use of larger vessels. For larger vessels, design drafts are projected to shift upward for the 41 and 42-foot channel plans. Because of depth constraints at shipping ports and other ports on the itineraries of the petroleum tankers calling on Charleston, the fleet distribution associated with the 42-foot channel is not projected to change with greater channel depths. Incremental petroleum benefits associated with the 43 to 46-foot channels are the result of reductions in tidal delays and light-loading costs.

The US Coast Guard (USCG) has ordered that single-hull petroleum tankers be phased out by 2010 and has issued a retirement schedule for single-hulled tankers that is based on the size and age of vessels. According to this schedule and the existing fleet mix, double-hulled tankers will make up 56 percent of Charleston's tanker fleet by 2002, 71 percent by 2007 and 100 percent by 2012. The projections of with and without-project petroleum tanker fleets used in this analysis reflect the USCG directive and phase-out schedule. None of the replacement ships are currently on order. Since there is no indication that the current fleet mix is uneconomical, it is assumed that the new double-hulled vessels will be equivalent in size to the single-hulled vessels they are replacing.

Table E-3
Charleston Harbor Study
Petroleum Tanker Fleet Distribution

	Percent of Vessels						
Draft	Existing	2002	2007	2017	2027	2037	2047
40' Channel							
30	0	0	0	0	0	0	0
31	5	2	2	2	2	2	2
32	1	2	2	2	2	2	2
33	0	3	3	3	3	3	3
34	9	6	6	6	6	6	6
35	16	15	15	15	15	15	15
36	9	10	10	10	10	10	10
37	16	16	16	16	16	16	16
38	5	4	4	4	4	4	4
39	0	2	2	2	2	2	2
40	5	6	6	6	6	6	6
41	3	3	3	3	3	3	3
42	27	27	27	27	27	27	27
43	1	2	2	2	2	2	2
44	1	2	2	2	2	2	2
45	0	0	0	0	0	0	0
46	2	0	0	0	0	0	0
41' Channel							
30	0	0	0	0	0	0	0
31	5	2	2	2	2	2	2
32	1	2	2	2	2	2	2
33	0	3	3	3	3	3	3
34	9	6	6	6	6	6	6
35	16	15	15	15	15	15	15
36	9	10	10	10	10	10	10
37	16	16	16	16	16	16	16
38	5	1	1	1	1	1	1
39	0	5	5	5	5	5	5
40	5	2	2	2	2	2	2
41	3	7	7	6	6	6	6
42	27	5	5	4	4	4	4
43	1	21	21	22	22	22	22
44	1	2	2	3	3	3	3
45	0	2	2	2	2	2	2
46	2	1	1	1	1	1	1
42' - 46' Channels							
30	0	0	0	0	0	0	0
31	5	2	2	2	2	2	2
32	1	2	2	2	2	2	2
33	0	3	3	3	3	3	3
34	9	6	6	6	6	6	6
35	16	15	15	15	15	15	15
36	9	10	10	10	10	10	10
37	16	16	16	16	16	16	16
38	5	1	1	1	1	1	1
39	0	1	1	1	1	1	1
40	5	5	5	5	5	5	5
41	3	2	2	2	2	2	2
42	27	7	7	6	6	6	6
43	1	5	5	4	4	4	4
44	1	21	21	22	22	22	22
45	0	2	2	3	3	3	3
46	2	2	2	2	2	2	2

Source: 1993 Pilots Logs and calculations by the Charleston District.

II. Dry Bulk Carriers

A. Grains. A listing of the vessels used to export grains from Charleston was obtained from pilots logs. These data were supplemented with information obtained from Lloyd's Register of Ships and the South Carolina Farm Bureau Marketing Association [FBMA], who operates Charleston's grain terminal. In 1993, design drafts ranged from 30 feet to 41 feet. About 25 percent of the vessels had design drafts of 34 feet to 36 feet. Another 30 percent had design drafts of 40 feet to 41 feet.

According to the FBMA, this distribution is projected to change over the planning horizon without increases in channel depth, as shown in Table E-4. Increases in channel draft are projected to result in increased use of large vessels already calling on the harbor and the addition of a small number of vessels with a design draft of 42 feet.

More than 70 percent of the grains is destined for Europe, the Mideast, and the Far East, where the depth alongside grain terminals usually exceeds the greatest depth considered for Charleston Harbor in this study. Important grain importing terminals include Antwerp, Belgium (55 feet); Amsterdam, Netherlands (49 feet); Rotterdam, Netherlands (48 feet); La Havre, France (52 feet); Haifa, Israel (44 feet); Ningbo, China (59 feet); and Ghent, Belgium (44 feet). One-way distances to these ports range from 3,800 miles to Rotterdam, 5,600 miles to Haifa, and 10,800 miles to Ningbo; the tonnage-weighted average distance is 5,100 miles.

B. Coal. A wide variety of specialty coal is exported from the Shipyard River Coal Terminal (SRCT), predominantly for metallurgical and other industrial uses. The SRCT is located on the Shipyard River, about a half-mile from the main channel of the Cooper River. The Shipyard River is maintained at its authorized depth of 38 feet.

A listing of the vessels used to export coal from Charleston was obtained from pilots logs. These data were supplemented with information obtained from Lloyd's Register of Ships to describe the existing fleet, which is shown in Table E-5.

A small volume of stoker coal is currently shipped in a dedicated fleet of small vessels with design drafts of 32 and 33 feet. The use of these vessels to ship stoker coal is not projected to increase over time-- all growth in stoker coal traffic will be allocated to larger vessel classes. The declining share of 32 and 33-foot draft vessels over time is equivalent to a constant absolute number of vessel calls.

Table E-4
Charleston Harbor Study
Grain Vessel Fleet Distribution
(Percent of Vessels)

Draft	Existing	2002	2007	2017	2027	2037	2047
<u>40' Channel</u>							
30	6	6	5	4	3	2	2
31	5	5	4	3	3	2	2
32	5	5	4	3	2	2	2
33	7	7	6	5	4	4	4
34	17	17	16	15	14	14	14
35	8	8	7	6	5	5	5
36	8	8	9	10	11	12	12
37	5	5	6	7	8	9	9
38	5	5	6	7	8	8	8
39	4	4	5	6	6	6	6
40	15	15	16	17	18	18	18
41	15	15	16	17	18	18	18
42	0	0	0	0	0	0	0
<u>41' Channel</u>							
30	6	5	4	3	2	1	1
31	5	5	4	3	2	2	2
32	5	4	3	2	2	2	2
33	7	7	6	5	4	3	3
34	17	14	13	12	11	11	11
35	8	7	6	5	5	4	4
36	8	8	9	10	11	12	12
37	5	6	7	8	8	9	9
38	5	6	6	7	8	8	8
39	4	4	5	6	6	6	6
40	15	16	17	18	19	19	19
41	15	16	17	18	19	19	19
42	0	2	3	3	3	4	4
<u>42' Channel</u>							
30	6	4	2	1	0	0	0
31	5	4	3	2	1	1	1
32	5	4	3	2	2	1	1
33	7	6	5	4	3	2	1
34	17	11	10	9	8	7	7
35	8	7	6	5	4	3	3
36	8	8	9	10	11	12	13
37	5	6	7	8	9	10	10
38	5	6	7	8	9	9	9
39	4	5	6	6	6	7	7
40	15	17	18	19	20	20	20
41	15	17	18	19	20	20	20
42	0	5	6	7	7	8	8

Table E-4
Charleston Harbor Study
Grain Vessel Fleet Distribution, Cont.
(Percent of Vessels)

Draft	Existing	2002	2007	2017	2027	2037	2047
<u>43' Channel</u>							
30	6	3	1	1	0	0	0
31	5	4	3	2	1	1	1
32	5	4	3	2	2	1	1
33	7	6	5	4	3	1	1
34	17	8	8	7	5	4	4
35	8	7	6	5	4	3	3
36	8	8	9	10	11	11	11
37	5	6	7	7	9	11	11
38	5	6	7	8	9	9	9
39	4	5	6	7	7	7	7
40	15	18	18	19	20	21	21
41	15	18	19	19	20	21	21
42	0	7	8	9	9	10	10
<u>44' Channel</u>							
30	6	2	0	0	0	0	0
31	5	3	2	1	0	0	0
32	5	3	2	1	2	0	0
33	7	5	4	3	2	0	0
34	17	6	5	4	3	1	1
35	8	6	5	4	3	1	1
36	8	8	9	10	11	11	11
37	5	7	8	9	10	11	11
38	5	7	8	9	10	10	10
39	4	6	7	8	8	8	8
40	15	19	20	20	20	22	22
41	15	19	20	20	20	23	23
42	0	9	10	11	11	13	13
<u>45' & 46' Channels</u>							
30	6	1	0	0	0	0	0
31	5	2	1	0	0	0	0
32	5	2	1	0	0	0	0
33	7	4	3	2	1	0	0
34	17	5	3	1	0	0	0
35	8	5	4	4	3	0	0
36	8	8	9	9	9	9	9
37	5	8	9	10	10	10	10
38	5	8	9	10	10	11	11
39	4	7	7	8	9	9	9
40	15	20	21	21	22	23	23
41	15	20	21	21	22	23	23
42	0	10	12	14	14	15	15

Source: Pilots logs, Lloyd's <u>Register of Ships</u>, SC Farm Bureau Marketing Association, and computations by the Charleston District.

Table E-5
Charleston Harbor Study
Coal Vessel Fleet Distribution
(Percent of Vessels)

Draft	Existing	2002	2007	2012	2017	2027
40’ Channel						
32	10	9	9	8	7	6
33	4	4	4	4	4	4
34	7	7	7	7	7	7
35	7	7	7	7	7	7
36	27	18	8	6	6	6
37	5	5	3	3	3	3
38	7	18	22	25	26	27
39	7	6	5	4	4	4
40	2	2	5	6	6	6
41	2	2	5	5	5	5
42	4	4	4	4	4	4
43	4	4	7	7	7	7
44	7	7	7	7	7	7
45	0	0	0	0	0	0
46	0	0	0	0	0	0
47	7	7	7	7	7	7
41' Channel						
32	10	9	9	8	7	6
33	4	4	4	4	4	4
34	7	7	7	7	7	7
35	7	7	7	7	7	7
36	27	18	8	6	6	6
37	5	5	3	3	3	3
38	7	6	5	4	4	4
39	7	18	22	25	26	27
40	2	2	5	6	6	6
41	2	2	5	5	5	5
42	4	4	4	4	4	4
43	4	4	7	7	7	7
44	7	7	7	7	7	7
45	0	0	0	0	0	0
46	0	0	0	0	0	0
47	7	7	7	7	7	7
42' Channel						
32	10	9	9	8	7	6
33	4	4	4	4	4	4
34	7	7	7	7	7	7
35	7	7	7	7	7	7
36	27	18	8	6	6	6
37	5	5	3	3	3	3
38	7	6	5	4	4	4
39	7	6	5	4	4	4
40	2	14	22	25	26	27
41	2	2	5	7	7	7
42	4	4	4	4	4	4
43	4	4	7	7	7	7
44	7	7	7	7	7	7
45	0	0	0	0	0	0
46	0	0	0	0	0	0
47	7	7	7	7	7	7

Table E-5
Charleston Harbor Study
Coal Vessel Fleet Distribution, Cont.
(Percent of Vessels)

Draft	Existing	2002	2007	2012	2017	2027
<u>43' Channel</u>						
32	10	9	9	8	7	6
33	4	4	4	4	4	4
34	7	7	7	7	7	7
35	7	7	7	7	7	7
36	27	18	8	6	6	6
37	5	5	3	3	3	3
38	7	6	5	4	4	4
39	7	6	5	4	4	4
40	2	2	5	7	7	7
41	2	14	22	25	26	27
42	4	4	4	4	4	4
43	4	4	7	7	7	7
44	7	7	7	7	7	7
45	0	0	0	0	0	0
46	0	0	0	0	0	0
47	7	7	7	7	7	7
<u>44' Channel</u>						
32	10	9	9	8	7	6
33	4	4	4	4	4	4
34	7	7	7	7	7	7
35	7	7	7	7	7	7
36	27	18	8	6	6	6
37	5	5	3	3	3	3
38	7	6	5	4	4	4
39	7	6	5	4	4	4
40	2	2	5	5	5	5
41	2	2	5	7	7	7
42	4	14	22	25	26	27
43	4	6	6	6	6	6
44	7	7	7	7	7	7
45	0	0	0	0	0	0
46	0	0	0	0	0	0
47	7	7	7	7	7	7
<u>45' & 46' Channels</u>						
32	10	9	9	8	7	6
33	4	4	4	4	4	4
34	7	7	7	7	7	7
35	7	7	7	7	7	7
36	27	18	8	6	6	6
37	5	5	3	3	3	3
38	7	6	5	4	4	4
39	7	6	5	4	4	4
40	2	2	5	5	5	5
41	2	2	5	7	7	7
42	4	6	6	6	6	6
43	4	14	22	25	26	27
44	7	7	7	7	7	7
45	0	0	0	0	0	0
46	0	0	0	0	0	0
47	7	7	7	7	7	7

Source: Pilots logs, Lloyd's <u>Register of Ships</u>, and computations by the Charleston District.

Under existing conditions, just over a quarter of the coal vessels have design drafts of 36 feet. These vessel require 2 feet of tidal advantage when fully loaded to provide the required four feet of underkeel clearance in Shipyard River. With increased project depth, these vessels are projected to be displaced by vessels making similar use of the available channel depth. No other changes in future coal fleets are projected to occur.

More than 80 percent of the coal is destined for Europe, where the depth alongside coal terminals usually exceeds the greatest depth considered for Charleston Harbor in this study. Important coal importing terminals include Antwerp, Belgium (55 feet); Amsterdam, Netherlands (49 feet); Rotterdam, Netherlands (48 feet); La Havre, France (52 feet); Ghent, Belgium (44 feet); Porsgrunn, Norway (49 feet); and Bourgas, Bulgaria (36 feet). One-way distances to these ports range from 3,800 miles to Rotterdam, 5,500 miles to Bourgas, and 4,300 miles to Porsgrunn; the tonnage-weighted average distance is 4,300 miles.

C. Iron Carbide. NUCOR steel currently ships iron carbide from its production plant in Trinidad using 42-foot draft, self-unloading bulk vessels. These vessels transload the iron carbide into 9 foot river barges in New Orleans for shipment to NUCOR mini-mills located in Arkansas and Indiana. These same vessels are projected to ship iron carbide to NUCOR's mini-mill on the Cooper River, transloading to ocean barges at the extreme upstream limits of the federally-maintained project. No changes are projected in this dedicated fleet of vessels over the study period, with or without increased channel depth.

III. Container Vessels

A. Pacific Trade Routes. Descriptions of container vessels calling on Charleston en route to the Pacific Ocean and Asia were obtained from pilots' logs and Lloyd's Register of Ships. All of these vessels must transit the Panama Canal and thus, no post-Panamax vessels are found in this segment of the fleet. Design drafts range from 34 feet to 44 feet. Three-fourths of the vessels have design drafts of 37 feet, 38 feet or 44 feet. Charleston is usually the last port of call before the vessels pass through the Panama Canal.

Charleston's major container cargo services have more than 50 new ships on order for use in their operations worldwide. Interviews conducted with operations and planning personnel from the North American headquarters of these carriers indicate that eight of the container vessels on order will call on Charleston, each making several calls per year. All eight ships have design drafts of 41 feet. These new vessel calls were added to those recorded in the 1993 pilot's logs to develop the fleet distribution shown in Table E-6.

Because of the constraint imposed by the Panama Canal, this distribution is not projected to change in response to increases in channel depth. The Panama Canal, which cannot accommodate vessels whose drafts exceed 40 feet, is the most important constraint on vessel draft. Most of Charleston's Pacific trading partners can accommodate vessels with drafts exceeding 40 feet. Table E-7 shows the depth alongside container wharves at the all Pacific ports of call whose shipments and receipts account for more than 3 percent of Charleston's total container traffic.

The depth available at other U.S. ports is not likely to constrain the use of a deeper channel in Charleston. For westbound traffic, Charleston is usually the last port of call before transiting the Panama Canal. Evergreen is one of Charleston's largest carriers to the Pacific. The itinerary of the westbound Evergreen vessels that call on Charleston is: New York, Norfolk, Charleston, Tokyo, and other Pacific ports. OOCL and other shippers follow similar itineraries.

B. Atlantic Trade Routes. Descriptions of container vessels calling on Charleston in Atlantic trade were obtained from pilots' logs and Lloyd's Register of Ships. Design drafts range from 31 feet to 44 feet, with nearly half the vessels at 37 to 38 feet. Another quarter of the Atlantic fleet has design drafts of 44 feet.

The itineraries of Sea-Land vessels are typical of Charleston's Atlantic trade. Elizabeth, NJ is the first U.S. port of call for Sea-Land vessels trading with Mediterranean ports and Charleston is the last U.S. port of call. Maersk vessels call on Savannah, Jacksonville, and finally Charleston before departing to Algecirus, Spain and other Mediterranean ports.

Table E-6
Charleston Harbor Study
Vessel Fleet Distribution
Pacific Container Trade

	Percent of Vessels	
Draft	Existing	W/O Project
34	14	12
35	6	5
36	2	2
37	25	20
38	23	19
39	3	2
40	0	0
41	2	18
42	1	0
43	1	0
44	25	21

Source: Pilots Logs, Lloyd's Register of Ships, and calculations by the Charleston District.

Table E-7
Charleston Harbor Study
Major Ports of Call for
Charleston's Pacific Fleet

Port	Nation	Percent of Pacific Trade	Depth
Hong Kong	Hong Kong	15	46
Kaohsiung	Taiwan	5	46
Keelung	Taiwan	11	42
Kobe	Japan	14	46
Singapore	Singapore	22	46
Yokohama	Japan	4	43

Source: PIERS Data, and Lloyd's Ports of the World.

For Sea-Land vessels trading with northern Europe, Charleston is the first and last port of call, with intermediate stops at other U.S. ports. The OOCL itinerary is Savannah, Jacksonville, Charleston, and Rotterdam, followed by other ports in northern Europe.

COSCO ships to the Pacific rim by way of the Atlantic Ocean, the Mediterranean Sea, and the Suez Canal. The itinerary for these vessels is New York, Baltimore, Charleston, Haifa, and Singapore, followed by other Pacific ports.[10]

Vessels with design drafts of 37 to 38 feet can use the existing 40-foot channel with minimal tidal delay and light-loading[11]. About 40 percent of these vessels are deployed in eastbound round-the-world (RTW) trade and must transit the Panama Canal. Although the Panama Canal does not constrain the loading of vessels in transit from the US to Europe, it does constrain the loadings further on in the itinerary. For this reason, 37 to 38-foot draft vessels used in eastbound RTW trade are not projected to be replaced by larger vessels with a deeper harbor in Charleston.

The remainder of the 37 to 38-foot draft vessels are used in North Atlantic trade routes, primarily between the east coast of North America to northern Europe and the Mediterranean. With increased channel depth, these vessels are projected to be replaced by larger, more efficient vessels, with the design drafts of replacement vessels increasing 1 foot for each additional foot of channel depth. Because Charleston is almost always the last port of call, these vessels can be fully loaded in trans-Atlantic trade without improvements at other US ports.

In the past, it took five to seven years to design, construct and deploy a ship. This can now be accomplished in 18 months or less. For this reason, the introduction of larger containerships is projected to occur as the older ships retire. Since nearly all of the 37 to 38 foot vessels will reach retirement age between 2002 and 2012, all of the fleet changes are projected to occur during that period of time.

A single set of vessel fleet projections for 41 to 46-foot channels, shown in Table E-8, were used to compute transportation costs in 2012 and in all years thereafter. The vessel fleet distribution shown for the 40-foot channel is the without-project fleet and was used for all channel plans in 2002.

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[10] Journal of Commerce, 2 January 1996.

[11] Shippers are reluctant to make extensive use of tidal advantage and have displayed a willingness to spend thousands of dollars for extra laborers and equipment in order to expedite their departure by one or two hours.

Table E-8
Charleston Harbor Study
Vessel Fleet Distribution
Atlantic Container Trade

	Percent of Vessels by Channel Depth					
Draft	Existing	41	42	43	44	45/46
31	3	3	3	3	3	3
32	6	6	6	6	6	6
33	1	1	1	1	1	1
34	4	4	4	4	4	4
35	4	4	4	4	4	4
36	6	6	6	6	6	6
37	23	9	9	9	9	9
38	24	23	9	9	9	9
39	3	17	17	3	3	3
40	1	1	15	15	1	1
41	0	0	0	15	14	0
42	0	0	0	0	14	14
43	0	0	0	0	0	15
44	24	24	24	24	24	24

Source: Pilots Logs, Lloyd's Register of Ships, and calculations by the Charleston District.

Table E-9 shows the depth alongside container wharves at the all Atlantic ports of call whose shipments and receipts account for more than 3 percent of Charleston's total container traffic.

C. Light-Loading Practices. Special consideration was given to the light-loading practices of container vessels. Container vessels sometimes sail fully loaded, but are usually light-loaded to some degree. Sailing drafts are a function of the design draft of the vessel, channel depth, variance in the density of the contents of containers, and other factors.

The average loading of container vessels in Charleston is just over 600 TEU's per vessel. The cranes and other loading equipment used in Charleston are among the most efficient in the world, with loading rates of about 31 containers per minute per crane. In this regard, Charleston is second only to Yokohama, Japan[12].

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[12] "Production Values," Port Development International, October 1995, pp. 45-47.

Table E-9
Charleston Harbor Study
Major Ports of Call for Charleston's Atlantic Fleet

Port	Nation	Percent of Atlantic Trade	Depth
Algeciras	Spain	6	46
Antwerp	Belgium	10	55
Bremerhaven	Germany	11	46
Felixstowe	England	10	44
La Havre	France	4	44
La Spezia	Italy	8	38
Rotterdam	Netherlands	24	45
Thamesport	England	4	44
Valencia	Spain	5	46

Source: PIERS Data, and Lloyd's Ports of the World.

Table E-10
Charleston Harbor Study
Actual Sailing Drafts of Container Vessels

Sailing Draft	Design Draft								
	37	38	39	40	41	42	43	44	Total
40					1				1
39					3			1	4
38		21			4			9	34
37		20	3	1	8			30	62
36		47	4		4			34	89
35	2	44	2	5	5			53	111
34		61	1	5	8			48	123
33	4	66	7	5	8			19	109
32		71	3	1	9			8	92
31	2	65	3	2	4				76
30		72		1					73
29		45							45
28		18							18
Total	8	530	23	20	54	0		202	837

Source: Pilots Logs, Fairplay data base, and computations by the Charleston District.

The actual sailing drafts of vessels that call on Charleston Harbor were obtained from the pilots' logs. These logs contain the name and type of vessel, direction of transit [inbound/outbound], actual sailing draft, and the date and time of arrival or departure. Design drafts for the vessels named in the pilots' logs were obtained from the Fairplay data base developed by IWR. Records for vessels whose names were not found in the Fairplay data base were deleted, and the distribution shown in Table E-10 was computed.

For many of the vessel sizes shown in Table E-10, only a few complete records were contained in the data derived from the pilots' logs and the Fairplay database. For this reason, the distributions for 38-foot and 44-foot vessels were used as described below to estimate the light-loading for other vessel sizes.

Using the spring tide, vessels whose design drafts are 40 feet or less are not physically constrained by the existing 40-foot channel-- the spring tide gives these vessels the required 4-feet of underkeel clearance even when fully loaded. Sailing drafts for these vessels were estimated by equating the level of light-loading to that recorded in the pilots' logs for 38-foot design draft vessels as shown in Table E-11. Atlantic and Pacific-bound container vessels with design drafts of 40-feet or less were treated similarly. Since channel depth is not a constraint to these vessels, the distributions derived in this manner are not projected to change with increases in channel depth except to reflect the limited availability of Spring Tides.

For vessels whose design drafts are greater than 40 feet, loadings are not constrained by the design draft of the vessel. Sailing drafts for these vessels were estimated by using the distribution of sailing drafts for 44-foot design draft vessels. Light-loading distributions for Atlantic and Pacific-bound container vessels were computed separately to account for the constraint imposed by the Panama Canal on Pacific-bound vessels.

The without-project sailing drafts of 41 to 44-foot design draft vessels transiting the Atlantic are shown in Table E-12. Since channel depth is a constraint on the full use vessels with design drafts of 41-foot or more, these distributions are projected to shift upward as the channel is deepened. To illustrate this, the light-loading distribution for the 41-foot channel is also shown in Table E-12.

The only benefits claimed for Pacific-bound traffic are those attributable to the elimination of tidal delays. For scheduling purposes, operators currently do not make full use of tides in Pacific trade. The light-loading distributions for the Pacific container fleet were adjusted to reflect the maximum practical use of tides in the without-project condition, as shown in Table E-13. This distribution is not projected to change with increased project depth, except to reflect the limited availability of spring tides. These distributions also reflect the constraint imposed by the Panama Canal.

Table E-11
Charleston Harbor Study
Light-Loading of 37 to 40-Foot Design Draft Container Vessels
Atlantic and Pacific Trade, All Channel Depths

Design Draft	Feet Light	Sailing Draft	Channel Depth						
			40	41	42	43	44	45	46
37	0	37	0.040	0.040	0.040	0.040	0.040	0.040	0.040
37	1	36	0.038	0.038	0.038	0.038	0.038	0.038	0.038
37	2	35	0.089	0.089	0.089	0.089	0.089	0.089	0.089
37	3	34	0.083	0.083	0.083	0.083	0.083	0.083	0.083
37	4	33	0.115	0.115	0.115	0.115	0.115	0.115	0.115
37	5	32	0.125	0.125	0.125	0.125	0.125	0.125	0.125
37	6	31	0.134	0.134	0.134	0.134	0.134	0.134	0.134
37	7	30	0.123	0.123	0.123	0.123	0.123	0.123	0.123
37	8	29	0.136	0.136	0.136	0.136	0.136	0.136	0.136
37	9	28	0.084	0.084	0.084	0.084	0.084	0.084	0.084
37	10	27	0.033	0.033	0.033	0.033	0.033	0.033	0.033
38	0	38	0.040	0.040	0.040	0.040	0.040	0.040	0.040
38	1	37	0.038	0.038	0.038	0.038	0.038	0.038	0.038
38	2	36	0.089	0.089	0.089	0.089	0.089	0.089	0.089
38	3	35	0.083	0.083	0.083	0.083	0.083	0.083	0.083
38	4	34	0.115	0.115	0.115	0.115	0.115	0.115	0.115
38	5	33	0.125	0.125	0.125	0.125	0.125	0.125	0.125
38	6	32	0.134	0.134	0.134	0.134	0.134	0.134	0.134
38	7	31	0.123	0.123	0.123	0.123	0.123	0.123	0.123
38	8	30	0.136	0.136	0.136	0.136	0.136	0.136	0.136
38	9	29	0.084	0.084	0.084	0.084	0.084	0.084	0.084
38	10	28	0.033	0.033	0.033	0.033	0.033	0.033	0.033
39	0	39	0.010	0.040	0.040	0.040	0.040	0.040	0.040
39	1	38	0.068	0.038	0.038	0.038	0.038	0.038	0.038
39	2	37	0.089	0.089	0.089	0.089	0.089	0.089	0.089
39	3	36	0.083	0.083	0.083	0.083	0.083	0.083	0.083
39	4	35	0.115	0.115	0.115	0.115	0.115	0.115	0.115
39	5	34	0.125	0.125	0.125	0.125	0.125	0.125	0.125
39	6	33	0.134	0.134	0.134	0.134	0.134	0.134	0.134
39	7	32	0.123	0.123	0.123	0.123	0.123	0.123	0.123
39	8	31	0.136	0.136	0.136	0.136	0.136	0.136	0.136
39	9	30	0.084	0.084	0.084	0.084	0.084	0.084	0.084
39	10	29	0.033	0.033	0.033	0.033	0.033	0.033	0.033
40	0	40	0.010	0.010	0.040	0.040	0.040	0.040	0.040
40	1	39	0.010	0.068	0.038	0.038	0.038	0.038	0.038
40	2	38	0.147	0.089	0.089	0.089	0.089	0.089	0.089
40	3	37	0.083	0.083	0.083	0.083	0.083	0.083	0.083
40	4	36	0.115	0.115	0.115	0.115	0.115	0.115	0.115
40	5	35	0.125	0.125	0.125	0.125	0.125	0.125	0.125
40	6	34	0.134	0.134	0.134	0.134	0.134	0.134	0.134
40	7	33	0.123	0.123	0.123	0.123	0.123	0.123	0.123
40	8	32	0.136	0.136	0.136	0.136	0.136	0.136	0.136
40	9	31	0.084	0.084	0.084	0.084	0.084	0.084	0.084
40	10	30	0.033	0.033	0.033	0.033	0.033	0.033	0.033

Source: Pilots Logs, Fairplay data base, and computations by the Charleston District.

Table E-12
Charleston Harbor Study
Light-Loading of Large Container Vessels
Atlantic Trade

Percent	41' Vessels Feet Light	41' Vessels Sailing Draft	42' Vessels Feet Light	42' Vessels Sailing Draft	43' Vessels Feet Light	43' Vessels Sailing Draft	44' Vessels Feet Light	44' Vessels Sailing Draft
40-Foot Channel								
4.0	9	32	10	32	11	32	12	32
9.4	8	33	9	33	10	33	11	33
23.8	7	34	8	34	9	34	10	34
26.2	6	35	7	35	8	35	9	35
16.8	5	36	6	36	7	36	8	36
14.9	4	37	5	37	6	37	7	37
4.5	3	38	4	38	5	38	6	38
0.5	2	39	3	39	4	39	5	39
41-Foot Channel								
4.0	8	33	9	33	10	33	11	33
9.4	7	34	8	34	9	34	10	34
23.8	6	35	7	35	8	35	9	35
26.2	5	36	6	36	7	36	8	36
16.8	4	37	5	37	6	37	7	37
14.9	3	38	4	38	5	38	6	38
4.5	2	39	3	39	4	39	5	39
0.5	1	40	2	40	3	40	4	40

Source: Pilots Logs, Fairplay data base, and computations by the Charleston District.

Table E-13
Charleston Harbor Study
Light-Loading of Large Container Vessels
Pacific Trade, All Channel Depths

Design Draft	Feet Light	Sailing Draft	Channel Depth						
			40	41	42	43	44	45	46
41	1	40	0.010	0.010	0.044	0.044	0.044	0.044	0.044
41	2	39	0.040	0.186	0.152	0.152	0.152	0.152	0.152
41	3	38	0.309	0.163	0.163	0.163	0.163	0.163	0.163
41	4	37	0.272	0.272	0.272	0.272	0.272	0.272	0.272
41	5	36	0.239	0.239	0.239	0.239	0.239	0.239	0.239
41	6	35	0.092	0.092	0.092	0.092	0.092	0.092	0.092
41	7	34	0.038	0.038	0.038	0.038	0.038	0.038	0.038
42	2	40	0.050	0.050	0.196	0.196	0.196	0.196	0.196
42	3	39	0.040	0.309	0.163	0.163	0.163	0.163	0.163
42	4	38	0.541	0.272	0.272	0.272	0.272	0.272	0.272
42	5	37	0.239	0.239	0.239	0.239	0.239	0.239	0.239
42	6	36	0.092	0.092	0.092	0.092	0.092	0.092	0.092
42	7	35	0.038	0.038	0.038	0.038	0.038	0.038	0.038
43	3	40	0.090	0.090	0.359	0.359	0.359	0.359	0.359
43	4	39	0.070	0.541	0.272	0.272	0.272	0.272	0.272
43	5	38	0.710	0.239	0.239	0.239	0.239	0.239	0.239
43	6	37	0.092	0.092	0.092	0.092	0.092	0.092	0.092
43	7	36	0.038	0.038	0.038	0.038	0.038	0.038	0.038
44	4	40	0.160	0.631	0.631	0.631	0.631	0.631	0.631
44	5	39	0.060	0.239	0.239	0.239	0.239	0.239	0.239
44	6	38	0.742	0.092	0.092	0.092	0.092	0.092	0.092
44	7	37	0.038	0.038	0.038	0.038	0.038	0.038	0.038

Source: Pilots Logs, Fairplay data base, and computations by the Charleston District.

Section 3. Vessel Operating Costs

The FY95 deep draft vessel costs published in the Economics Guidance Memorandum (EGM) 95-1 are markedly lower than those of the last several years. According to the EGM, two important factors that contributed to this decline are: (1) an influx of Malaysian labor that drove down fixed operating costs, and (2) declining fuel costs. Larger vessels are more labor-efficient and fuel-efficient than smaller vessels. Therefore, the changes described above did not affect all vessels similarly. Per ton costs for smaller vessels declined substantially, while the effect on some of the largest vessels was marginal.

Benefits from deepening a channel accrue from (1) the use of larger, more efficient vessels and (2) more efficient use of the large vessels that already call on the harbor through reductions of light-loading and tidal delay. Changing the slope of the cost curve will change estimates of the benefits that accrue from shifts to larger vessels. Changing the absolute magnitude of the cost curve will change estimates of the benefits that accrue from reductions in light-loading and tidal delay. The changes inherent in the FY95 vessel costs resulted in sharp declines in estimates of both classes of benefits.

The vessel costs published in the EGM are used by Corps analysts as indicators of the long-term cost of operating vessels. Changes that are short-term in nature should not be allowed to skew indicators of long-term trends.

There are two strong indications that the declines in fuel prices reflected in the FY95 vessel costs are not indicative of long-term trends. First, the data upon which the vessel costs are based are severely distorted by a significant, but short-run phenomena. Second, declines in petroleum prices are indicative of increasing abundance of petroleum, which is unlikely in the long-run.

The fuel costs reflected in the FY95 vessel cost computations are based upon time-series data that includes an extended slump in the price of fuel. According to the EGM, the FY95 vessel costs reflect a 17 percent reduction in fuel prices as compared with 1993 figures. Although fuel prices have declined somewhat through the 1990's, the dramatic reduction reflected in the FY95 vessel costs is largely a result of short-term forces. The fuel costs used to compute FY95 vessel costs are an average of global fuel prices over the 3-year period beginning July 1991 and ending June 1994. During 1993, oil prices reached five-year lows. This problem was caused by a gradual buildup of excess stocks through the first three quarters of the year and was exacerbated by OPEC's November 1993 announcement to maintain their output ceiling despite falling prices[13]. This resulted in a shallow but protracted trough in the price of bunkering fuels. HVO Marine Fuel prices were below average for 11 consecutive months. In December 1993, HVO prices were 27 percent below the average price of $87.20/ton. Although such cycles are common, the magnitude and duration of this trough is anomalous, affecting nearly one-third of the data in the time-series used to compute the FY95 vessel costs.

Price is an indicator of relative scarcity. The EGM states that estimates of fuel prices and thus, vessel operating costs reflect the "downward trend [in fuel prices] that has occurred in recent years." Since these vessel costs are used as indicators of the cost of operating vessels over a 50 to 60-year period, the implication that petroleum is becoming less scarce may be unrealistic.

Most bunkering fuels are residuals of the refining process. With the development of more efficient refining processes and catalysts that reduce heavier components of petroleum into lighter, more valuable products, the volume of residuals is diminishing. This trend will continue as older refineries are retired and replaced by plants using newer technologies. The price of bunkering fuels is usually about 80 percent of the price of crude oil. As residual fuels become more scarce, prices are likely to increase. This could continue until other fuels, including crude oil, become attractive substitutes. In their "Annual Energy Outlook[14]," the Department of Energy (DOE) depicts the recent downward trend in residual fuel prices in the early 1990's that is described in the 1995 EGM. However, the DOE projects substantial increases[15] in the price of residual fuel oil used in transportation through 2010. Real price increases are projected even in the "Low Oil Price" scenario.

The magnitude of the wage response to an influx of Malaysian labor into the shipping industry's labor force is probably overstated and is likely to be short-lived. The EGM notes that although other fixed operating costs have increased, "these increases are greatly overshadowed by the cheaper wage costs." However, the movement of the Pacific Rim's industrial revolution from Japan to Korea to Singapore to the Philippines is largely a result of rising wages in formerly "cheap-labor" countries and indicates that the FY95 vessel costs may significantly overstate the magnitude and persistence of the wage response to changes in the labor force.

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[13] "Global Petroleum Monthly," The WEFA Group, December 8, 1993.

[14] "Annual Energy Outlook 1994," US Department of Energy, January 1994.

[15] Prices are projected to increase at an annual rate of 4.2 percent between 1992 and 2010 in "Reference Case" projections.

In the absence of convincing evidence that the FY95 estimates of vessel costs accurately represent the long-term cost of operating vessels, we have decided to dampen the magnitude of the change reflected in those numbers by extending the time-series upon which the vessel costs are based. Our benefit evaluation reflects vessel costs that are based upon estimates of vessel costs developed for EGM's published in 1992, 1993, and 1995, expressed in 1995 dollars. These average vessel costs, shown in Table E-14, fall at the low end of the range of estimates produced from 1987 to 1993, both in the magnitude and in the slope of the cost curve.

Table E-14
Charleston Harbor Study
Hourly Vessel Operating Costs

Draft	DWT	At-Sea	In-Port
Foreign Flag Bulk Vessels			
30	20,000	$523	$423
31	22,083	536	433
32	24,167	548	443
33	26,667	563	454
34	29,444	579	466
35	32,222	594	478
36	35,000	610	490
37	38,333	628	504
38	41,852	646	519
39	45,556	666	534
40	49,259	685	549
41	53,333	706	566
42	57,500	726	582
43	62,051	749	600
44	67,179	774	620
45	72,308	798	640
46	77,436	823	659
47	82,941	849	680
Foreign Flag Container Vessels			
25	9,647	$534	$456
26	10,995	577	488
27	12,469	623	522
28	14,077	667	554
29	15,824	721	593
30	17,717	779	636
31	19,764	841	681
32	21,971	907	730
33	24,345	979	783
34	26,893	1,055	838
35	29,622	1,136	898
36	32,539	1,223	961
37	35,651	1,315	1,028
38	38,967	1,413	1,099
39	42,492	1,516	1,174
40	46,235	1,626	1,254
41	50,202	1,741	1,338
42	54,402	1,864	1,427
43	58,842	1,993	1,520
44	63,530	2,128	1,618
45	68,473	2,271	1,721
46	73,679	2,421	1,829
47	79,157	2,578	1,943
48	84,913	2,743	2,061
49	90,956	2,916	2,186
50	97,294	3,097	2,316

Table E-14
Charleston Harbor Study
Hourly Vessel Operating Costs
(Cont.)

Draft	DWT	At-Sea	In-Port
<u>US Flag Tankers, Double-Hulled</u>			
31	23,434	$1,934	$1,830
32	25,944	1,968	1,860
33	28,633	2,004	1,892
34	31,507	2,041	1,926
35	34,574	2,080	1,961
36	37,840	2,121	1,998
37	41,313	2,163	2,037
38	44,998	2,208	2,077
39	48,904	2,254	2,119
40	53,037	2,302	2,163
41	57,404	2,353	2,209
42	62,013	2,405	2,256
43	66,869	2,459	2,306
44	71,981	2,515	2,357
45	77,356	2,574	2,411
46	83,001	2,635	2,466
<u>US Flag Tankers, Single-Hulled</u>			
31	23,434	$1,844	$1,739
32	25,944	1,870	1,762
33	28,633	1,897	1,786
34	31,507	1,926	1,811
35	34,574	1,955	1,836
36	37,840	1,986	1,863
37	41,313	2,017	1,891
38	44,998	2,050	1,919
39	48,904	2,084	1,949
40	53,037	2,120	1,980
41	57,404	2,156	2,012
42	62,013	2,194	2,045
43	66,869	2,233	2,080
44	71,981	2,274	2,115
45	77,356	2,316	2,152
46	83,001	2,359	2,191

Source: Economic Guidance Memorandum, 1992 - 1995, and computations by the Charleston District.

Section 4. Benefit Analysis

I. Channel Deepening Alternatives. The benefits from deepening Charleston Harbor are measured as reductions in the future cost of transporting bulk commodities and containerized cargo. Transportation savings under with-project conditions result from the use of larger, more efficient vessels and the more efficient use of large vessels that already call on the harbor. These savings are measured by subtracting the cost of shipping commodities under with-project conditions from the cost under without-project conditions.

Transportation costs under with and without-project conditions were computed as shown in Tables E-15 and E-16. Vessel attributes, such as draft, DWT, IMF, and speed were obtained from the 1995 Economic Guidance Memorandum. Vessel operating costs were computed as described in Section 3. Round-trip distance is a weighted average, based on a detailed analysis of 1993 origins and destinations. Tidal delays were computed at one-foot increments using a sine curve and a 12.5 hour tidal cycle.

Separate transportation cost computations were performed for each commodity group. Computations for dry and liquid bulk commodities were performed as shown in Table E-15. These sample computations yield transportation costs per ton of cargo for a 37 foot dry bulk vessel when the vessel is fully loaded and one foot light.[16] Similar computations were performed for all dry and liquid bulk vessel sizes, lightloading conditions, and tidal requirements. A weighted average of these costs was computed using the projected fleet distributions and light-loading practices described in Section 2.

Special consideration was given to the light-loading practices of container vessels. Transportation cost computations for container vessels were computed as shown in Table E-16. These sample computations yield transportation costs per ton of cargo for Pacific container cargo and reflect the projected fleet distributions and the detailed evaluations of light-loading practices described in Section 2.

Transportation savings per ton of cargo were computed by comparing the per-ton weighted average transportation costs under with and without-project conditions. These per-ton savings were applied to projected traffic levels described in Section 1 to compute total savings by commodity group.

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[16] Since commodity traffic projections are expressed in short tons, DWT, IMF, and cargo capacity are also expressed in short tons in all computations.

Table E-15
Charleston Harbor Study
Sample Computations
Foreign Flag Bulk Carriers

Vessel Design Draft	37 feet
Vessel DWT	42,930 short tons
IMF (Short Tons)	113.9 short tons/ inch
Cargo, Fully Loaded	39,496 short tons
Cargo, One Foot Light	38,129 short tons
Loading Rate	1,785 tons/hour
Round-Trip Distance	8,500 nautical miles
Speed	14 knots
Maximum Tidal Delay, 1 Foot	3.47 hours
In-Port Costs	504 $/hour
At-Sea Costs	628 $/hour

Total In-Port Costs

Cargo Capacity = (Vessel DWT - 12 x IMF x Feet Light) x .92
Total In-Port Cost = (Cargo Capacity/Loading Rate) x 2 x Hourly In-Port Cost

Fully Loaded	(42,930 - (12 x 113.9 x 0 ft light) * .92 / 1,785 x 2 x 504 =	22,303
One Foot Light	(42,930 - (12 x 113.9 x 1 ft light) * .92 / 1,785 x 2 x 504 =	21,532

Total At-Sea Costs

Total At-Sea Costs = Round-Trip Distance / Speed x Hourly At-Sea Cost

Fully Loaded	8,500 / 14 x 628 =	381,286
One Foot Light	8,500 / 14 x 628 =	381,286

Tidal Delay Costs

Average Tidal Delay = (Maximum Delay^2) / 2 x Tidal Cycle
Tidal Delay Costs = (Average Delay) x Hourly In-Port Cost

Fully Loaded	(3.47 ^2) / (2 x 12.5) x 504 =	243
One Foot Light	(0.0^2) / (2 x 12.5) x 504 =	0

Total Costs

Total Costs = In-Port Costs + At-Sea Costs + Tidal Delay Costs

Fully Loaded	22,303 + 381,286 + 243 =	403,832
One Foot Light	21,532 + 381,286 + 0 =	402,817

Unit Cost

Unit Cost = Total Costs / Cargo

Fully Loaded	403,832 / 39,496 =	10.22
One Foot Light	402,817 / 38,129 =	10.56

Table E-15
Charleston Harbor Study
Sample Computations
Foreign Flag Bulk Carriers, Cont.

Year = 2002

Channel Depth = 38 feet

Tidal Advantage	Vessel Draft	Vessel Loading	Cost	Percent Commerce	Weighted Cost
NO	32.0	FULLY LOADED	13.86	8.38	1.16
NO	33.0	FULLY LOADED	12.95	3.70	.48
NO	34.0	FULLY LOADED	12.11	3.57	.43
NO	35.0	1 FT LIGHT	11.81	1.94	.23
NORMAL	35.0	FULLY LOADED	11.42	5.81	.66
NO	36.0	2 FT LIGHT	11.61	7.55	.88
NORMAL	36.0	FULLY LOADED	10.84	8.25	.89
NO	37.0	3 FT LIGHT	11.34	1.43	.16
NORMAL	37.0	1 FT LIGHT	10.56	1.67	.18
MAXIMUM	37.0	FULLY LOADED	10.22	3.32	.34
NO	38.0	4 FT LIGHT	11.09	2.14	.24
NORMAL	38.0	2 FT LIGHT	10.35	2.44	.25
MAXIMUM	38.0	FULLY LOADED	9.74	5.08	.49
NO	39.0	5 FT LIGHT	10.88	2.25	.24
NORMAL	39.0	3 FT LIGHT	10.16	2.57	.26
MAXIMUM	39.0	FULLY LOADED	9.27	5.53	.51
NO	40.0	6 FT LIGHT	10.73	.69	.07
NORMAL	40.0	4 FT LIGHT	10.01	.75	.07
MAXIMUM	40.0	1 FT LIGHT	9.13	1.65	.15
NO	41.0	7 FT LIGHT	10.58	.29	.03
NORMAL	41.0	5 FT LIGHT	9.87	.47	.05
MAXIMUM	41.0	2 FT LIGHT	9.00	2.60	.23
NO	42.0	8 FT LIGHT	10.44	.76	.08
NORMAL	42.0	6 FT LIGHT	9.74	.82	.08
MAXIMUM	42.0	3 FT LIGHT	8.88	5.44	.48
NO	43.0	9 FT LIGHT	10.32	.79	.08
NORMAL	43.0	7 FT LIGHT	9.63	.86	.08
MAXIMUM	43.0	4 FT LIGHT	8.78	5.70	.50
NO	44.0	10 FT LIGHT	10.17	1.34	.14
NORMAL	44.0	8 FT LIGHT	9.49	1.62	.15
MAXIMUM	44.0	5 FT LIGHT	8.66	10.60	.92

TOTAL WEIGHTED COST = 10.54

Table E-16
Charleston Harbor Study
Transportation Cost Computations for Pacific Container Traffic

Maximum Draft	Feet Light Loaded	Actual Draft	DWT Metric Tons	DWT Short Tons	IMF Metric Tons	IMF Short Tons	Short Tons Cargo	Knots	Nautical Miles (RT)	Hours At-Sea	Hourly At-Sea Cost	Total At-Sea Cost	Loading Rate	Time In-Port	Hourly In-Port Cost	Total In-Port Cost	Tidal Adv.	Avg. Hrs. Tidal Delay	Tidal Delay Cost	Total Cost	Cost Per S-Ton	Fleet Dist.	Weighted Tonnage	Tonnage Dist.	Weighted Cost Per S-Ton	Base Tidal Dist.	Base Fleet Dist.
31	0	31	19,764	21,800	81	89	19,600	17	11,200	659	841	554,100	833	8.51	681	5,800	No	0.00	0	559,900	28.566	0.000	0	0.0000	0.0000	1.0000	0.0000
32	0	32	21,971	24,200	86	94	21,800	17	11,200	659	907	598,000	833	9.47	730	6,900	No	0.00	0	604,900	27.748	0.000	0	0.0000	0.0000	1.0000	0.0000
33	0	33	24,345	26,800	91	100	24,100	18	11,200	622	979	608,800	833	10.47	783	8,200	No	0.00	0	617,000	25.602	0.000	0	0.0000	0.0000	1.0000	0.0000
34	0	34	26,893	29,600	96	106	26,600	18	11,200	622	1,055	656,200	833	11.55	838	9,700	No	0.00	0	665,900	25.034	0.119	3,165	0.0882	2.2091	1.0000	0.1190
35	0	35	29,622	32,700	102	112	29,400	18	11,200	622	1,136	706,700	833	12.77	898	11,500	No	0.00	0	718,200	24.429	0.046	1,349	0.0376	0.9190	1.0000	0.0459
36	0	36	32,539	35,900	107	118	32,300	18	11,200	622	1,223	760,600	833	14.03	961	13,500	No	0.00	0	774,100	23.966	0.017	539	0.0150	0.3604	1.0000	0.0167
37	0	37	35,651	39,300	113	125	35,400	18	11,200	622	1,315	817,900	833	15.38	1,028	15,800	Normal	3.24	11,792	845,492	23.884	0.008	290	0.0081	0.1929	0.0400	0.2046
37	1	36	35,651	39,300	113	125	33,900	18	11,200	622	1,315	817,900	833	14.72	1,028	15,100	No	0.00	0	833,000	24.572	0.008	264	0.0073	0.1805	0.0380	0.2046
37	2	35	35,651	39,300	113	125	32,400	18	11,200	622	1,315	817,900	833	14.07	1,028	14,500	No	0.00	0	832,400	25.691	0.018	590	0.0164	0.4225	0.0890	0.2046
37	3	34	35,651	39,300	113	125	30,900	18	11,200	622	1,315	817,900	833	13.42	1,028	13,800	No	0.00	0	831,700	26.916	0.017	525	0.0146	0.3937	0.0830	0.2046
37	4	33	35,651	39,300	113	125	29,400	18	11,200	622	1,315	817,900	833	12.77	1,028	13,100	No	0.00	0	831,000	28.265	0.024	692	0.0193	0.5451	0.1150	0.2046
37	5	32	35,651	39,300	113	125	27,900	18	11,200	622	1,315	817,900	833	12.12	1,028	12,500	No	0.00	0	830,400	29.763	0.026	714	0.0199	0.5920	0.1250	0.2046
37	6	31	35,651	39,300	113	125	26,400	18	11,200	622	1,315	817,900	833	11.47	1,028	11,800	No	0.00	0	829,700	31.428	0.027	724	0.0202	0.6341	0.1340	0.2046
37	7	30	35,651	39,300	113	125	24,900	18	11,200	622	1,315	817,900	833	10.82	1,028	11,100	No	0.00	0	829,000	33.293	0.025	627	0.0175	0.5816	0.1230	0.2046
37	8	29	35,651	39,300	113	125	23,400	18	11,200	622	1,315	817,900	833	10.16	1,028	10,400	No	0.00	0	828,300	35.397	0.028	651	0.0182	0.6425	0.1360	0.2046
37	9	28	35,651	39,300	113	125	21,900	18	11,200	622	1,315	817,900	833	9.51	1,028	9,800	No	0.00	0	827,700	37.795	0.017	376	0.0105	0.3966	0.0840	0.2046
37	10	27	35,651	39,300	113	125	20,400	18	11,200	622	1,315	817,900	833	8.86	1,028	9,100	No	0.00	0	827,000	40.539	0.007	138	0.0038	0.1557	0.0330	0.2046
38	0	38	38,967	43,000	119	132	38,700	19	11,200	589	1,413	832,000	833	16.81	1,099	18,500	Normal	3.24	13,783	864,283	22.333	0.008	301	0.0084	0.1872	0.0400	0.1942
38	1	37	38,967	43,000	119	132	37,100	19	11,200	589	1,413	832,000	833	16.11	1,099	17,700	Normal	3.24	13,213	862,913	23.259	0.007	274	0.0076	0.1775	0.0380	0.1942
38	2	36	38,967	43,000	119	132	35,500	19	11,200	589	1,413	832,000	833	15.42	1,099	16,900	No	0.00	0	848,900	23.913	0.017	614	0.0171	0.4090	0.0890	0.1942
38	3	35	38,967	43,000	119	132	34,000	19	11,200	589	1,413	832,000	833	14.77	1,099	16,200	No	0.00	0	848,200	24.947	0.016	548	0.0153	0.3811	0.0830	0.1942
38	4	34	38,967	43,000	119	132	32,400	19	11,200	589	1,413	832,000	833	14.07	1,099	15,500	No	0.00	0	847,500	26.157	0.022	724	0.0202	0.5276	0.1150	0.1942
38	5	33	38,967	43,000	119	132	30,800	19	11,200	589	1,413	832,000	833	13.38	1,099	14,700	No	0.00	0	846,700	27.490	0.024	748	0.0208	0.5730	0.1250	0.1942
38	6	32	38,967	43,000	119	132	29,200	19	11,200	589	1,413	832,000	833	12.68	1,099	13,900	No	0.00	0	845,900	28.969	0.026	760	0.0212	0.6137	0.1340	0.1942
38	7	31	38,967	43,000	119	132	27,700	19	11,200	589	1,413	832,000	833	12.03	1,099	13,200	No	0.00	0	845,200	30.513	0.024	662	0.0184	0.5628	0.1230	0.1942
38	8	30	38,967	43,000	119	132	26,100	19	11,200	589	1,413	832,000	833	11.34	1,099	12,500	No	0.00	0	844,500	32.356	0.026	689	0.0192	0.6218	0.1360	0.1942
38	9	29	38,967	43,000	119	132	24,500	19	11,200	589	1,413	832,000	833	10.64	1,099	11,700	No	0.00	0	843,700	34.437	0.016	400	0.0111	0.3837	0.0840	0.1942
38	10	28	38,967	43,000	119	132	22,900	19	11,200	589	1,413	832,000	833	9.95	1,099	10,900	No	0.00	0	842,900	36.808	0.006	147	0.0041	0.1506	0.0330	0.1942
39	0	39	42,492	46,800	126	138	42,100	19	11,200	589	1,516	893,000	833	18.29	1,174	21,500	Max	4.00	19,778	934,278	22.192	0.000	10	0.0003	0.0060	0.0100	0.0230
39	1	38	42,492	46,800	126	138	40,500	19	11,200	589	1,516	893,000	833	17.59	1,174	20,700	Normal	3.24	15,412	929,112	22.941	0.002	63	0.0018	0.0405	0.0680	0.0230
39	2	37	42,492	46,800	126	138	38,800	19	11,200	589	1,516	893,000	833	16.85	1,174	19,800	Normal	3.24	14,765	927,565	23.906	0.002	79	0.0022	0.0529	0.0890	0.0230
39	3	36	42,492	46,800	126	138	37,100	19	11,200	589	1,516	893,000	833	16.11	1,174	18,900	No	0.00	0	911,900	24.580	0.002	71	0.0020	0.0485	0.0830	0.0230
39	4	35	42,492	46,800	126	138	35,500	19	11,200	589	1,516	893,000	833	15.42	1,174	18,100	No	0.00	0	911,100	25.665	0.003	94	0.0026	0.0672	0.1150	0.0230
39	5	34	42,492	46,800	126	138	33,800	19	11,200	589	1,516	893,000	833	14.68	1,174	17,200	No	0.00	0	910,200	26.929	0.003	97	0.0027	0.0729	0.1250	0.0230
39	6	33	42,492	46,800	126	138	32,100	19	11,200	589	1,516	893,000	833	13.94	1,174	16,400	No	0.00	0	909,400	28.330	0.003	99	0.0028	0.0781	0.1340	0.0230
39	7	32	42,492	46,800	126	138	30,500	19	11,200	589	1,516	893,000	833	13.25	1,174	15,600	No	0.00	0	908,600	29.790	0.003	86	0.0024	0.0717	0.1230	0.0230
39	8	31	42,492	46,800	126	138	28,800	19	11,200	589	1,516	893,000	833	12.51	1,174	14,700	No	0.00	0	907,700	31.517	0.003	90	0.0025	0.0792	0.1360	0.0230
39	9	30	42,492	46,800	126	138	27,200	19	11,200	589	1,516	893,000	833	11.81	1,174	13,900	No	0.00	0	906,900	33.342	0.002	53	0.0015	0.0488	0.0840	0.0230
39	10	29	42,492	46,800	126	138	25,500	19	11,200	589	1,516	893,000	833	11.08	1,174	13,000	No	0.00	0	906,000	35.529	0.001	19	0.0005	0.0192	0.0330	0.0230
40	0	40	46,235	51,000	132	146	45,900	19	11,200	589	1,626	957,500	833	19.94	1,254	25,000	Max	4.00	23,024	1,005,524	21.907	0.000	0	0.0000	0.0000	0.0100	0.0000
40	1	39	46,235	51,000	132	146	44,200	19	11,200	589	1,626	957,500	833	19.20	1,254	24,100	Max	4.00	22,172	1,003,772	22.710	0.000	0	0.0000	0.0000	0.0100	0.0000
40	2	38	46,235	51,000	132	146	42,400	19	11,200	589	1,626	957,500	833	18.42	1,254	23,100	Normal	3.24	17,228	997,828	23.534	0.000	0	0.0000	0.0000	0.1470	0.0000
40	3	37	46,235	51,000	132	146	40,700	19	11,200	589	1,626	957,500	833	17.68	1,254	22,200	Normal	3.24	16,537	996,237	24.478	0.000	0	0.0000	0.0000	0.0830	0.0000
40	4	36	46,235	51,000	132	146	38,900	19	11,200	589	1,626	957,500	833	16.90	1,254	21,200	No	0.00	0	978,700	25.159	0.000	0	0.0000	0.0000	0.1150	0.0000
40	5	35	46,235	51,000	132	146	37,200	19	11,200	589	1,626	957,500	833	16.16	1,254	20,300	No	0.00	0	977,800	26.285	0.000	0	0.0000	0.0000	0.1250	0.0000
40	6	34	46,235	51,000	132	146	35,400	19	11,200	589	1,626	957,500	833	15.38	1,254	19,300	No	0.00	0	976,800	27.593	0.000	0	0.0000	0.0000	0.1340	0.0000
40	7	33	46,235	51,000	132	146	33,700	19	11,200	589	1,626	957,500	833	14.64	1,254	18,400	No	0.00	0	975,900	28.958	0.000	0	0.0000	0.0000	0.1230	0.0000
40	8	32	46,235	51,000	132	146	31,900	19	11,200	589	1,626	957,500	833	13.86	1,254	17,400	No	0.00	0	974,900	30.561	0.000	0	0.0000	0.0000	0.1360	0.0000
40	9	31	46,235	51,000	132	146	30,200	19	11,200	589	1,626	957,500	833	13.12	1,254	16,400	No	0.00	0	973,900	32.248	0.000	0	0.0000	0.0000	0.0840	0.0000
40	10	30	46,235	51,000	132	146	28,400	19	11,200	589	1,626	957,500	833	12.34	1,254	15,500	No	0.00	0	973,000	34.261	0.000	0	0.0000	0.0000	0.0330	0.0000
41	0	41	50,202	55,300	139	153	49,800	20	11,200	560	1,741	975,200	833	21.63	1,338	28,900	No	0.00	0	1,004,100	20.163	0.000	0	0.0000	0.0000	0.0000	0.1816
41	1	40	50,202	55,300	139	153	47,900	20	11,200	560	1,741	975,200	833	20.81	1,338	27,800	Max	4.00	25,637	1,028,637	21.475	0.002	87	0.0024	0.0521	0.0100	0.1816
41	2	39	50,202	55,300	139	153	46,100	20	11,200	560	1,741	975,200	833	20.02	1,338	26,800	Max	4.00	24,673	1,026,673	22.271	0.007	335	0.0093	0.2079	0.0400	0.1816
41	3	38	50,202	55,300	139	153	44,300	20	11,200	560	1,741	975,200	833	19.24	1,338	25,700	Normal	3.24	19,205	1,020,105	23.027	0.056	2,486	0.0693	1.5958	0.3090	0.1816
41	4	37	50,202	55,300	139	153	42,400	20	11,200	560	1,741	975,200	833	18.42	1,338	24,600	Normal	3.24	18,381	1,018,181	24.014	0.049	2,094	0.0584	1.4020	0.2720	0.1816
41	5	36	50,202	55,300	139	153	40,600	20	11,200	560	1,741	975,200	833	17.63	1,338	23,600	No	0.00	0	998,800	24.601	0.043	1,762	0.0491	1.2085	0.2390	0.1816
41	6	35	50,202	55,300	139	153	38,800	20	11,200	560	1,741	975,200	833	16.85	1,338	22,500	No	0.00	0	997,700	25.714	0.017	648	0.0181	0.4647	0.0920	0.1816
41	7	34	50,202	55,300	139	153	36,900	20	11,200	560	1,741	975,200	833	16.03	1,338	21,400	No	0.00	0	996,600	27.008	0.007	255	0.0071	0.1917	0.0380	0.1816
41	8	33	50,202	55,300	139	153	35,100	20	11,200	560	1,741	975,200	833	15.25	1,338	20,400	No	0.00	0	995,600	28.365	0.000	0	0.0000	0.0000	0.0000	0.1816
41	9	32	50,202	55,300	139	153	33,200	20	11,200	560	1,741	975,200	833	14.42	1,338	19,300	No	0.00	0	994,500	29.955	0.000	0	0.0000	0.0000	0.0000	0.1816
41	10	31	50,202	55,300	139	153	31,400	20	11,200	560	1,741	975,200	833	13.64	1,338	18,200	No	0.00	0	993,400	31.637	0.000	0	0.0000	0.0000	0.0000	0.1816

Table E-16
Charleston Harbor Study
Transportation Cost Computations for Pacific Container Traffic, Cont.

Maximum Draft	Feet Light Loaded	Actual Draft	DWT Metric Tons	DWT Short Tons	IMF Metric Tons	IMF Short Tons	Short Tons Cargo	Knots	Nautical Miles (RT)	Hours At-Sea	Hourly At-Sea Cost	Total At-Sea Cost	Loading Rate	Time In-Port	Hourly In-Port Cost	Total In-Port Cost	Tidal Adv.	Avg. Hrs. Tidal Delay	Tidal Delay Cost	Total Cost	Cost Per S-Ton	Fleet Dist.	Weighted Tonnage	Tonnage Dist.	Weighted Cost Per S-Ton	Base Tidal Dist.	Base Fleet Dist.
42	0	42	54,402	60,000	146	161	54,000	20	11,200	560	1,864	1,043,700	833	23.45	1,427	33,500	No	0.00	0	1,077,200	19.948	0.000	0	0.0000	0.0000	0.0000	0.0042
42	1	41	54,402	60,000	146	161	52,100	20	11,200	560	1,864	1,043,700	833	22.63	1,427	32,300	No	0.00	0	1,076,000	20.653	0.000	0	0.0000	0.0000	0.0000	0.0042
42	2	40	54,402	60,000	146	161	50,100	20	11,200	560	1,864	1,043,700	833	21.76	1,427	31,000	Max	4.00	28,589	1,103,289	22.022	0.000	11	0.0003	0.0065	0.0500	0.0042
42	3	39	54,402	60,000	146	161	48,200	20	11,200	560	1,864	1,043,700	833	20.94	1,427	29,900	Max	4.00	27,505	1,101,105	22.844	0.000	8	0.0002	0.0052	0.0400	0.0042
42	4	38	54,402	60,000	146	161	46,300	20	11,200	560	1,864	1,043,700	833	20.11	1,427	28,700	Normal	3.24	21,401	1,093,801	23.624	0.002	105	0.0029	0.0693	0.5410	0.0042
42	5	37	54,402	60,000	146	161	44,400	20	11,200	560	1,864	1,043,700	833	19.29	1,427	27,500	Normal	3.24	20,522	1,091,722	24.588	0.001	45	0.0012	0.0305	0.2390	0.0042
42	6	36	54,402	60,000	146	161	42,400	20	11,200	560	1,864	1,043,700	833	18.42	1,427	26,300	No	0.00	0	1,070,000	25.236	0.000	16	0.0005	0.0115	0.0920	0.0042
42	7	35	54,402	60,000	146	161	40,500	20	11,200	560	1,864	1,043,700	833	17.59	1,427	25,100	No	0.00	0	1,068,800	26.390	0.000	6	0.0002	0.0048	0.0380	0.0042
42	8	34	54,402	60,000	146	161	38,600	20	11,200	560	1,864	1,043,700	833	16.77	1,427	23,900	No	0.00	0	1,067,600	27.658	0.000	0	0.0000	0.0000	0.0000	0.0042
42	9	33	54,402	60,000	146	161	36,700	20	11,200	560	1,864	1,043,700	833	15.94	1,427	22,700	No	0.00	0	1,066,400	29.057	0.000	0	0.0000	0.0000	0.0000	0.0042
42	10	32	54,402	60,000	146	161	34,700	20	11,200	560	1,864	1,043,700	833	15.07	1,427	21,500	No	0.00	0	1,065,200	30.697	0.000	0	0.0000	0.0000	0.0000	0.0042
43	0	43	58,842	64,900	153	168	58,400	20	11,200	560	1,993	1,115,800	833	25.37	1,520	38,600	No	0.00	0	1,154,400	19.767	0.000	0	0.0000	0.0000	0.0000	0.0042
43	1	42	58,842	64,900	153	168	56,400	20	11,200	560	1,993	1,115,800	833	24.50	1,520	37,200	No	0.00	0	1,153,000	20.443	0.000	0	0.0000	0.0000	0.0000	0.0042
43	2	41	58,842	64,900	153	168	54,400	20	11,200	560	1,993	1,115,800	833	23.63	1,520	35,900	No	0.00	0	1,151,700	21.171	0.000	0	0.0000	0.0000	0.0000	0.0042
43	3	40	58,842	64,900	153	168	52,300	20	11,200	560	1,993	1,115,800	833	22.72	1,520	34,500	Max	4.00	31,795	1,182,095	22.602	0.000	20	0.0006	0.0125	0.0900	0.0042
43	4	39	58,842	64,900	153	168	50,300	20	11,200	560	1,993	1,115,800	833	21.85	1,520	33,200	Max	4.00	30,579	1,179,579	23.451	0.000	15	0.0004	0.0097	0.0700	0.0042
43	5	38	58,842	64,900	153	168	48,300	20	11,200	560	1,993	1,115,800	833	20.98	1,520	31,900	Normal	3.24	23,784	1,171,484	24.254	0.003	144	0.0040	0.0974	0.7100	0.0042
43	6	37	58,842	64,900	153	168	46,300	20	11,200	560	1,993	1,115,800	833	20.11	1,520	30,600	Normal	3.24	22,800	1,169,200	25.253	0.000	18	0.0005	0.0126	0.0920	0.0042
43	7	36	58,842	64,900	153	168	44,300	20	11,200	560	1,993	1,115,800	833	19.24	1,520	29,200	No	0.00	0	1,145,000	25.847	0.000	7	0.0002	0.0051	0.0380	0.0042
43	8	35	58,842	64,900	153	168	42,200	20	11,200	560	1,993	1,115,800	833	18.33	1,520	27,900	No	0.00	0	1,143,700	27.102	0.000	0	0.0000	0.0000	0.0000	0.0042
43	9	34	58,842	64,900	153	168	40,200	20	11,200	560	1,993	1,115,800	833	17.46	1,520	26,500	No	0.00	0	1,142,300	28.415	0.000	0	0.0000	0.0000	0.0000	0.0042
43	10	33	58,842	64,900	153	168	38,200	20	11,200	560	1,993	1,115,800	833	16.59	1,520	25,200	No	0.00	0	1,141,000	29.869	0.000	0	0.0000	0.0000	0.0000	0.0042
43	11	32	58,842	64,900	153	168	36,200	20	11,200	560	1,993	1,115,800	833	15.72	1,520	23,900	No	0.00	0	1,139,700	31.483	0.000	0	0.0000	0.0000	0.0000	0.0042
44	0	44	63,530	70,000	160	177	63,000	20	11,200	560	2,128	1,191,800	833	27.36	1,618	44,300	No	0.00	0	1,236,100	19.621	0.000	0	0.0000	0.0000	0.0000	0.2066
44	1	43	63,530	70,000	160	177	60,900	20	11,200	560	2,128	1,191,800	833	26.45	1,618	42,800	No	0.00	0	1,234,600	20.273	0.000	0	0.0000	0.0000	0.0000	0.2066
44	2	42	63,530	70,000	160	177	58,800	20	11,200	560	2,128	1,191,800	833	25.54	1,618	41,300	No	0.00	0	1,233,100	20.971	0.000	0	0.0000	0.0000	0.0000	0.2066
44	3	41	63,530	70,000	160	177	56,600	20	11,200	560	2,128	1,191,800	833	24.58	1,618	39,800	No	0.00	0	1,231,600	21.760	0.000	0	0.0000	0.0000	0.0000	0.2066
44	4	40	63,530	70,000	160	177	54,500	20	11,200	560	2,128	1,191,800	833	23.67	1,618	38,300	Max	4.00	35,271	1,265,371	23.218	0.033	1,802	0.0502	1.1661	0.1600	0.2066
44	5	39	63,530	70,000	160	177	52,400	20	11,200	560	2,128	1,191,800	833	22.76	1,618	36,800	Max	4.00	33,912	1,262,512	24.094	0.012	650	0.0181	0.4363	0.0600	0.2066
44	6	38	63,530	70,000	160	177	50,300	20	11,200	560	2,128	1,191,800	833	21.85	1,618	35,300	Normal	3.24	26,368	1,253,468	24.920	0.153	7,711	0.2150	5.3567	0.7420	0.2066
44	7	37	63,530	70,000	160	177	48,200	20	11,200	560	2,128	1,191,800	833	20.94	1,618	33,900	Normal	3.24	25,267	1,250,967	25.954	0.008	378	0.0105	0.2738	0.0380	0.2066
44	8	36	63,530	70,000	160	177	46,100	20	11,200	560	2,128	1,191,800	833	20.02	1,618	32,400	No	0.00	0	1,224,200	26.555	0.000	0	0.0000	0.0000	0.0000	0.2066
44	9	35	63,530	70,000	160	177	43,900	20	11,200	560	2,128	1,191,800	833	19.07	1,618	30,900	No	0.00	0	1,222,700	27.852	0.000	0	0.0000	0.0000	0.0000	0.2066
44	10	34	63,530	70,000	160	177	41,800	20	11,200	560	2,128	1,191,800	833	18.16	1,618	29,400	No	0.00	0	1,221,200	29.215	0.000	0	0.0000	0.0000	0.0000	0.2066
44	11	33	63,530	70,000	160	177	39,700	20	11,200	560	2,128	1,191,800	833	17.24	1,618	27,900	No	0.00	0	1,219,700	30.723	0.000	0	0.0000	0.0000	0.0000	0.2066
44	12	32	63,530	70,000	160	177	37,600	20	11,200	560	2,128	1,191,800	833	16.33	1,618	26,400	No	0.00	0	1,218,200	32.399	0.000	0	0.0000	0.0000	0.0000	0.2066
																							Total Cost Per Ton		26.0191		

Source: Computations by the Charleston District.

The benefits accruing to each project alternative were computed in this manner for each year from 2000 to 2052. The construction periods are expected to range from 26 months for a 41-foot channel to 49 months for a 46-foot channel, as shown in Table E-17. A 50-year benefit stream was computed for each project alternative beginning with the first year that the project is fully operational. The present value of these streams of benefits and the equivalent average annual benefit were computed using the current federal discount rate of 7.625 percent and a base year of 2002. A sample computation for Pacific container traffic is shown in Table E-18. The results of this analysis are summarized in Table E-19.

Table E-17
Charleston Harbor Study
Dates and Duration of Construction Period
by Project Depth

	Channel Depth					
Item	41	42	43	44	45	46
Construction Begins	10/97	10/97	10/97	10/97	10/97	10/97
Benefits Begin to Accrue	10/99	01/00	05/00	07/00	09/00	12/00
Construction Ends	12/99	03/00	10/00	02/01	05/01	11/01
Months BDC	2	2	5	7	8	11
Months Duration	26	29	36	40	43	49

Source: Computations by the Charleston District.

Computations of benefits during construction are based on the construction schedules shown in Table E-17. Because of the large volumes of material to be removed from the entrance channel, this work will not be completed until after the completion of the channel to the Wando and Columbus Street container terminals, the Shipyard River Coal Terminal, and the petroleum terminals located in and at the mouth of the Shipyard River. Benefits during construction begin to accrue to vessels calling on these terminals with the completion of the entrance channel and continue to accrue to these and other terminals, as the added depth becomes available until the project is complete. Benefits during construction were computed on a monthly basis using benefits per ton computed as described above. Table E-20 shows a summary of channel deepening benefits and benefits during construction.

Table E-18
Charleston Harbor Study
Benefit Computations for Pacific Container Traffic

Year	Transportation Costs Per Ton by Channel Depth							Transportation Savings Per Ton by Channel Depth						Pacific Container Tonnage (1,000 Tons)	Total Transportation Savings by Channel Depth ($1,000)						Present Value[1] of Total Transportation Savings by Channel Depth ($1,000)					
	40	41	42	43	44	45	46	41	42	43	44	45	46		41	42	43	44	45	46	41	42	43	44	45	46
2001	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	4,605.3	1,782.1	2,116.0	2,364.6	2,863.7	2,863.7	2,863.7	1,848.8	2,116.0	0.0	0.0	0.0	0.0
2002	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	4,831.7	1,869.7	2,220.0	2,480.8	3,004.5	3,004.5	3,004.5	1,802.3	2,139.9	2,391.3	2,896.1	2,896.1	0.0
2003	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	5,069.6	1,961.8	2,329.3	2,602.9	3,152.4	3,152.4	3,152.4	1,757.1	2,086.2	2,331.3	2,823.4	2,823.4	2,823.4
2004	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	5,319.7	2,058.6	2,444.2	2,731.3	3,307.9	3,307.9	3,307.9	1,713.1	2,034.0	2,273.0	2,752.8	2,752.8	2,752.8
2005	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	5,582.5	2,160.3	2,564.9	2,866.3	3,471.3	3,471.3	3,471.3	1,670.4	1,983.3	2,216.3	2,684.1	2,684.1	2,684.1
2006	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	5,858.7	2,267.1	2,691.8	3,008.1	3,643.1	3,643.1	3,643.1	1,628.8	1,933.9	2,161.1	2,617.4	2,617.4	2,617.4
2007	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	6,149.0	2,379.5	2,825.2	3,157.1	3,823.6	3,823.6	3,823.6	1,588.4	1,886.0	2,107.5	2,552.4	2,552.4	2,552.4
2008	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	6,454.1	2,497.5	2,965.4	3,313.8	4,013.3	4,013.3	4,013.3	1,549.1	1,839.3	2,055.4	2,489.3	2,489.3	2,489.3
2009	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	6,774.8	2,621.6	3,112.7	3,478.4	4,212.7	4,212.7	4,212.7	1,510.9	1,793.9	2,004.6	2,427.8	2,427.8	2,427.8
2010	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	7,111.8	2,752.0	3,267.6	3,651.5	4,422.3	4,422.3	4,422.3	1,473.6	1,749.7	1,955.3	2,368.0	2,368.0	2,368.0
2011	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	7,278.5	2,816.6	3,344.2	3,737.1	4,526.0	4,526.0	4,526.0	1,401.3	1,663.8	1,859.3	2,251.8	2,251.8	2,251.8
2012	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	7,449.2	2,882.6	3,422.6	3,824.7	4,632.1	4,632.1	4,632.1	1,332.6	1,582.2	1,768.1	2,141.4	2,141.4	2,141.4
2013	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	7,623.9	2,950.2	3,502.9	3,914.4	4,740.8	4,740.8	4,740.8	1,267.2	1,504.6	1,681.4	2,036.3	2,036.3	2,036.3
2014	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	7,802.9	3,019.5	3,585.1	4,006.3	4,852.1	4,852.1	4,852.1	1,205.1	1,430.8	1,598.9	1,936.5	1,936.5	1,936.5
2015	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	7,986.2	3,090.4	3,669.3	4,100.4	4,966.0	4,966.0	4,966.0	1,146.0	1,360.7	1,520.6	1,841.5	1,841.5	1,841.5
2016	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	8,173.9	3,163.0	3,755.6	4,196.8	5,082.7	5,082.7	5,082.7	1,089.8	1,294.0	1,446.0	1,751.3	1,751.3	1,751.3
2017	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	8,366.0	3,237.4	3,843.9	4,295.4	5,202.2	5,202.2	5,202.2	1,036.4	1,230.6	1,375.2	1,665.5	1,665.5	1,665.5
2018	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	8,562.8	3,313.6	3,934.3	4,396.5	5,324.6	5,324.6	5,324.6	985.7	1,170.3	1,307.8	1,583.9	1,583.9	1,583.9
2019	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	8,764.3	3,391.5	4,026.9	4,499.9	5,449.9	5,449.9	5,449.9	937.4	1,113.0	1,243.7	1,506.3	1,506.3	1,506.3
2020	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	8,970.7	3,471.4	4,121.7	4,605.9	5,578.2	5,578.2	5,578.2	891.5	1,058.5	1,182.8	1,432.5	1,432.5	1,432.5
2021	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	9,076.3	3,512.3	4,170.2	4,660.1	5,643.9	5,643.9	5,643.9	838.1	995.1	1,112.0	1,346.7	1,346.7	1,346.7
2022	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	9,183.2	3,553.6	4,219.3	4,715.0	5,710.4	5,710.4	5,710.4	787.9	935.5	1,045.4	1,266.0	1,266.0	1,266.0
2023	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	9,291.4	3,595.5	4,269.1	4,770.6	5,777.7	5,777.7	5,777.7	740.7	879.4	982.7	1,190.2	1,190.2	1,190.2
2024	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	9,400.9	3,637.9	4,319.4	4,826.8	5,845.8	5,845.8	5,845.8	696.3	826.7	923.9	1,118.9	1,118.9	1,118.9
2025	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	9,511.8	3,680.8	4,370.3	4,883.7	5,914.7	5,914.7	5,914.7	654.6	777.2	868.5	1,051.9	1,051.9	1,051.9
2026	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	9,623.9	3,724.2	4,421.8	4,941.3	5,984.4	5,984.4	5,984.4	615.4	730.7	816.5	988.9	988.9	988.9
2027	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	9,737.4	3,768.1	4,473.9	4,999.6	6,055.0	6,055.0	6,055.0	578.5	686.9	767.6	929.7	929.7	929.7
2028	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	9,852.2	3,812.5	4,526.7	5,058.5	6,126.4	6,126.4	6,126.4	543.9	645.8	721.6	874.0	874.0	874.0
2029	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	9,968.5	3,857.5	4,580.1	5,118.2	6,198.7	6,198.7	6,198.7	511.3	607.1	678.4	821.6	821.6	821.6
2030	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	10,086.1	3,903.0	4,634.2	5,178.6	6,271.8	6,271.8	6,271.8	480.7	570.7	637.8	772.4	772.4	772.4
2031	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	10,205.1	3,949.1	4,688.8	5,239.7	6,345.8	6,345.8	6,345.8	451.9	536.6	599.6	726.2	726.2	726.2
2032	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	10,325.6	3,995.7	4,744.2	5,301.6	6,420.7	6,420.7	6,420.7	424.9	504.4	563.7	682.7	682.7	682.7
2033	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	10,447.5	4,042.9	4,800.2	5,364.1	6,496.5	6,496.5	6,496.5	399.4	474.2	530.0	641.8	641.8	641.8
2034	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	10,570.9	4,090.6	4,856.9	5,427.5	6,573.2	6,573.2	6,573.2	375.5	445.8	498.2	603.4	603.4	603.4
2035	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	10,695.7	4,138.9	4,914.3	5,491.6	6,650.9	6,650.9	6,650.9	353.0	419.1	468.4	567.3	567.3	567.3
2036	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	10,822.1	4,187.8	4,972.3	5,556.5	6,729.4	6,729.4	6,729.4	331.9	394.1	440.3	533.3	533.3	533.3
2037	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	10,949.9	4,237.3	5,031.1	5,622.1	6,809.0	6,809.0	6,809.0	312.0	370.5	414.0	501.4	501.4	501.4
2038	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	11,079.3	4,287.4	5,090.5	5,688.6	6,889.4	6,889.4	6,889.4	293.3	348.3	389.2	471.4	471.4	471.4
2039	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	11,210.3	4,338.0	5,150.7	5,755.8	6,970.9	6,970.9	6,970.9	275.8	327.4	365.9	443.1	443.1	443.1
2040	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	11,342.8	4,389.3	5,211.6	5,823.8	7,053.3	7,053.3	7,053.3	259.3	307.8	344.0	416.6	416.6	416.6
2041	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	11,476.9	4,441.2	5,273.2	5,892.7	7,136.7	7,136.7	7,136.7	243.7	289.4	323.4	391.7	391.7	391.7
2042	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	11,612.6	4,493.7	5,335.6	5,962.4	7,221.1	7,221.1	7,221.1	229.2	272.1	304.0	368.2	368.2	368.2
2043	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	11,750.0	4,546.9	5,398.7	6,032.9	7,306.5	7,306.5	7,306.5	215.4	255.8	285.8	346.2	346.2	346.2
2044	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	11,889.0	4,600.7	5,462.5	6,104.3	7,392.9	7,392.9	7,392.9	202.5	240.5	268.7	325.5	325.5	325.5
2045	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	12,029.7	4,655.1	5,527.2	6,176.5	7,480.4	7,480.4	7,480.4	190.4	226.1	252.7	306.0	306.0	306.0
2046	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	12,172.0	4,710.2	5,592.6	6,249.6	7,568.9	7,568.9	7,568.9	179.0	212.6	237.5	287.7	287.7	287.7
2047	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	12,316.1	4,766.0	5,658.8	6,323.6	7,658.5	7,658.5	7,658.5	168.3	199.8	223.3	270.5	270.5	270.5
2048	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	12,461.9	4,822.4	5,725.7	6,398.4	7,749.1	7,749.1	7,749.1	158.2	187.9	209.9	254.3	254.3	254.3
2049	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	12,609.4	4,879.5	5,793.5	6,474.2	7,840.9	7,840.9	7,840.9	148.8	176.6	197.4	239.1	239.1	239.1
2050	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	12,758.7	4,937.2	5,862.1	6,550.8	7,933.7	7,933.7	7,933.7	139.9	166.1	185.6	224.7	224.7	224.7
2051	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	12,909.8	4,995.7	5,931.6	6,628.4	8,027.7	8,027.7	8,027.7	0.0	0.0	174.5	211.3	211.3	211.3
2052	26.02	25.63	25.56	25.51	25.40	25.40	25.40	0.3870	0.4595	0.5134	0.6218	0.6218	0.6218	13,062.8	5,054.9	6,001.8	6,706.9	8,122.8	8,122.8	8,122.8	0.0	0.0	0.0	0.0	0.0	198.7
																					39,635.3	46,980.9	50,310.3	60,930.9	60,930.9	58,233.4
																					3,100.9	3,675.6	3,936.0	4,766.9	4,766.9	4,555.9

Source: Computations by the Charleston District.

[1] Discount Rate = 0.07625

Table E-19
Charleston Harbor Study
Transportation Savings and Benefits by Commodity Group

		Channel Depth						
Item		40	41	42	43	44	45	46
Container Cargo, Atlantic Trade								
Transportation Cost / ton								
2002		10.22	10.06	9.91	9.77	9.64	9.51	9.48
2012		10.22	9.95	9.76	9.42	9.11	8.96	8.89
Benefits / ton								
2002			0.16	0.31	0.45	0.58	0.71	0.74
2012			0.27	0.46	0.79	1.11	1.26	1.33
K-Tons Traffic								
2002			4,036	4,036	4,036	4,036	4,036	4,036
2012			6,222	6,222	6,222	6,222	6,222	6,222
Transportation Savings ($1,000)								
2002			638.1	1,238.6	1,796.0	2,333.2	2,847.7	2,978.1
2012			1,657.0	2,832.4	4,942.3	6,889.3	7,828.8	8,245.1
Container Cargo, Pacific Trade								
Transportation Cost / ton		26.02	25.63	25.56	25.51	25.40	25.40	25.40
Benefits / ton			0.39	0.46	0.51	0.62	0.62	0.62
K-Tons Traffic (2002)			4,832	4,832	4,832	4,832	4,832	4,832
Transportation Savings ($1,000)			1,869.7	2,220.0	2,480.8	3,004.5	3,004.5	3,004.5
Coal								
Transportation Cost / ton								
2002	10.54[1]	9.96	9.88	9.76	9.66	9.54	9.51	9.51
2027	10.43[1]	9.68	9.53	9.38	9.25	9.12	9.06	9.06
Benefits / ton								
2002		0.58	0.66	0.78	0.88	1.00	1.03	1.03
2027		0.75	0.90	1.05	1.18	1.31	1.37	1.37
K-Tons Traffic								
2002			1,425	1,425	1,425	1,425	1,425	1,425
2027			2,017	2,017	2,017	2,017	2,017	2,017
Transportation Savings ($1,000)								
2002			940.8	1,111.8	1,254.4	1,425.4	1,468.2	1,468.2
2027			1,815.6	2,118.2	2,380.2	2,642.7	2,763.7	2,763.7

Table E-19
Charleston Harbor Study
Transportation Savings and
Benefits by Commodity Group, Cont.

	Channel Depth						
Item	40	41	42	43	44	45	46
Grain Traffic							
Transportation Cost / ton							
2002	12.52	12.19	11.96	11.76	11.44	11.12	10.80
2027	11.99	11.62	11.32	11.20	11.01	10.63	10.25
Benefits / ton							
2002		0.33	0.56	0.76	1.08	1.40	1.72
2027		0.37	0.67	0.79	0.98	1.36	1.74
K-Tons Traffic							
2002		382	382	382	382	382	382
2027		443	443	443	443	443	443
Transportation Savings ($1,000)							
2002		126.2	214.1	290.6	413.0	535.4	657.7
2027		163.9	297.7	349.9	434.0	602.4	770.7
Iron							
Transportation Cost / ton	3.74	3.64	3.63	3.62	3.61	3.60	3.59
Benefits / ton		0.09	0.10	0.12	0.13	0.14	0.14
K-Tons Traffic (2002)		400	400	400	400	400	400
Transportation Savings ($1,000)		36.6	43.7	48.0	51.5	54.3	57.2
Petroleum Products							
Transportation Cost / ton							
2002[2]	10.64	10.22	9.99	9.88	9.88	9.81	9.74
2027[2]	11.00	10.56	10.34	10.22	10.21	10.13	10.06
Benefits / ton							
2002		0.42	0.65	0.76	0.76	0.83	0.90
2027		0.44	0.66	0.78	0.79	0.87	0.94
K-Tons Traffic							
2002		2,448	2,448	2,448	2,448	2,448	2,448
2027		3,058	3,058	3,058	3,058	3,058	3,058
Transportation Savings ($1,000)							
2002		1,017.3	1,580.2	1,852.4	1,852.4	2,023.8	2,195.1
2027		1,376.0	2,048.7	2,415.6	2,446.2	2,690.8	2,935.4

Source: Computations by the Charleston District. Notes: [1] Based on existing 38-foot channel in Shipyard River. [2] Reflects replacement of single-hulled tankers with double-hulled tankers.

Table E-20
Charleston Harbor Study
Summary of Channel Deepening Benefits by Commodity Group

	Channel Depth					
Item	41	42	43	44	45	46
Present Value of Benefits						
European Containers	20,761.1	35,492.9	59,786.0	80,407.2	92,339.7	97,145.8
Pacific Containers	41,334.1	47,137.1	52,674.8	61,129.5	61,129.5	61,129.5
Coal	21,172.3	23,688.7	26,669.1	28,235.5	29,298.1	29,398.1
Grains	2,211.3	3,697.1	4,592.9	5,978.6	7,711.6	9,444.5
Iron Carbide	615.1	691.1	758.8	763.8	806.2	848.7
Petroleum	17,929.0	25,664.1	30,224.7	28,685.8	31,465.9	34,246.0
Subtotal	104,022.8	136,370.9	174,706.4	205,200.4	222,851.0	232,212.6
BDC	569.6	2,182.3	2,970.9	4,474.9	5,388.9	7,543.6
Total	104,592.4	138,553.2	177,677.3	209,675.3	228,239.9	239,756.2
Average Annual Benefits						
European Containers	1,624.2	2,776.8	4,677.4	6,290.6	7,224.2	7,600.2
Pacific Containers	3,233.8	3,687.8	4,121.0	4,782.5	4,782.5	4,782.5
Coal	1,656.4	1,853.3	2,086.5	2,209.0	2,300.0	2,300.0
Grains	173.0	289.2	359.3	467.7	603.3	738.9
Iron	48.1	54.1	59.4	59.8	63.1	66.4
Petro	1,402.7	2,007.8	2,364.6	2,244.2	2,461.7	2,679.2
Subtotal	8,138.2	10,669.0	13,668.1	16,053.8	17,434.7	18.167.1
BDC	44.6	170.7	232.4	350.1	421.6	590.2
Total	8,182.8	10,839.7	13,900.6	16,403.9	17,856.3	18,757.3

Source: Computations by the Charleston District.

II. Turning Basin for New Daniel Island Terminal. Analysis was conducted to determine the feasibility of creating this turning basin to accommodate projected container vessel traffic at the new Daniel Island Terminal. Commerce projections and fleet characteristics developed for the analysis of channel deepening alternatives were used in calculating the benefits of the turning basin.

The Daniel Island Terminal is scheduled to go on line in the year 2003, as the existing facilities approach capacity constraints. With the opening of the Daniel Island Terminal, the utilization rates for container ports will rapidly equilibrate as large segments of the traffic move to the new facilities. Contract negotiations with prospective users will be conducted during construction to facilitate immediate occupancy upon the completion of the terminal. A similar process enabled shippers to move into the new facilities at the Wando Terminal a few days after construction was completed. When existing facilities again reach their full capacity, all further growth in container cargo traffic is projected to occur at Daniel Island with the further development of the facilities at that site.

The Daniel Island Terminal is projected to handle 3.5 million tons of traffic in its first year of operation, which accounts for about 30 percent of total container traffic. Traffic levels at Daniel Island are projected to grow at the same rate as Charleston's total level of container traffic until the capacity of other facilities is reached in 2010. After 2010, all increases in traffic in Charleston Harbor will be accommodated by the Daniel Island Terminal.

The number of vessel movements through the terminal was computed by dividing the projected tonnage levels by the average loading per vessel. The projected vessel movements through the Daniel Island Terminal are shown in Table E-21.

Table E-21
Charleston Harbor Study
Projected Annual Vessel Movements at the
New Daniel Island Terminal

Vessel Flag	2003	2013	2023	2033	2043	2052
US Flag	111	194	317	402	499	596
Foreign Flag	394	686	1,123	1,427	1,768	2,112
Total	505	880	1,440	1,829	2,267	2,708

Source: Computations by the Charleston District.

Without the proposed Daniel Island turning basin, each vessel calling at the Daniel Island Terminal would be required to use the existing Ordnance turning basin. Interviews with Charleston's pilots indicate that this would increase each vessel's total turn-around time by two hours; an additional 12 miles of intraharbor travel and delays associated with the deceleration and acceleration of the vessels account for this time[17]. The resulting cost increase for the US flag and foreign flag vessels projected to call on the new Daniel Island Terminal was calculated using the following equation.

- Increased Cost = 1/2 (yearly vessel movements) x (hourly at-sea cost) x (2 hours)

The total number of vessel movements was divided by two in this computation since the turning basin will only be used for outbound movements. Vessel operating costs used in this evaluation are the same as those used in the analysis of channel deepening alternatives.

The benefits of a turning basin at the Daniel Island terminal will result from the elimination of this increase in each vessel's turn-around time. Average annual benefits of the Daniel Island Turning Basin are shown in Table E-22.

Table E-22
Average Annual Benefits of
Daniel Island Turning Basin

	Turning Basin Depth				
	41 Feet	42 Feet	43 Feet	44 Feet	45 Feet
Avg. Ann. Benefits	$687,800	$690,500	$758,500	$793,200	$832,200

Source: Computations by the Charleston District.

III. Shutes/Folly Channel Realignment. The proposed channel realignment in the Shutes and Folly Reaches will result in two main classes of benefits, resulting from the creation of additional two-way traffic areas and the shortening of the navigation channel. The commodity traffic and fleet projections used to evaluate channel

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[17] The increased use of the Ordnance turning basin would also cause costly delays due to congestion in the upper reaches of the harbor. However, sufficient data are not available to analyze these costs.

deepening alternatives were used in calculating the benefits derived from the channel realignment.

Interviews with the Pilots Association and local shipping agents revealed that vessels 900 feet or more in length are considered to be too large for safe passage with oncoming vessels throughout most of the inner harbor. This results delays of up to two hours in duration, with an average duration of one hour. These delays are incurred as inbound vessels reduce approach speeds or outbound vessels wait at the wharf to avoid meeting large vessels in constricted reaches.

The probability of a ship being delayed was determined using the 1994 Pilot's Log. Table E-23 contains the delay probabilities for container, bulk, and roll-on/roll-off (roro) vessels. It also contains the percent of delays occurring at-sea and at-port for each vessel type.

Table E-23
Charleston Harbor Study
Probabilities of Vessel Delays

Vessel Type	Probability of Delay	Percent of Delays At Sea	Percent of Delays At Port
Container	0.14	47	53
Bulk	0.07	41	59
Roro	0.06	22	78

Source: 1994 Pilot's Logs and Computations by the Charleston District.

The number of future yearly vessel movements through the harbor was estimated for container and bulk vessels by dividing the projected tonnage by the average loadings for each type of vessel. Due to the shallow draft of roro vessels, no benefits were claimed for channel deepening and, therefore, future tonnages of roro traffic were not projected. In 1994, there were 18 delays of roro vessels (4 at sea and 14 at port). For this analysis, the number of delays for roro vessels were held constant for the life of the project. Table E-24 contains the projected movements for each vessel type.

Table E-24
Charleston Harbor Study
Total Yearly Vessel Movements

	Yearly Vessel Movements					
Vessel Type	2002	2012	2022	2032	2042	2052
Coal	80	93	106	120	137	155
Grain	17	19	20	21	22	23
Iron	15	16	18	19	20	22
Petroleum	114	127	137	148	161	174
Container, FF	1,267	1,954	2,408	2,708	3,045	3,425
Container, US	358	551	680	764	859	966

Source: Computations by the Charleston District.

The number of vessel delays were determined by applying the 1994 delay probabilities to the annual movements. As vessel movements through the harbor increase in the future it is highly likely that the probability of delays would also increase. However, due to a lack of sufficient data to determine the magnitude of the increase, the probability of delay was held constant for each vessel type. The total number of delays for each vessel type was broken down into delays at-sea and at-port based on the percentages shown in Table E-23. The projected number of vessels delayed are shown in Table E-25.

The total cost of the delays for each vessel type was determined by using the following equations:

- At-Sea Delay = (Yearly delays) x (average delay time) x (hourly at-sea cost)
- At-Port Delay = (Yearly delays) x (average delay time) x (hourly at-port cost)

As noted above, the average delay time under the without project conditions is one hour. For bulk vessels, the cost of delay was computed using the same at-sea and at-port vessel operating costs used to evaluate channel deepening alternatives.

However, when container vessels are delayed, they typically have unloading gangs waiting for the vessels to arrive at the berth. The shipping agent must still pay for the idle labor while it awaits the vessels arrival. The average hourly cost for the unloading gangs, $2,117, was therefore added to the at-sea vessel costs to obtain the total at-sea

Table E-25
Charleston Harbor Study
Number of Vessels Delayed, Without-Project

Vessel Type	Number of Vessels Delayed											
	2002 at		2012 at		2022 at		2032 at		2042 at		2052 at	
	Sea	Port	Sea	Port	Sea	Port	Sea	Port	Sea	Port	Sea	Port
Coal	2	4	3	4	3	5	4	5	4	6	5	6
Grain	1	1	1	1	1	1	1	1	1	1	1	1
Iron	1	1	1	1	1	1	1	1	1	1	1	1
Petroleum	3	5	4	5	4	6	5	6	5	7	5	8
Roro	4	14	4	14	4	14	4	14	4	14	4	14
Container F.F.	84	94	129	145	159	179	179	201	201	226	226	254
Container U.S.	24	27	37	41	45	51	50	57	57	64	64	72

Source: Computations by the Charleston District.

delay costs for incoming vessels. Total delay costs and the average annual equivalent (A.A.E.) for the without-project conditions are displayed in Table E-26.

The with-project condition provides additional two-way traffic reaches that will reduce most delays by 15 minutes and completely eliminate others. Assuming a uniform distribution of delays between the minimum delay of 1 minute and a maximum delay of 2 hours, the with-project condition will decrease the average delay time to 45 minutes and decrease the number of delays by 25 percent. The with-project delay costs, shown in Table E-27, were computed by applying these figures to the previously mentioned equations. The average annual benefits attributable to delay reduction, $398,198, were determined by comparing with and without-project delay costs.

Additional benefits to the realignment are the result of decreased intra-harbor transit time associated with the realigned channel. The realigned channel is 0.4 nautical miles shorter than the existing alignment. The average speed of vessels transiting these reaches is 9 knots. Using the projected number of vessel movements shown in Table E-24 and the vessel operating costs used to evaluate deepening alternatives yield average annual benefits of $424,372. The total average annual benefits of the realignment, including delay reduction benefits, are $822,570.

E-26
Charleston Harbor Study
Benefit Computations for Shutes/Folly Realignment

Vessel Type	Total Delay Costs					
	2002	2012	2022	2032	2042	2052
Existing Channel						
Coal	$3,180	$3,790	$4,280	$4,890	$5,380	$5,990
Grain	1,200	1,200	1,200	1,200	1,200	1,200
Iron	1,308	1,308	1,308	1,308	1,308	1,308
Petroleum	17,357	19,611	21,730	23,984	26,103	28,222
Roro	7,532	7,532	7,532	7,532	7,532	7,532
Container	556,471	855,106	1,052,702	1,181,194	1,330,083	1,495,102
Total	$587,048	$888,547	$1,088,752	$1,220,108	$1,371,606	$1,539,354
Realigned Channel						
Coal	$2,018	$2,018	$2,385	$2,843	$3,210	$3,668
Grain	401	401	900	900	900	900
Iron	437	437	437	437	981	981
Petroleum	9,738	11,429	13,018	13,018	14,708	16,298
Roro	5,649	5,649	5,649	5,649	5,649	5,649
Container	313,135	479,997	591,664	665,762	747,309	840,073
Total	$331,378	$499,931	$614,053	$688,609	$772,757	$867,569
Delay Reduction Benefits						
Total	$246,670	$388,616	$474,699	$531,499	$598,849	$671,785
Transit Time Reduction Benefits						
Total	$282,004	$428,560	$525,960	$590,690	$663,608	$745,634

Average Annual Benefits

Delay Reduction	$398,198
Transit Time Reduction	424,372
Total	$822,570

Source: Computations by the Charleston District.

Section 5. NED Benefit-Cost Analysis

The economic feasibility of a deep draft navigation project is determined by comparing the benefits and costs associated with the project alternatives. National Economic Development (NED) benefits are the contribution of a project to the national output of goods and services. Typically, these benefits are the result of reduced transportation costs. NED costs are the economic value of the resources consumed in the construction, operation, and maintenance of the project. Any project alternative with net NED benefits is economically justified. The optimal plan is that which maximizes net NED benefits.

The total investment cost of each alternative is the sum of direct construction costs, administrative and design costs, real estate costs and interest that accrues from expenditures made prior to the base year. The deepening of Charleston Harbor is scheduled to begin in 1998, but the construction period will vary with project depth. The construction periods for the alternative project depths range from 26 months for a 41-foot channel to 49 months for a 46-foot channel, as shown in Table E-17 above. Computations of interest during construction are based on these construction schedules.

For all channel depths, the total project will be accomplished under five main contracts. The lower harbor, from the entrance channel up to and including Myers Bend will be deepened under Contract 1; this contract will also provide for deepening to the Wando and Columbus Street terminals. The entrance channel will be deepened under Contract 2. Contract 3 will provide for deepening the existing channel in the upper harbor, from Shipyard River to the Ordnance Reach Turning Basin. All new channel work in the vicinity of the Daniel Island Terminal will be performed under Contract 4. All work on contraction dikes will be performed under Contract 5. Expenditures under these five contracts and the associated interest during construction for the 45-foot channel are shown in Table E-27. Interest during construction was computed in a similar manner for other channels depths.

The methods used to evaluate the economic value of project costs and benefits also account for anticipated differences in construction schedules. Project benefits were analyzed over a 50-year project life beginning with the first year that the project is fully operational. Evaluations of benefits during construction were based on the anticipated construction schedules. All interest, discounting and present value computations for all costs and benefits and for all channel depths were made using a base year of 2002. The costs and benefits associated with the complete harbor deepening project are shown in Table E-28.

Table E-27
Charleston Harbor Study
Interest During Construction Computations
45-Foot Channel

		Contract														
Month	Year	1	2	3	4	5	Berths	PED	S&A	Monitoring Disposal	Real Estate	Aids to Navig.	Mitigation	Diking	Total	Interest
Oct	1996							25,000							25,000	12,260
Nov	"							25,000							25,000	12,025
Dec	"							25,000							25,000	11,791
Jan	1997							25,000							25,000	11,559
Feb	"							25,000							25,000	11,328
Mar	"							25,000							25,000	11,099
Apr	"							25,000							25,000	10,871
May	"							25,000							25,000	10,644
Jun	"							25,000							25,000	10,419
Jul	"							25,000							25,000	10,195
Aug	"							25,000							25,000	9,973
Sep	"							25,000							25,000	9,752
Oct	"							40,000						204,079	244,079	93,071
Nov	"							40,000						204,079	244,079	90,943
Dec	"							40,000						204,079	244,079	88,827
Jan	1998							40,000						204,079	244,079	86,725
Feb	"							40,000						204,079	244,079	84,637
Mar	"							40,000						204,079	244,079	82,561
Apr	"							40,000	30,000					204,079	274,079	90,393
May	"	2,261,410						40,000	30,000	5,000				204,079	2,540,489	816,537
Jun	"	1,679,000						40,000	40,000	10,000				204,079	1,973,079	617,704
Jul	"	1,578,667	683,100					40,000	40,000	10,000				204,079	2,555,846	778,958
Aug	"	1,213,250	807,300					40,000	40,000	10,000				204,079	2,314,629	686,372
Sep	"	1,213,250	807,300					40,000	40,000	10,000				204,079	2,314,629	667,424
Oct	"	1,213,250	807,300					40,000	40,000	10,000					2,110,550	591,409
Nov	"	1,213,250	807,300					40,000	40,000	10,000					2,110,550	574,349
Dec	"	1,213,250	3,512,100					40,000	40,000	10,000					4,815,350	1,271,734
Jan	1999	1,338,944	2,960,100					40,000	40,000	10,000					4,389,044	1,124,115
Feb	"	1,638,750	2,960,100					40,000	40,000	10,000					4,688,850	1,163,712
Mar	"	1,736,370	2,960,100					40,000	40,000	10,000					4,786,470	1,150,218
Apr	"	1,667,500	1,175,300					40,000	40,000	10,000					2,932,800	681,802
May	"	1,718,104	807,300					40,000	40,000	10,000					2,615,404	587,662
Jun	"	1,832,683	807,300					40,000	40,000	10,000					2,729,983	592,297
Jul	"	1,878,052	807,300				504,735	40,000	40,000	10,000					3,280,087	686,444
Aug	"	1,586,545	807,300				202,975	40,000	40,000	10,000					2,686,820	541,772
Sep	"	1,522,113	807,300	1,259,250			180,028	40,000	40,000	10,000					3,858,691	748,792
Oct	"	1,291,802	807,300	585,147			380,594	40,000	40,000	10,000					3,154,842	588,423
Nov	"		807,300	604,038				40,000	40,000	10,000					1,501,338	268,773
Dec	"		3,512,100	577,103				40,000	40,000	10,000					4,179,203	717,060
Jan	2000		2,960,100	483,863				40,000	40,000	10,000					3,533,963	580,208
Feb	"		2,960,100	443,953				40,000	40,000	10,000					3,494,053	547,972
Mar	"		2,960,100	341,550				40,000	40,000	10,000					3,391,650	507,139
Apr	"		1,175,300	341,550				40,000	40,000	10,000					1,606,850	228,603

Table E-27
Charleston Harbor Study
Interest During Construction Computations
45-Foot Channel, Cont.

		Contract														
Month	Year	1	2	3	4	5	Berths	PED	S&A	Monitoring Disposal	Real Estate	Aids to Navig.	Mitigation	Diking	Total	Interest
May	"		807,300	344,967				40,000	40,000	10,000					1,242,267	167,775
Jun	"		807,300	373,192				40,000	40,000	10,000					1,270,492	162,481
Jul	"		381,533	344,713				40,000	40,000	10,000					816,245	98,575
Aug	"		276,000	360,406				40,000	40,000	10,000					726,406	82,585
Sep	"			395,313			250,322	40,000	40,000	10,000					735,635	78,462
Oct	"			395,313				40,000	40,000	10,000					485,313	48,372
Nov	"			401,156				40,000	40,000	10,000					491,156	45,544
Dec	"			401,638				40,000	40,000	10,000					491,638	42,196
Jan	2001			379,914				40,000	40,000	10,000					469,914	37,110
Feb	"			380,847			476,948	40,000	40,000	10,000					947,795	68,392
Mar	"			382,663				40,000	40,000	10,000					472,663	30,907
Apr	"			723,101				40,000	40,000	10,000		78,000	23,000		914,101	53,624
May	"														0	0
Jun	"														0	0
Jul	"														0	0
Aug	"														0	0
Sep	"										17,250				17,250	443
Oct	"					315,286		40,000	40,000	10,000					405,286	7,775
Nov	"					521,009		40,000	40,000	10,000					611,009	7,790
Dec	"					347,339		40,000	40,000	10,000					437,339	2,779
Jan	2002					200,415		40,000	40,000	10,000					290,415	0
Feb	"					267,220		40,000	40,000	10,000					357,220	(2,256)
Mar	"					200,415		40,000	40,000	10,000					290,415	(3,656)
Apr	"				1,658,185	670,657		40,000	40,000	10,000					2,418,842	(45,529)
May	"				1,511,675	894,210		40,000	40,000	10,000					2,495,885	(62,442)
Jun	"				286,350	687,881		40,000	40,000	10,000					1,064,231	(33,176)
Jul	"				1,861,275			40,000	40,000	10,000					1,951,275	(72,766)
Aug	"				1,861,275			40,000	40,000	10,000					1,951,275	(84,627)
Sep	"				1,861,275			40,000	40,000	10,000					1,951,275	(96,413)
Oct	"				1,861,275			40,000	30,000	10,000					1,941,275	(107,570)
Nov	"				873,010		2,008,590	40,000	20,000	10,000					2,951,600	(181,158)
Dec	"				464,140		2,008,590	40,000	10,000	5,000					2,527,730	(170,123)
Total		7,796,189	38,970,933	9,519,673	12,238,460	4,104,432	6,012,782	2,620,000	2,000,000	500,000	17,250	78,000	23,000	2,448,949	106,329,668	17,543,645

Source: Computations by the Charleston District using January 1995 price levels and the current Federal Discount Rate of 7.625 percent.

Table E-28
Charleston Harbor Study
Net Benefit Evaluation
Complete Harbor Deepening Project
(Thousands of 1995 Dollars)

	Project Draft in Feet					
Item	41	42	43	44	45	46
General Navigation Features						
Channel Deepening	34,093	44,918	51,798	59,596	65,407	73,916
Contraction Dikes	3,569	3,569	3,569	3,569	3,569	3,569
Mitigation	20	20	20	20	20	20
Subtotal	37,682	48,507	55,387	63,185	68,997	77,505
Contingencies, 15 Percent	5,652	7,276	8,308	9,478	10,349	11,626
Subtotal	43,335	55,783	63,695	72,663	79,346	89,130
Monitoring of ODMDS	500	500	500	500	500	500
PED	2,620	2,620	2,620	2,620	2,620	2,620
Construction Management	1,600	1,600	2,000	2,000	2,000	2,400
Total	48,055	60,503	68,815	77,783	84,466	94,650
Aids to Navigation	78	78	78	78	78	78
Non-Federal Costs						
Berthing Areas	4,290	4,505	4,679	4,698	5,229	5,405
Disposal Diking	583	939	1,322	1,720	2,130	2,549
Real Estate	15	15	15	15	15	15
Subtotal	4,888	5,459	6,016	6,433	7,373	7,968
Contingencies, 15 Percent	733	819	902	965	1,106	1,195
Total	5,621	6,278	6,919	7,397	8,479	9,164
Total First Costs	53,754	66,859	75,812	85,258	93,023	103,892
IDC	9,844	12,601	13,578	15,402	16,704	18,060
Total Investment Cost	63,598	79,459	89,390	100,661	109,727	121,952
Average Annual Cost						
Interest	4,849	6,059	6,816	7,675	8,367	9,299
Amortization	126	158	177	200	218	242
Annual O&M	145	341	538	734	930	1,227
Total AAC	5,121	6,557	7,531	8,609	9,515	10,768
Average Annual Benefits						
Channel Deepening	8,183	10,840	13,901	16,404	17,856	18,757
B/C Ratio	1.60	1.65	1.85	1.91	1.88	1.74
Net Benefits	3,062	4,282	6,369	7,795	8,342	7,989

Source: Computations by the Charleston District; reflects January 1995 dollars and the current federal discount rate of 7.625 percent.

Direct construction costs include the cost of dredging and disposal of dredged material (shown together under "Channel Deepening" in Table E-28), the cost of constructing and improving dikes at disposal sites, and the cost of mobilizing and demobilizing construction operations. Real estate, PED, and construction management costs were added to construction costs to determine total first costs. Interest during construction reflects the varying construction schedules and was added to first costs to determine total investment costs.

The present value of total investment costs was converted to an equivalent average annual cost for comparison with average annual benefits. First, total investment costs were adjusted to reflect the discounting of construction costs incurred after the base year. This yielded the present value of the total investment. Average annual costs were determined by adding annual O&M charges to the interest and amortization of the present value of the total investment.

The present value of benefits includes both the discounted value of the 50-year stream of benefits and the present value of benefits that accrue during the construction of the project. All costs and benefits are expressed in 1995 dollars and all interest and discounting computations reflect the current federal discount rate of 7.625 percent.

The optimal project depth was determined by comparing total project costs and benefits as shown in Table E-28. All benefits and costs for all components involving channel deepening were included in the determination of optimal project depth. Net NED benefits will be maximized by deepening the harbor to 45 feet, yielding a benefit/cost ratio of 1.88.

Separate evaluations of benefits and costs were then conducted for the main channel on the Cooper River and for each separable increment of construction, including deepening the Custom House and Lower Town Creek reaches to the Columbus Street Terminal; deepening the existing Wando River channel to the Wando Terminal; and deepening the Shipyard River channel. The main channel increment benefits all commodity classes except coal traffic. Most of the traffic that benefits from the main channel increment is concentrated in the extreme upstream reaches of this increment. The Wando and Columbus Street increments benefit container traffic only. As shown in Table E-29, the optimal channel depth of 45 feet is economically justified for the main channel and for each separable increment of the total deepening project.

All of Charleston's coal traffic originates from the Shipyard River. Coal benefits account for the vast majority of benefits attributable to deepening Shipyard River. For this reason, the deepening of Shipyard River was evaluated at one-foot increments from 41 to 45 feet. A 46-foot channel at Shipyard River was not evaluated since the optimal depth of the main channel is 45-feet. The results of this evaluation are shown in Table E-30. Net NED benefits will be maximized at a channel depth of 45 feet for the Shipyard River.

Table E-29
Charleston Harbor Study
Net Benefit Evaluation by
Major Harbor Component, 45-foot Channel
(Thousands of 1995 Dollars)

	Channel Segment				
	Main Channel	Columbus Street	Wando River	Shipyard River	Total
General Navigation Features					
Channel Deepening	$55,748	$3,440	$5,375	$844	$65,407
Contraction Dikes	3,569				3,569
Mitigation	20				20
Subtotal	59,337	3,440	5,375	844	68,997
Contingencies	8,901	516	806	127	10,349
Subtotal	68,238	3,956	6,181	971	79,346
Monitoring of ODMDS	500				500
PED	2,620				2,620
Construction Management	1,720	100	156	24	2,000
Total	73,078	4,055	6,337	996	84,466
Aids to Navigation	78				78
Non-Federal Costs					
Berthing Areas	4,302	439	331	157	5,229
Disposal Diking	1,969			161	2,130
Real Estate	15				15
Subtotal	6,286	439	331	317	7,373
Contingencies	943	66	50	48	1,106
Total	7,229	504	381	365	8,479
Total First Costs	80,385	4,560	6,718	1,360	93,023
IDC	14,007	937	1,489	271	16,704
Total Investment Cost	94,392	5,497	8,207	1,632	109,727
Average Annual Costs					
Interest	$7,197	$419	$626	$124	$8,367
Amortization	187	10	16	3	218
Annual O&M	228	215	218	269	930
Total AAC	7,613	645	860	397	9,515
Average Annual Benefits					
Total AAB	7,974	1,967	5,338	2,577	17,856
B/C Ratio	1.05	3.05	6.21	6.50	1.88
Net Benefits	361	1,322	4,478	2,180	8,342

Source: Computations by Charleston District; reflects January 1995 dollars and the current federal discount rate of 7.625 percent.
* Reflects discounting of costs incurred after base year of 2002.

Table E-30
Charleston Harbor Study
Net Benefit Evaluation for
Shipyard River
(Thousands of 1995 Dollars)

	Channel Depth				
	41	42	43	44	45
Summary of Costs					
General Navigation Features					
Channel Deepening	374	516	624	733	844
Contingencies	56	77	94	110	127
Subtotal	430	593	718	843	971
Construction Management	24	24	24	24	24
Total	455	618	743	867	996
Non-Federal Costs					
Berthing Areas	130	136	106	146	157
Disposal Diking	74	100	113	139	161
Subtotal	204	236	219	286	317
Contingencies	31	35	33	43	48
Total	234	271	252	329	365
Total First Costs	689	889	995	1,196	1,360
IDC	137	177	198	238	271
Total Investment Cost	827	1,066	1,193	1,434	1,632
Average Annual Costs					
Interest	63	81	91	109	124
Amortization	2	2	2	3	3
Annual O&M	240	247	254	261	269
Total AAC	305	330	347	373	397
Average Annual Benefits					
Total AAB	1,777	2,046	2,320	2,455	2,577
B/C Ratio	5.83	6.19	6.68	6.58	6.50
Net Benefits	1,472	1,716	1,972	2,082	2,180

Source: Computations by Charleston District; reflects January 1995 dollars and the current federal discount rate of 7.625 percent.

Once the optimal project depth was determined, incremental evaluations were conducted for plans to realign the channel in the Shutes/Folly reaches to allow two-way traffic; plans to widen the Wando River channel to allow two-way traffic; and plans to construct a turning basin for vessels that will use the new Daniel Island Terminal. Providing two-way traffic on the Wando River was found to be infeasible by a wide margin. The delays associated with one-way traffic on the Wando are minor and infrequent. Benefits and costs for this project component are not shown. A summary of the benefits and costs associated with the Daniel Island turning basin and the Shutes/Folly realignment are shown in Tables E-31 and E-32, respectively.

With the construction of a 45-foot channel, the optimal depth of the new Daniel Island turning basin is also 45 feet, yielding a benefit/cost ratio of 1.17. The optimal depth of the turning basin was determined by incremental analysis of depths ranging from 41 feet to 45 feet. Because the NED channel deepening plan is a 45 foot channel, a 46 foot turning basin was not evaluated. The average annual benefits, average annual costs, net benefits, and benefit-to-cost ratios for each depth are shown in Table E-31.

The incremental cost of the Shutes/Folly channel realignment was determined by subtracting the cost of deepening the existing channel to a depth of 45 feet from the cost of similar deepening of the realigned channel. As shown in Table E-32, the channel realignment in the Shutes/Folly reaches is economically justified, with a benefit/cost ratio of 1.73.

A summary of total costs and benefits of the recommended project is shown in Table E-33. The total investment cost of the recommended project is $124 million, yielding a benefit/cost ratio of 1.82.

This report also serves as the authorizing document for without-project modifications to the Cooper River near the mouth of the Shipyard River. The main report presents the justification for these modifications, which are required to maintain safe navigation of these reaches. The estimated first cost of this work is $10.3 million, which will be cost-shared with the local sponsor as a general navigation feature. The allocation of the first costs to Federal and Non-Federal sources is shown in Table E-34.

Table E-31
Charleston Harbor Study
Net Benefit Evaluation
Daniel Island Turning Basin
(Thousands of 1995 Dollars)

	Project Draft in Feet				
Item	41	42	43	44	45
Summary of Costs					
General Navigation Features					
Construction Cost	$6,388	$6,656	$6,950	$7,244	$7,482
Contingencies	958	998	1,043	1,087	1,122
Total First Costs	7,347	7,655	7,993	8,330	8,604
IDC*	(362)	(377)	(393)	(410)	(423)
Total Investment Cost	6,985	7,287	7,599	7,920	8,181
Average Annual Costs					
Interest	532	555	579	604	624
Amortization	14	14	15	16	16
Annual O&M	55	59	62	66	70
Total AAC	601	628	657	686	710
Average Annual Benefits					
Total AAB	687	690	759	793	832
B/C Ratio	1.14	1.10	1.16	1.16	1.17
Net Benefits	86	62	102	107	122

Source: Computations by Charleston District; reflects January 1995 dollars and the current federal discount rate of 7.625 percent.

* Reflects discounting of costs incurred after base year of 2002.

Table E-32
Charleston Harbor Study
Net Benefit Evaluation
Shutes/Folly Channel Realignment
(Thousands of 1995 Dollars)

Item	Costs/Benefits for 45' Channel
<u>Summary of Costs</u>	
<u>Existing Alignment</u>	
Construction Cost	
Rebellion/Folly Reach	$4,094
Horse/Shutes Reach	1,732
Contingencies	873
Subtotal	6,700
<u>New Alignment</u>	
Construction Cost	
Rebellion/Folly Reach	3,670
Horse/Shutes Reach	6,246
Contingencies	1,487
Subtotal	11,402
Total Incremental First Cost	4,702
IDC	1,263
Total Investment Cost	5,965
<u>Average Annual Cost</u>	
Interest	455
Amortization	12
O&M	10
Total AAC	477
<u>Average Annual Benefits</u>	
Delay Reduction	398
Reduced Transit Time	424
Total AAB	823
<u>B/C Ratio</u>	1.73
<u>Net Benefits</u>	346

Source: Computations by Charleston District; reflects January 1995 dollars and the current federal discount rate of 7.625 percent.

Table E-33
Charleston Harbor Study
Net Benefit Evaluation
Total Harbor Project
(Thousands of 1995 Dollars)

Item	Main Channel	Daniel Island Turning Basin	Shutes/Folly Realignment	Total Project
Total First Costs	$93,023	$8,604	$4,702	$106,330
IDC	16,704	(423)	1,263	17,544
Total Investment Cost	109,727	8,181	5,965	123,873
Average Annual Costs				
Interest	8,367	624	455	9,445
Amortization	218	16	12	246
Annual O&M	930	70	10	1,010
Total AAC	9,515	710	477	10,701
Average Annual Benefits				
Total AAB	17,856	832	823	19,511
B/C Ratio	1.88	1.17	1.73	1.82
Net Benefits	8,342	122	346	8,810

Source: Computations by Charleston District; reflects January 1995 dollars and the current federal discount rate of 7.625 percent.

Table E-34
Charleston Harbor Study
Allocation of Costs for Recommended Plan and Without-Project Modifications
(Thousands of 1995 Dollars)

Item	$1,000
Summary of First Costs	
General Navigation Features	
Recommended Plan	$97,773
Without-Project Safety Modifications	10,309
Subtotal	108,082
Aids to Navigation	78
Non-Federal Costs	8,479
Total First Cost	116,639
LERRD	
Disposal Diking	2,449
Real Estate	17
Total LERRD	2,466
Non-Federal Cash Contribution	
25% GNF = (.25 X $108,082) =	27,020
10% GNF, less LERRD = (.10 X $108,082) - $2,466 =	8,342
Total Non-Federal Cash Contribution	35,362
Total Non-Federal Costs	
Berthing Area Deepening	6,012
LERRD	2,466
Cash Contribution	35,362
Total Non-Federal Costs	43,840
Federal Costs	
Federal Share of GNF (.75 X $108,082)	81,062
less Non-Federal Reimbursement Funds	(8,342)
Other Federal Costs	78
Total Federal Costs	72,798

Source: Computations by the Charleston District.

Section 6. Sensitivity/Risk Analysis

I. Overview.

The sensitivity/risk analysis evaluates the sensitivity of project benefits to variance in inputs to the benefit analysis that is caused by risk and uncertainty. Two main inputs to the benefit analysis are considered: estimates of vessel operating costs and commodity traffic projections.

II. Vessel Operating Costs.

A primary focus of this analysis is the impact of periodic revisions of vessel operating costs on project benefits. Vessel operating costs are a key variable in determining the economic feasibility of deep draft navigation projects. Until 1995, estimates of vessel operating costs presented in the Corps' Economic Guidance Memorandum had not varied greatly over the last decade. The 1995 vessel cost formulations are a marked departure from those computed in previous years.

In evaluating the impact of changes in estimates of vessel operating costs to the economic feasibility of the Charleston Harbor Deepening Study, project benefits were recomputed using all estimates of vessel operating costs developed since 1986. Per ton transportation costs and the resulting benefits were computed for each year from 1986 to 1995 for which vessel operating costs were estimated.

Since estimates of vessel operating costs for all vessel types have been affected similarly by the changes described in Section 3, this analysis evaluates the impact of changing estimates of vessel operating costs on one commodity group. Coal traffic was selected for use in this analysis, in part, because the benefit evaluations for other commodities were developed while the risk analysis was performed by a consultant.

Vessel operating costs were recalculated for the foreign-flagged bulk carriers used to export coal from Charleston as described below. Hourly in-port and hourly at-sea costs were calculated for all sizes of vessels projected to call on Charleston over the study period. These hourly costs were input into the computations of transportation costs to estimate weighted average per ton transportation costs for two harbor depth scenarios: without-project conditions and the 42 foot channel[18].

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[18] The 42-foot channel was selected for analysis because this alternative was evaluated and found to be economically feasible in the reconnaissance study. The evaluation of the full range of channel deepening alternatives was completed concurrently with the risk analysis.

The per-ton project benefits associated with coal exports were calculated by subtracting the per ton transportation costs associated with the without-project channel from the per ton transportation costs associated with the 42-foot channel. This process was repeated for each year that new vessel transportation costs were published in the EGM: 1986, 1987, 1988, 1990, 1991, 1992, 1993, and 1995. The results were statistically evaluated to describe distributions and expected values of project benefits, illustrating the effects of uncertainty in estimating vessel operating costs.

The eight sets of in-port and at-sea vessel costs developed since 1986 were adjusted to account for changing price levels and discount rates. For each set of costs developed since 1986, annual vessel capitalization costs were recalculated assuming the replacement costs of the vessel would be amortized using the current Federal discount rate of 7.625 percent. All other inputs into the vessel cost formulas were held at their original values. The results were adjusted to 1995 dollars using the Implicit Price Deflator Indices presented in the 1995 EGM. The results of this analysis are shown in Table E-35.

The difference in per ton transportation costs and benefits over the projection years is the result of changes in the fleet that is projected to use the harbor under with-project conditions. The fleet is projected to change over time in response to the deepening of the harbor, with deeper draft vessels calling at the port under the with-project conditions. This change is projected to occur during first 10 years that the project is operational. The composition of the fleet is projected to remain constant thereafter.

Table E-35 shows that variance in the EGM's estimates of vessel operating costs has a substantial impact on per-ton project benefits in 2002, which range from $0.67 to $1.12 and average $0.86. The range of per-ton benefits is much narrower if vessel cost estimates from the 1986 and 1995 EGM are omitted from the analysis; the total range is just $0.18, from $0.79 to $0.97.

The estimates of vessel costs used to determine project feasibility lie close to the middle of the range depicted in this sensitivity analysis. These vessel costs, described in Section 3 of this appendix, yield per-ton benefits of $0.88 for traffic moving in 2002. A small part of this benefit (about $0.10 per ton) is attributable to refinements in the fleet projections that were made after the consultant initiated the risk analysis. The adjusted per-ton benefit for traffic in year 2002 is $0.78.

Table E-35
Charleston Harbor Study
Transportation Cost Estimates
(Constant 1995 Dollars and Discount Rate)

Project Year	Vessel Cost Formulation Year							
	1995	1993	1992	1991	1990	1988	1987	1986
Without-Project Costs per Ton								
2002	$9.58	$10.98	$11.06	$11.18	$11.03	$10.62	$13.29	$15.72
2007	9.56	10.95	11.03	11.16	11.01	10.59	13.26	15.68
2012	9.54	10.92	11.00	11.14	10.98	10.56	13.22	15.64
With-Project Costs per Ton								
2002	$8.91	$10.15	$10.22	$10.39	$10.24	$9.75	$12.32	$14.60
2007	8.71	9.88	9.95	10.15	10.02	9.44	12.09	14.39
2012	8.65	9.79	9.87	10.08	9.94	9.35	12.01	14.31
Benefits per Ton								
2002	$0.67	$0.83	$0.84	$0.79	$0.79	$0.87	$0.97	$1.12
2007	0.85	1.07	1.08	1.01	0.99	1.15	1.17	1.29
2012	0.89	1.13	1.13	1.06	1.04	1.21	1.21	1.33

Source: Calculations by Gulf Engineering and Consultants, Inc., 1995.

III. Commodity Forecasts.

Commodity forecasts are another key variable in estimating benefits of deep draft navigation projects and are an important source of uncertainty in navigation projects. Transportation savings associated with a harbor improvement are a function of vessel operating costs and the fleet forecasts. These savings are computed on a per ton basis and are applied to projected commodity movements to estimate total project benefits.

When evaluating a deep draft navigation project, commodity forecasts must be developed for each commodity affected by the project. Some projects may benefit only one or two commodities. The deepening of Charleston Harbor will impact several commodities, namely containerized cargo shipments and receipts, iron carbide receipts, grain exports, coal exports, and receipts of petroleum and petroleum products.

Two general classes of benefits accrue to channel deepening projects. First, a deeper channel allows for traffic to be shipped more efficiently. With a deeper channel, large vessels that already call on the port can do so with fewer tidal delays and less light-loading. In addition, larger vessels can be used instead of smaller, less efficient vessels.

Induced traffic movements produce another class of benefits. In this case, larger volumes of traffic are shipped under with-project conditions. This can occur when reductions in transportation costs, and thus the delivered price of the commodity, are sufficient to allow entry into new markets or to cause increased use of the commodity in existing markets.

All benefits of the deepening of the Charleston Harbor are the result of improved efficiency. No induced traffic flows are projected to result from the channel deepening.

Commodity projections for the Charleston Harbor deepening study were developed in two major steps. First, time-series data were evaluated to identify historical trends and to compute normalized base-year traffic levels from which to project future traffic. Normalized traffic levels were used to avoid projecting from atypical years with extraordinarily high or low levels of traffic.

Growth rates were then applied to the normalized base-year traffic levels to project future traffic levels. These growth rates were derived from exogenously developed projections of variables that are good predictors of commodity traffic at the port. If the demand for the commodity being forecast is believed to be driven by domestic production or consumption, the growth rate of a comprehensive economic indicator such as OBERS county population or earnings projections was used. If the demand for the commodity is driven by foreign trade factors, the growth rate of macroeconomic commodity forecasts such as DOE projections of US coal exports was used.

Risk arises in commodity forecasts because the quantity of commodities to be handled through a port in future years cannot be known with certainty. In a global economy, changing factors such as the value of the dollar, the local or regional capacity to supply the commodity, the world commodity market, and the relative competitiveness of the local market and port are just a few factors that impact future commodity movements through a port and result in uncertainty in the commodity forecasts. Estimation of the normalized base-year traffic levels, the choice of the appropriate growth rate, the ability of the growth rate to accurately project commodity movements, and the definition of the area of supply and demand are all potential sources of risk and uncertainty in developing commodity projections.

Commodity forecasts are dependent on assumptions about uncontrollable factors that affect demand for traffic, which gives rise to uncertainty in the forecast. These uncontrollable factors can be broadly classified as economic and governmental factors. Economic factors can be disaggregated as international, regional, market, and enterprise factors. International factors affect rates of growth of world trade for specific nations, trade routes, or industries. Regional factors affect local traffic demand when the demand is defined as a function of an economic indicator of the local study area. Market factors reflect the competitiveness between competing industries and firms, whereas enterprise factors pertain to particular firms. Governmental factors are future changes to laws, regulations, and policies that could impact traffic at the local harbor, including changes in tariffs, embargoes, subsidies, and foreign aid that could affect the supply of and demand for commodities. The future impact on the local commodity traffic resulting from these factors cannot be estimated with certainty.

To illustrate the sensitivity of the results of this study to risk and uncertainty in the commodity forecasts, the net benefits of the total 45-foot channel-deepening component of the recommended project were reevaluated under two alternative scenarios. The first scenario assumes that no growth of commodity traffic will occur after the base year of 2002. The second scenario assumes that no growth will occur beyond 1992. The results of this analysis are shown in Table E-36.

Despite the sensitivity of benefits to changes in commodity traffic projections, the 45-foot channel-deepening component of the recommended project is economically viable under the assumption that traffic will not grow beyond 2002. Holding projected future traffic constant at 1992 levels yields negative net benefits. Since 1992, however, Charleston Harbor has attained nearly all the growth in commodity traffic needed to render this component economically viable should no further growth occur.

Table E-36
Charleston Harbor Study
Benefits and Costs of 45-Foot Channel Under Alternative Traffic Growth Scenarios
(Thousands of Dollars)

Item	Baseline Projections	No Growth After 2002	No Growth After 1992
Costs			
Total AAC	9,515	9,515	9,515
Benefits			
Total AAB	17,856	12,673	8,418
B/C Ratio	1.88	1.33	0.88
Net Benefits	8,342	3,158	(1,097)

Source: Computations by Charleston District; reflects January 1995 dollars and the current federal discount rate of 7.625 percent.

Section 7. Multiport Analysis

Multiport analysis is a systematic assessment of the effects of the with-project condition on other ports. The primary objective of this analysis is to allow the planner to adjust the traffic forecast to account for shifts of cargoes among alternative ports in response to the with-project condition at the port of study.

In this feasibility study, no shifts of cargoes from alternative ports are projected to occur in response to the with-project condition. The commodity projections upon which this feasibility study is based assume that traffic levels in Charleston change in proportion to broad, regional patterns of growth. Projected traffic levels are a function of regional growth rates and base-year traffic levels. They do not contain any induced traffic or traffic that shifted from another port. With and without-project traffic levels are identical.

Petroleum products are shipped to Charleston from the Gulf Coast, Jacksonville, the Virgin Islands and elsewhere. These products consist of gasoline, distillate fuel oil, residual fuel oil, and lubricating oil and are consumed in Charleston and the surrounding area. If these products were shipped to the Charleston area through another port, such as Savannah or Wilmington, the cost of moving the products by truck or rail from the competing port would far outweigh any potential navigation benefit. Similarly, iron carbide shipments to the NUCOR steel plant that is being constructed just outside of Charleston would incur substantial overland costs if received at another port.

Coal exports from Charleston are a very small part of total US coal exports, consisting of highly-specialized blends of coal for metallurgical and other industrial uses. The Shipyard River Coal Terminal (SRCT) is the only coal terminal on the east coast with CSX and Norfolk-Southern rail access and on-site blending capabilities. The benefit analysis for coal exports does not depend on SRCT's ability to capture another port's coal traffic, but reflects the assumption that SRCT traffic levels will grow at the same rate as coal exports in general. It is very unlikely that this traffic will shift to another port in light of SRCT's access to such a broad range of coals, their on-site blending capabilities, and the highly-specialized market that is being served.

Grain exports primarily consist of wheat, soybeans, and other grains that are grown in South Carolina and are shipped to Europe and the Mideast. Estimates of benefits to grain exports do not depend on future transfers of grain shipments from competing ports but assume that Charleston's grain exports will grow at the same rate as those of the nation. It is unlikely that this traffic will shift to another port in light of the very small potential for navigation benefits and the certainty of significant increases in overland transportation charges.

Charleston is the second largest container port on the east and Gulf coasts and the second most efficient port in the world, measured in terms of throughput per crane. The benefit evaluation upon which this study is based assumes that containerized cargo in Charleston will grow at the same rate as that of the rest of the southeastern United States. Thus, the realization of the benefits projected in this study are not dependent upon the diversion of traffic from other ports to Charleston. In light of the size and efficiency of the harbor, it is very unlikely that any of Charleston's traffic will be diverted to other ports.

APPENDIX F

Correspondence

south carolina state ports authority
Post Office Box 817, Charleston, South Carolina 29402-0817 Telephone 803/577-8600

W. Don Welch
EXECUTIVE DIRECTOR

February 13, 1996

Lt. Col. Thomas F. Julich
Charleston District
U. S. Army Corps of Engineers
P. O. Box 919
Charleston, S. C. 29402

Dear Col. Julich:

The South Carolina State Ports Authority is pleased to see the completion of the feasibility study for the Charleston Harbor Deepening/Widening Project. Since 1990 when this study was authorized by resolutions of the U. S. Congress, the Authority has been ever aware of the increasing demands placed on our shipping channels by the longer, deeper-draft container vessels now being introduced into service. It is critical that we move ahead with harbor deepening and appropriate channel modifications in response to the demands of international trade so vital to our country's economic well-being.

The Authority has thoroughly reviewed the feasibility study report and agrees with its findings and recommendations that Charleston Harbor be deepened from 40 feet to 45 feet with channel alterations in several reaches. The Authority is also fully aware of the terms of the Project Cooperation Agreement and is prepared to accept its responsibilities as the non-federal sponsor of the project.

Please consider this the Authority's letter of intent to enter into a final agreement with the Corps at the appropriate time in preparation for project construction. Our statement of financial capability demonstrates that the Authority will have the necessary funding in place to meet the project cost-sharing obligation.

The Authority looks forward to working with the Corps in an attempt to expedite the authorization and timely construction of the Charleston Harbor Deepening/Widening Project. As we move toward this important goal, please do not hesitate to contact me if the Authority can assist in any way.

Sincerely,

W Don Welch

W. Don Welch

WDW:jrl

South Carolina
Department of Parks, Recreation & Tourism
Engineering and Planning Office

January 30, 1996

Mr. Thomas F. Julich
Lieutenant Colonel, U.S. Army
Charleston District Corps of Engineers
P.O. Box 919
Charleston, SC 29402-0919

Re: Draft Feasibility Report and Environmental Assessment
Charleston Harbor, South Carolina

Dear Mr. Julich:

The South Carolina Department of Parks, Recreation and Tourism has no comments or concerns pertinent to your project at this time. Thank you for the opportunity to review and comment on this and other projects that could possibly affect existing and/or planned recreational facilities.

Sincerely,

Tony L. Bebber,
Planner

1205 Pendleton Street - Columbia, South Carolina 29201, USA (803) 734-0122, FAX (803) 734-1042

EVERGREEN AMERICA CORPORATION
CHARLESTON OFFICE
167 EAST BAY STREET, P.O. BOX 1019
CHARLESTON, SOUTH CAROLINA 29402, U.S.A.
TEL.: (803) 722-4431 • TELFAX: (803) 577-7151
TELEX: 4939335 GRENCHS

January 9, 1996

Attn: Thomas F. Julich
Lieutenant Colonel, U.S. Army
District Engineer
Department of Army
Charleston District Corp of Engineers
P.O. Box 919
Charleston, SC 29402-0919

Lieutenant Colonel Julich:

Thank you for sending the Draft Feasibility Report with Environmental Assessment to the Charleston office of Evergreen America Corporation. We appreciate your allowing Evergreen America Corporation the opportunity to review this material. The report is very thorough in detail and extremely educational.

The deepening of the channel is a very important issue for our company. Our new generation vessels are longer and deeper than the present vessels that call Charleston. Currently we have 10 "R" type vessels calling Charleston. The "R" type is 965' long with a 41' 4" draft. In the near future we will have a total of 20 vessels this size calling Charleston. Due to the existing channel conditions and size of our vessels, the Charleston Pilot's have issued certain restrictions. Our "R" type ships are only allowed in and out of the harbor during flood tide. With drafts over 37' we must wait for higher water during the flood tide. For Evergreen this means we must adjust our vessel schedule to arrive and depart our "R" type vessels through the port. It also means that we must carry lighter loads than normal. This creates a tremendous disadvantage for our steamship line and the Port Authority.

By deepening the channel we will be able to load more cargo and channel our new Panamix vessel along with the "R" type vessels in and out of the Charleston Port. This would be very advantageous for Evergreen America Corporation. Your report is of great interest to our company.

Sincerely,

Sam Lord
Manager of Operations

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9721 Executive Center Drive N.
St. Petersburg, FL 33702

March 6, 1995 F/SEO13:JEB

Thomas W. Waters
Chief
Engineering and Planning Division
U.S. Army Corps of Engineers
P.O. Box 919
Charleston, SC 29402-0919

Dear Mr. Waters:

This responds to your letter dated January 25, 1995, regarding deepening the Charleston Harbor channel and Shipyard River entrance channel, from 40 and 38 feet respectively, to 42 feet below mean low water with 2 feet of allowable depth and 2 feet of advance maintenance. A biological assessment was submitted pursuant to Section 7 of the Endangered Species Act of 1973 (ESA) in 1991 prior to the issuance of a generic biological opinion on channel dredging along the Atlantic coast of the Southeast United States.

We have reviewed this project and concur with your determination that populations of threatened or endangered species under our purview would not be adversely affected by the proposed action provided that all dredging is carried out in accordance with the November 1991 biological opinion.

This concludes consultation responsibilities under Section 7 of the ESA. However, consultation should be reinitiated if new information reveals impacts of the identified activity that may affect listed species or their critical habitat, a new species is listed, the identified activity is subsequently modified, or critical habitat is determined that may be affected by the proposed activity.

If you have any questions please contact Jeffrey Brown, Fishery Biologist, at (813) 570-5312.

Sincerely,

for:

Andrew J. Kemmerer
Regional Director

cc: F/PR8
F/SEO2

South Carolina Department of
Natural Resources

James A. Timmerman, Jr., Ph.D.
Director
Alfred H. Vang
Deputy Director for
Water Resources

February 6, 1995

Ms. Robin Socha
EN-PR
Dept. of the Army
Charleston District, Corps of Engineers
P.O. Box 919
Charleston, SC 29402-0919

RE: Charleston Harbor Deepening Project

Dear Robin,

I have reviewed the 404(b)(1) Evaluation for the Charleston Harbor Deepening Project for any potential adverse impacts on underlying aquifers. The project involves deepening the Charleston Harbor from 40 feet to between 42 and 45 feet below mean low water.

According to SCDNR-WRD records, the top of the Cooper Formation lies between the approximate elevations of -10 and -60 feet mean sea level in the project area, with thickness varying from 200 to 260 feet. This formation acts as the upper confining layer to the Santee Limestone. The aquifers of the Santee Limestone and the underlying Black Mingo Formation contain salt water in the vicinity of Charleston Harbor.

In light of hydrogeologic conditions, no adverse impacts to aquifers are expected as a result of deepening Charleston Harbor by a maximum of five feet. Should you need additional information, please feel free to contact this office.

Sincerely,
Brenda L. Hockensmith P.G.
Brenda L. Hockensmith, P.G.
Senior Hydrologist

cc: Rod Cherry, Section Chief
A. Drennan Park, Regional Hydrologist
file

South Carolina
DHEC
Department of Health and Environmental Control
4130 Faber Place, Suite 300
Charleston, SC 29405

Commissioner: Douglas E. Bryant

Board: John H. Burriss Chairman
Sandra J. Molander, Secretary

Richard E. Jabbour, DDS,
William M. Hull, Jr., MD
Roger Leaks, Jr.

Promoting Health, Protecting the Environment

Office of Ocean and Coastal Resource Management

H. Wayne Beam, Ph.D., Deputy Commissioner
Christopher L. Brooks, Assistant Deputy Commissioner

(803) 744-5838
(803) 744-5847 (fax)

February 1, 1996

Mr. Richard M. Jackson, P. E.
Charleston District Corps of Engineers
Post Office Box 919
Charleston, South Carolina 29402-0919

Re: Amendment to Charleston Harbor
Deepening Widening Project
Charleston county
Federal Consistency

Dear Mr. Jackson:

The staff of the Office of Ocean and Coastal Resource Management (OCRM) certifies that the above referenced project is consistent with the Coastal Zone Management Program. This project approval is based upon revised plans submitted to SCDHEC/OCRM on January 31, 1996, and marked as such. Except as shown on these plans, no construction is to occur in any wetland areas. These plans do not include approval for construction of the proposed Daniel Island Terminal Facility.

Interested parties are provided ten days from receipt of this letter to appeal the action of the OCRM.

Sincerely,

Robert D. Mikell
Director of Planning and
Federal Certification

JHA
JHA/23197/jk

cc: Dr. H. Wayne Beam
Mr. Christopher L. Brooks
Mr. H. Stephen Snyder

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 4

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

DEC 13 1995

James L. Joslin, Acting Chief
Planning Division
Charleston District, Corps of Engineers
P.O. Box 919
Charleston, SC 29402-0919
Attn: Ms. Coller-Socha, ER-PR

Subject: Draft Environmental Assessment (EA) for Charleston Harbor Upgrades, Charleston County, SC

Dear Mr. Joslin:

Pursuant to Section 309 of the Clean Air Act, Region 4 has reviewed the subject document which discusses the consequences of deepening, widening, and realigning the existing navigation channel along with certain associated facility improvements, e.g., contraction dikes and a turning basin, to expedite shipping transit. Although the channel has recently been upgraded, the container/bulk cargo shipping market favors the use of ever larger deep draft vessels which would have to enter/leave light loaded to traverse the berthing/fairway areas safely. Channel excavation will be done with a combination of hydraulic, hopper, and clam shell dredges with material placed in existing upland and offshore disposal sites.

The following comments are provided to assist in the preparation of the final document and the proposed "Finding of No Significant Impact" (FONSI):

> This proposal has an extensive scope, a large economic component, significant environmental/societal/economic ramifications, and takes place over a fifty-year period. Decision-making associated with projects of this magnitude/type are normally addressed in the context of an environmental impact statement. Hence, the District's election to use the EA format is perplexing given the absence of specific discussion as to how/why the determination to use this model was reached. Subsequent documentation should provide detailed exposition regarding the rationale(s) for the conclusion that a FONSI is, in fact, appropriate.
>
> The cited ultimate channel depths of this project are characterized in a number of different ways throughout the EA and supporting material. Hence, resultant differing figures

may be more apparent that real, i.e., based on different reference points. For example, the limits of the entrance channel will be extended to the depth of the natural ocean contour which is mentioned as either 47′ or 51′. If the latter value is correct, the values presented in Table 4 (p.35) would need to be revised unless reaches below 47′ will not be dredged. Our difficulties in this matter may center on the advanced and overdraft components associated with the project. That is, it was clearly stated that deepening will not occur where the present depth is already at 47 feet. However, it is unclear whether this stipulation takes into account overdraft elements (which would then actually result in a 51-foot depth). It would be helpful if there were a table in Section 8 (p. 61) with current authorized dimensions compared with those of the proposed project based on a common bench mark.

The South Carolina Department of Health and Environmental Control (SCDHEC) noted that the water quality classification within the project area is sometimes violated, e.g., the SB rating for Charleston Harbor fails to meet standards for dissolved oxygen and fecal coliform parameters. Dredging activities are sometimes the reason for these transgressions, viz., dissolved oxygen concentrations in the return water from disposal areas were noted to fall below standards. Water quality classification (SFH) for tidewater portions of the Wando River is more restrictive due to its shellfish harvesting potential. Whether or not this classification is in constant conformance was not mentioned, but should be. Regardless, the most recent studies cited in the EA are somewhat dated, ca. 5-6 years since publication. Hence, the present condition of the area can only be inferred, but the literature should be examined to determine if more current data are available. More importantly, there is no basis for the conclusionary statements made throughout the documents that the water quality effects (short- or long-term) of deepening/widening would be insignificant. We suggest that substantiating evidence from this or similar projects be provided at least by reference to support these conclusions.

Some of the calcareous material which would have to be excavated from the channel bottom may require a special cutter head. We understand that the dredging contractor for each reach will make the final determination as to the particular technique/equipment to use. From an environmental perspective this cutter head removal does not appear substantively different from the more usual hydraulic suction. However, if explosives are deemed necessary to fracture some of the more indurate coquina deposits, addition discussion(s) regarding the ramifications of this method on estuarine biota will be necessary. The protocol for this type excavation should determine how recurrent blasting will affect life cycle functioning within any nursery areas adjacent to the channel as well as transit of the area by anadromous fish. Representative monitoring should focus on how these parameters will be affected and the results shared with involved state/federal resource agencies for comment.

Induced impacts associated with this proposal are only briefly mentioned. For example, the State Ports Authority has purchased land on Daniel Island to develop a fourth container terminal. However, neither the degree to which development of Daniel Island is contingent on this upgrade nor the impacts of this new terminal are discussed in the EA. Further, it appears likely that additional upgrades, e.g., channel realignment together with efficiency/safety measures, will be likely when this facility become operational. It would be prudent if these immediately anticipated impacts were addressed in total rather than in an incremental fashion. Moreover, the relationship of how this particular construction will affect other competing facilities along the Atlantic coast which are subsidized by the federal government should be discussed in a multi-port analysis.

The federal government's share of the estimated initial cost of this facility is approximately 75%. The sponsor will pay the remainder together with an additional 10% of the cost of the general navigation features of the project. It should be noted that funding for all federal activities is currently undergoing some significant congressional revisions. With this in mind it would be prudent to ascertain whether the local sponsor is sufficiently well capitalized and/or disposed to assume a larger share of the funding if this becomes necessary.

Concern has been raised regarding the potential effects that channel widening/deepening would have on the adjacent bottom geometry, especially as it relates to bridge crossings. The fact that hydrographic survey data indicate that scouring occurs at piers far removed from the navigation channel does not necessarily mean that topographic changes associated with maintaining a deepened channel are not operative in this scouring phenomenon. It is also important to note that the use of contraction dikes along the channel are going to introduce a new element in the esturary's hydrodynamics. Plan 2-5T contained the sediment modelling for these structures, but we did not see a comparable reference for the hydrodynamics associated with same.

The cost and relationship of same to the remaining capacity of adjacent upland disposal sites (UDS) was mentioned as an important planning consideration. In fact, maintenance costs for the inner harbor were calculated based upon the current practice of upland disposal for material in this reach. However, no definitive conclusions were made as to whether there would be adequate UDS capacity during project life to support this assumption. Because this uncertainty could have a significant effect on long-term project costs, additional examination of this matter needs to be made before initiating construction. This is especially true given the expected increases in annual maintenance which will be necessary after channel widening/deepening occurs.

Certain of the assumptions made regarding dredging need additional explanation. We understand that a dredge operator (especially with clam shell equipment) seeks to maximize efficiencies via deep versus shallow increments of material excavated. However, the logic that alternatives with shallow channel depths are relatively more expensive needs to be applied with caution. That is, at some juncture in the excavation process, ca. approaching limits of authorized depths, material removal will have to taper off unless it can be demonstrated that the technology to dredge in bulk to these limits presently exist. In the absence of this precision, tapering occurs regardless of the amount of material removed. If, however, an operator will bid a lower per cubic yard cost for larger jobs (three vs five years of work in this case), this should be stated. We would also observe that even with the shallower channel alternatives (such as the 42′ channel option which incidentally has the greatest B/C ratio) there could be at least 6′ of material dredged. Hence, the idea of differential costs associated with varied depths of channel excavations may just be a relative situation. Irrespectively, it needs further discussion.

We wish to add our support to the proposal by state and federal wildlife agencies to provide additional nesting habitat at Crab Bank if suitable coarse clean sand/gravel can be obtained. In a related matter, if the clam shell dredge which will be used in the Shutes/Folly reaches can excavate sufficiently large pieces of limestone, consideration should be given to protecting historic Castle Pinckney with this material.

It was noted that there are only slight environmental differences between the channel deepening alternatives. Yet, an examination of Table 4/5 demonstrates that there are dramatic differences in the amount of material which must be excavated with increasing depths. If there were even just a linear relationship between dredging impacts and volume, this "nominal consequence" characterization needs more complete development.

We agree that wetland mitigation for unavoidable losses will be necessary. As soon as the exact amount of this habitat (less than one acre p.52 of the Study Report or two acres p. 7 of the EA) sacrificed by construction activities is available, Ms. Marjan Farzaad (404-347-3555 VM 6562) should be contacted for consultation. In a related matter, Mr. Gary Collins (706-542-2297) should be contacted relative to use and/or testing requirements for offshore sediment disposal.

It was indicated (EA-6) that the salinity intrusion model forecasts no significant difference between the existing -40 foot and the proposed -45 foot channel. This may be true, however, we believe that the document would be improved with some additional explanation/documentation about this issue.

The conclusionary statement is made that the fishery resources of Charleston Harbor would not be significantly impacted by the proposed project. However, the EA would be improved with at least a citation from previous research which serves to substantiate this premise.

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

Sincerely yours,

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

State of South Carolina

Office of the Governor

David M. Beasley
Governor

Office of Executive
Policy and Programs

ACKNOWLEDGEMENT

January 4, 1996

LT. COL. Thomas F. Julich
District Engineer
U. S. Department of the Army
Charleston District Corps of Engineer
Post Office Box 919
Charleston, South Carolina 29402-0919

Project Name: Charleston Harbor Charleston, South Carolina Draft Feasibility Report with Environmenntal Assessment US Army Corps of Engineers

Project Number: SC960111-001

Suspense Date: 1/29/96

Dear LT. COL. Julich,

Receipt of the above referenced project is acknowledged. The Governor's Office, Grant Services Unit, has initiated an intergovernmental review of this project. You will be notified of the results of this review by the suspense date indicated above. South Carolina state agencies are reminded that if additional budget authorization is needed for this project, three copies of the completed GCR-1 form and two copies of the project proposal must be submitted to this office. This action should be initiated immediately, if required. You should use the State Application Identifier number in your correspondence with our office regarding this project. Contact me at (803) 734-0485 if you have any questions.

Sincerely,

Rodney P. Grizzle
Grants Services Supervisor

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9721 Executive Center Drive North
St. Petersburg, Florida 33702-2432

January 18, 1996

Lt. Colonel Thomas F. Julich
District Engineer, Charleston District
Department of the Army, Corps of Engineers
P.O. Box 919
Charleston, South Carolina 29402-0919

Dear Colonel Julich:

The National Marine Fisheries Service (NMFS) has reviewed Public Notice 95-1R-406 which announces addition of components to the Corps of Engineers' Charleston Harbor Deepening Project, Charleston County, South Carolina. The NMFS provided comments on the overall project and the Draft Environmental Assessment in our letter dated December 5, 1995. Planned additional work includes refurbishing of two existing contraction dikes; construction of a third contraction dike; and excavation of a ship turning basin. Planned activities would occur in waters of the Cooper River (Charleston Harbor) and involve:

o Construction of a 300-foot-long solid-fill marl causeway and 700-foot-long sheet-pile dike covering approximately 2 acres of regularly flooded wetlands and 4 acres of intertidal and subtidal unconsolidated estuarine bottom.

o Construction of an 80-acre (approximate) by 49-foot-deep ship turning basin in submerged bottom.

o Placement of 3 million cubic yards of dredged material in the Clouter Island diked disposal site.

Three distinct aquatic zones -- unconsolidated deepwater bottom, intertidal flats, and emergent wetlands would be affected by the additional work. Unconsolidated deep-water bottoms in the vicinity of Charleston Harbor generally do not support large populations of commercially or ecologically important benthic organisms. Possible exceptions include bivalves such as hard clams (Mercenaria mercenaria); transitory invertebrates such as blue crabs (Callinectes sapidus) and shrimp (Penaeus spp.); and demersal fish such as summer flounder (Paralichthys dentatus).

Intertidal sand and mud flats generally provide more suitable habitat for living marine resources. Conditions such as shallow water depth and exposure to sunlight favor fish nursery functions and increased food production. The intertidal flats of the Cooper

River are recognized as important sites for the growth and maturation of a large and diverse group of fish and invertebrates that are of ecological and economic importance.

The regularly flooded smooth cordgrass (Spartina alterniflora) marsh is a highly productive resource. Its use as forage, cover, and reproductive sites for a variety of living marine resources is also well established. The tidal marsh also has considerable value with regard to estuarine food production and water quality enhancement as provided through erosion abatement, sediment retention, and assimilation of excess nutrients and pollutants.

Based on the ecological and economic value of the aquatic areas that will be affected by the proposed action, impact avoidance, minimization, and mitigation are needed to preclude significant degradation of living marine resources. Needed measures, which are hereby provided in accordance with provisions specified the Fish and Wildlife Coordination Act, include:

1. Restriction of all work involving excavation and filling of aquatic habitats to periods of low biological activity. This would limit such work to December 1 through March 15 of any year;

2. Assessment of the location and size of shellfish beds (if any) in the vicinity of all proposed excavation and fill activities;

3. Avoidance, to the extent practicable, of the loss and degradation of productive shellfish (hard clam) beds, intertidal habitats, and emergent wetlands; and

4. Development of remedial measures needed to offset unavoidable wetland and aquatic resource impacts.

In the absence of these measures we conclude that a significant and unacceptable loss of high quality public trust resources will occur and these elements of the overall Charleston Harbor Deepening Project should not be implemented. The NMFS is willing to cooperate with the Charleston District in the design of project features needed to ensure that project purposes are met and South Carolina's aquatic resources are sufficiently protected. Mr. David Rackley of my staff is available to assist you in this regard. He may be reached at P.O. Box 12607, Charleston, South Carolina 29412, or at (803) 762-8574.

Sincerely,

David H. Rackley

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

August 7, 1995

Lieutenant Colonel Thomas F. Julich
Department of The Army
Charleston District, Corps of Engineer
P. O. Box 919
Charleston, S. C. 29402-0919

Subject: Charleston Harbor Channel Deepening/Widening Study
US 17 - Cooper River Bridges - Charleston, S. C.

Dear Sir:

This is regarding Lieutenant Colonel George H. Hazel's letter dated June 8, 1995 concerning the above subject. Personnel of the Department's Hydraulic and Bridge Engineering Staff have reviewed your proposal and offer the following comments.

The Silas N. Pearman Bridge (US 17 - NBL) and the John P. Grace Memorial Bridge (US 17 - SBL) have both experienced major problems with scour at the pier foundations. Many repair projects have been performed over the past several years to correct these scour problems and maintain the structural integrity of the affected pier foundations. Past channel deepening operations, along with severe tidal and river currents, at this location have been the major cause of the prior foundation scour problems. It is felt that a further deepening and widening of the existing channel would significantly worsen an already bad situation. Therefore, the Department opposes the proposed Deepening/Widening project.

Thank you for your attention in this matter. If further information or comment is desired please advise.

Yours very truly,

W. A. KELLER, III

W. A. Keller, III
Deputy Director for Construction,
Engineering & Planning

CC:
Dir. of Maint.
Distr. 6 DEA

RDH/psj
COR.ENG/Hutson/2

SCDOT
South Carolina
Department of Transportation

955 Park Street
Post Office Box 191
Columbia, South Carolina 29202-0191

Office of the Director
(803) 737-1302 ◆ Fax (803) 737-2038

Deputy Director of Engineering
(803) 737-1314 ◆ Fax (803) 737-2038

Deputy Director of Finance and Administration
(803) 737-1240 ◆ Fax (803) 737-1719

Deputy Director of Mass Transit
(803) 737-1280 ◆ Fax (803) 737-1862

January 22, 1996

Lt. Colonel Thomas F. Julich
District Engineer
ACOE, Charleston District
P.O. Box 919
Charleston, SC 29402-0919

Subject: Draft Feasibility Report and Environmental Assessment for Charleston Harbor, South Carolina

Dear Colonel Julich:

The South Carolina Department of Transportation has reviewed the environmental assessment for the proposed dredging activities in Charleston Harbor, specifically as it pertains to the existing Cooper River Bridges. This correspondence constitutes a follow-up to our letter of August 7, 1995, concerning the proposal's impact on the foundations of the Silas N. Pearman Bridge (NBL) and John P. Grace Memorial Bridge (SBL). As you are aware, the Department met with Corps planning officials this past fall to discuss in greater detail the probable affects of deepening the harbor on the bridge foundations.

The Department agrees with the Corps hydrologist who stated during the meeting that additional investigations appear warranted before a final determination can be made on whether the proposed deepening of the harbor would undermine portions of the bridges. It is requested that your agency work with the Department toward a satisfactory resolution of this matter prior to determining whether a Finding of No Significant Impact (FONSI) can be issued.

You may contact Mr. Ron Hutson of our bridge maintenance office to arrange for further coordination efforts. The Department appreciates the opportunity to comment on the proposed undertaking and looks forward to resolving this issue.

Sincerely,

B K Jones

B. K. Jones
Director

Attachments

PFE/cdw

cc: Mr. Keller – Deputy Dir. for Constr.,
Engr., and Planning
Mr. Hutson – Bridge Maint. Engr.

APPENDIX G

South Carolina State Ports Authority Financing Plan

south carolina state ports authority
Post Office Box 817, Charleston, South Carolina 29402-0817 Telephone 803/577-8123

W. M. Lawrence
CHIEF FINANCIAL OFFICER

February 20, 1996

Lt. Col. Thomas F. Julich
Charleston District
U. S. Army Corps of Engineers
P. O. Box 919
Charleston, SC 29402-0919

Dear Col. Julich:

Attached is the Financing Plan and the Statement of Financial Capability of the South Carolina State Ports Authority ("the Authority") in connection with the deepening of the Federal Navigation Channel in Charleston Harbor to a depth of 45 feet.

I hereby state for the officers and Board of the Authority that the Authority, as the local sponsor, understands its financial commitment under this Project, and I am confident you will find that the following information demonstrates the Ports Authority can meet that commitment.

As to the information contained in our Plan and Statement, I hereby certify that: all copies are from original documents in my possession; and, all excerpts have been taken faithfully from original documents in my possession. I further certify that: I have personally prepared the pro forma financial data contained therein; and, I believe them to be true and attainable.

Sincerely,

W. M. Lawrence

WML:jrl

Attachments

South Carolina State Ports Authority

Financing Plan

and

Statement and Financial Capability

as the Non-Federal Partner

under an

AGREEMENT

BETWEEN

THE DEPARTMENT OF THE ARMY

AND

THE SOUTH CAROLINA STATE PORTS AUTHORITY

FOR THE DEEPENING OF THE FEDERAL NAVIGATION CHANNEL

IN CHARLESTON, SOUTH CAROLINA

TO A DEPTH OF 45 FEET

South Carolina State Ports Authority
FINANCING PLAN
for the
Non-Federal Cost Share
of the
Deepening of the Federal Channel
at
Charleston Harbor To 45 Feet

I. Costs

A) Estimated Total Project Cost	$116,639,000
B) Non-Federal Cost Share -	
During construction (5/98 - 4/02)	$ 27,000,000
Post construction (post 4/02)	8,500,000
	$ 35,500,000

II. Financing Plan

A) As with the project to deepen the Federal navigation channel to 42 feet, the South Carolina State Ports Authority plans to seek funding for the Non-Federal cost share of $35,500,000 from the South Carolina Legislature. The Authority believes there is a reasonable chance to secure such funding just as it was able to for the 42-foot deepening project.

B) In the event such funding shall not be available from the South Carolina Legislature, the South Carolina State Ports Authority is fully prepared to, capable of and shall fund the Non-Federal cost share of $35,500,000 from:

1) an accumulation of cash before and during construction; plus the sale, if required, of Revenue Bonds; plus extending the 10% ($8,500,000, plus interest) payment over a period not-to-exceed 30 years;

or

2) a combination of two of the foregoing sources;

or

3) only the sale of Revenue Bonds.

As evidence of its ability to so fund its share as outlined, the Authority provides herewith: the appropriate citation from its enabling legislation; its latest audited annual report; a five-year cash pro forma; a statement from its independent fiscal advisor; and, copies of its bond ratings.

South Carolina State Ports Authority

STATEMENT OF FINANCIAL CAPABILITY

for the
Non-Federal Cost Share
of the
Deepening of the Federal Channel
at
Charleston Harbor To 45 Feet

In its fiscal year 1995 the South Carolina State Ports Authority ("the Authority") produced, after debt service payments, $11,386,000 in net cash flow available for either reinvestment in facilities or debt service payments on additional debt ("available net cash flow" or "ANCF"). Based on its historical financial performance, business under contract and expected cargo trends the Authority projects ANCF for its FY's 1996-2000 to increase from $12,548,000 in FY96 to $14,940,000 in FY 2000.

Based on $12,000,000 in ANCF, the Authority could now issue $117,000,000 in additional revenue bonds, or 3.3 times the Non-Federal share ($35,500,000) of the projected cost to deepen the Federal navigation channel in Charleston Harbor to 45 feet.

W. M. Lawrence
Chief Financial Officer

EXHIBITS

ARTICLE 11

FINANCIAL MATTERS

§ 54-3-1010. Issuance of bonds.

As a means of raising the funds needed from time to time in the acquisition, construction, equipment, maintenance and operation of any facility, building structure, terminal railroad or any other matter or thing which the Authority is herein authorized to acquire, construct, equip, maintain or operate, all or any of them, the Authority may issue bonds, payable both as to principal and interest from the revenues to be derived from the operation of all or any part of its properties and facilities, and the powers and authority granted to counties, cities, school districts and other political subdivisions of the State are hereby extended to and made available to the Authority. All revenue bonds issued by the Authority to obtain funds for the acquisition, construction, equipment, maintenance and operation of its properties and facilities shall be issued in accordance with the provisions of §§ 6-21-10 to 6-21-570 and all conditions, restrictions and limitations imposed by said §§ 6-21-10 to 6-21-570 as amended, shall be observed by the Authority in the issuance of such bonds, except as follows:

(1) A pledge of the net revenues derived from the operation of its properties and facilities, all or any of them, rather than its gross revenues, may be made; and

(2) Free service may, in the discretion of the Authority, be afforded to the United States of America, or any agency, department, corporation or instrumentality thereof, by any property or facility of the Authority to acquire, construct, equip, maintain and operate which funds were obtained from the revenue bonds purchased and held by a Federal agency, provided such free service is with the consent and at the request of the Federal agency then holding the whole of such revenue bonds.

HISTORY: 1962 Code § 54-61; 1952 Code § 54-61; 1942 (42) 1535.

Cross references—
Revenue Bond Act for utilities, see §§ 6-21-10 to 6-21-570.

Research and Practice References—
64 Am Jur 2d, Public Securities and Obligations § 46.
81A CJS, States § 215.
15 Am Jur Legal Forms 2d, Public Securities and Obligations, §§ 214:41 et seq. (issuance of revenue bonds); 214:73 (revenue bond).

FROM: S. C. CODE OF LAWS

South Carolina State Ports Authority
Abbreviated Cash Flow Statements, FY 1995
and
Cash Flow Pro Forma, FY 1996-2000
000's Omitted

	Actual	Pro Forma				
	FY 95	FY 96	FY 97	FY 98	FY 99	FY 2000
Operating Revenues	55,278	59,408	61,784	64,255	66,825	69,498
Operating Expenses	49,668	53,298	55,429	57,647	59,953	62,351
Operating Earnings	5,610	6,110	6,355	6,608	6,872	7,147
Plus Depreciation Expenses	12,234	14,388	14,819	15,264	15,722	16,193
Plus Interest Income	1,520	-0-	-0-	-0-	-0-	-0-
Less Adjustments (net)	1,578	-0-	-0-	-0-	-0-	-0-
	17,786	20,498	21,174	21,872	22,594	23,340
Less Debt Service	6,400	8,400	8,400	8,400	8,400	8,400
Net Cash Flow	11,386	12,048	12,774	13,472	14,194	14,940

Notes

1. FY 95 data from audited financial statements.
2. Pro Forma data based on revenue and expense escalation of 4 % per year.
3. In Pro Forma data, "Interest Income" and "Adjustments" are assumed to be "a wash".
4. Debt service payments consists of two components- $5.4 million per year fixed under senior debt Trust Agreement plus $1.0 -$3.0 million per year on junior debt, sized at the Authority's election.

GFAA

GOVERNMENT FUNDING
ADVISORY ASSOCIATES
ATLANTA • BOSTON • SAN FRANCISCO

February 20, 1996

Mr. W.M. Lawrence
Chief Financial Officer
South Carolina State Ports Authority
176 Concord Street
Charleston, SC 29401

Dear Mr. Lawrence:

You have asked my opinion on the tax-exempt bonding capacity of the South Carolina State Ports Authority assuming certain factual circumstances. According to the information you have provided me, the Authority currently has free cash flow available for debt service requirements, after paying debt service on the Authority's presently outstanding revenue bonds, of approximately $12.5 million. You indicated you wished to know the Authority's bonding capacity assuming a 20-year level debt service amortization schedule based on present market conditions.

For the purposes of this analysis, I have assumed an interest rate of 5.67%, which is equal to the current Revenue Bond Index published weekly by *The Bond Buyer*, and a debt service coverage factor of 125%. Based on these assumptions, and the parameters you have specified, I have calculated a potential bonding capacity for the Authority of approximately $117 million. This calculation assumes that the Authority's present independent credit ratings on its outstanding indebtedness remain unchanged from existing levels.

I have represented the Chief Financial Officer and the Authority as an independent financial advisor and consultant on several transactions since 1989. I am thoroughly familiar with the credit history and good-standing of the Authority in the tax-exempt marketplace, as well as the Authority's ability to issue tax-exempt revenue bonds in a cost effective manner.

Please let me know if there is any additional information I can provide you regarding the Authority's bonding capacity at this time.

Yours very truly,

Robert L. Morrison

Robert L. Morrison
Managing Consultant

1051 Somerset Drive, N.W. • Atlanta, Georgia 30327 • Telephone: (404) 237-5836

Moody's Municipal Credit Report

South Carolina State Ports Authority

November 15, 1991

	New Issue	**Revenue**
sale:	$65,725,000	Revenue Bonds, Series 1991
date:	Expected through negotiation November 19	

Moody's rating: A
Revenue Bonds

opinion: Substantial growth of the authority's diversified container freight operations at Charleston, together with its moderate debt position and historically strong financial operations, provides upper medium grade security. The authority is an active independent operator of an ocean freight terminal system based primarily on four, now heavily containerized facilities in Charleston and two smaller, largely breakbulk and bulk facilities.

key facts:

Type System: Container, bulk and breakbulk cargo seaport, comprising four major ocean terminals at Charleston and facilities at Georgetown and Port Royal. Charleston terminals comprises roughly 85% of total fiscal year 1991 tonnage.

Service Area: Largely southeastern U.S., with 65% of container traffic outside of South Carolina.

Bonds Outstanding: $65,725,000.

Peak Debt Coverage, by FY 1991 Net Revenues:	3.88x
Tonnage by Commodity, FY 1991,	
Wood Pulp:	25.2%
Paper:	15.5%
Iron and Steel:	11.7%
Machinery:	11.5%
Largest Shipping Line as % of Gross Revenues, FY 1991:	12.3%
Ten Largest Shipping Lines as % of Gross Revenues,	
FY 1990:	57.6%
FY 1991:	60.6%
Container Freight as % of Total Tonnage,	
1987:	66.5%
1989:	73.9%
FY 1991:	75.4%
Average Annual Growth in Tonnage,	
FYs 1981-91:	9.1%
1987-91:	6.4%
Average Annual Growth in Container Tonnage, FYs 1987-91:	13.0%
Freight Traffic Origin/Destination as % of Total, FY 1991,	
Far East:	21.1%
Northern Europe:	27.3%

analysis: The emergence of the authority's Charleston ocean freight terminals as a center for diversified containerized shipping operations serving the southeast is a key rating factor. Credit strengths are also derived from the authority's moderate amount of current and planned indebtedness and strong, conservatively managed financial operations that provide a broad level of peak debt service coverage. With the author-