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LONG-TERM MANAGEMENT STRATEGY FOR DREDGED MATERIAL DISPOSAL FOR THE NAVAL WEAPONS STATION, YORKTOWN, YORKTOWN, VIRGINIA; NAVAL SUPPLY CENTER, CHEATHAM ANNEX, WILLIAMSBURG, VIRGINIA; AND NAVAL AMPHIBIOUS BASE, LITTLE CREEK, NORFOLK, VIRGINIA

PHASE I: EVALUATION OF EXISTING MANAGEMENT OPTIONS AND DATA

by

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This report is the first in a five-phased process designed to locate the most suitable sites for the long-term management of material dredged from three naval bases located in southeastern Virginia. These bases include the Naval Weapons Station, Yorktown, Yorktown, VA; the Naval Supply Center, Cheatham Annex, Williamsburg, VA; and the Naval Amphibious Base, Little Creek, Norfolk, VA. The long-term management strategy (LTMS) used in this process consists of evaluating existing management options, formulating the alternatives, performing a detailed analysis of the alternatives, implementing the LTMS, and conducting a periodic review and update of the LTMS. The purpose of such an LTMS is to provide a consistent, logical procedure by which alternatives can be identified, evaluated, screened, and recommended so that the dredged material placement operations are conducted in a timely and cost-effective manner.

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18. SUBJECT TERMS (Continued).

Chesapeake Bay	Dredging
Craney Island	Environmental resources
Dredged material disposal alternatives	Long-term management strategies
	York River

19. ABSTRACT (Continued).

This report describes the location, dredging requirements and material characteristics, environmental resources, and disposal resources and alternatives of the three naval bases. Based on the results of Phase 1, recommendations are made for Phase 2 of the process.

PREFACE

The work described herein was conducted by the Environmental Laboratory (EL) of the US Army Engineer Waterways Experiment Station (WES). Funding was provided by the US Navy, Atlantic Division, Naval Facilities Engineering Command (LANTNAVFACENGCOM) under Project Order Nos. N0018988P000006 and N61414-88-P000040. The planner in charge for LANTNAVFACENGCOM was Mr. Ron Dudley.

This report was prepared by Mr. Paul A. Zappi, Water Resources Engineering Group, Environmental Engineering Division (EED); Dr. Michael R. Palermo, Research Projects Group, EED; and Dr. Mark W. LaSalle, Coastal Ecology Group, Environmental Resources Division (ERD), EL. The contributions of Messrs. Ron Vann, Steve Powell, and Terry Getchell of the Civil Programs Branch, US Army Engineer District (USAED), Norfolk, and Messrs. Ernest L. Fulford and Paul Steele, LANTNAVFACENGCOM are acknowledged. Technical review of this report was provided by Mr. Norman R. Francingues, Chief, Water Supply and Waste Treatment Group, EED, EL; Messrs. Powell, Getchell, and Vann, USAED, Norfolk; LT Timothy P. O'Rourke, Naval Supply Center, Cheatham Annex; Mr. Fulford, Code 405; Ms. Cindy Hiddemen, Code 201; and Ms. Sharon Waligora, Code 2032E3, LANTNAVFACENGCOM.

This study was conducted under the direct supervision of Dr. Raymond L. Montgomery, Chief, EED, and Dr. C. J. Kirby, Chief, ERD, and under the general supervision of Dr. John Harrison, Chief, EL.

Commander and Director of WES was COL Larry B. Fulton, EN. Technical Director was Dr. Robert W. Whalin.

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CONTENTS

CONVERSION FACTORS, NON-SI TO SI (METRIC)
UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
acres	4,046.873	square metres
cubic yards	0.7645549	cubic metres
degrees (angle)	0.01745329	radians
feet	0.3048	metres
inches	2.54	centimetres
miles (US nautical)	1.852	kilometres
miles (US statute)	1.609347	kilometres
square feet	0.09290304	square metres
square miles	2.589998	square kilometres
yards	0.9144	metres

LONG-TERM MANAGEMENT STRATEGY FOR DREDGED MATERIAL DISPOSAL FOR THE NAVAL WEAPONS STATION, YORKTOWN, YORKTOWN, VIRGINIA; NAVAL SUPPLY CENTER, CHEATHAM ANNEX, WILLIAMSBURG, VIRGINIA; AND NAVAL AMPHIBIOUS BASE, LITTLE CREEK, NORFOLK, VIRGINIA

PHASE I: EVALUATION OF EXISTING MANAGEMENT OPTIONS AND DATA

PART I: INTRODUCTION

Background

1. In past years, the preponderance of material dredged at the Naval Weapons Station, Yorktown (NWS Yorktown), Yorktown, VA, the Naval Supply Center, Cheatham Annex (CAX), Williamsburg, VA, and the Naval Amphibious Base, Little Creek (NAVPHIBASE LCREEK), Norfolk, VA, has been placed at the Craney Island Facility, operated by the US Army Engineer District, Norfolk. The location of these facilities is shown in Figure 1.

2. Craney Island was authorized by Congress for disposal of material dredged from a specific geographic area known as "Hampton Roads." The naval facilities aforementioned are physically outside this geographic area; however, historically, the placement of materials from these projects at Craney Island has been allowed on a case-by-case basis. As a condition of issuing a recent permit, the Norfolk District required the development of a long-term management solution.

3. The Atlantic Division, Naval Facilities Engineering Command (LANTNAVFACENGCOM), the Norfolk District, and the US Army Engineer Waterways Experiment Station (WES) discussed the need for developing a long-range dredged material management strategy for NWS Yorktown, CAX, and NAVPHIBASE LCREEK. The Navy concluded from these discussions that Norfolk District and WES should develop the engineering, economic, and environmental data related to formulating and analyzing alternatives for establishing a Long-Term Management Strategy (LTMS) for these naval facilities. These data would be incorporated into appropriate environmental and other documentation needed to establish and implement a viable LTMS for the facilities. The LTMS would be

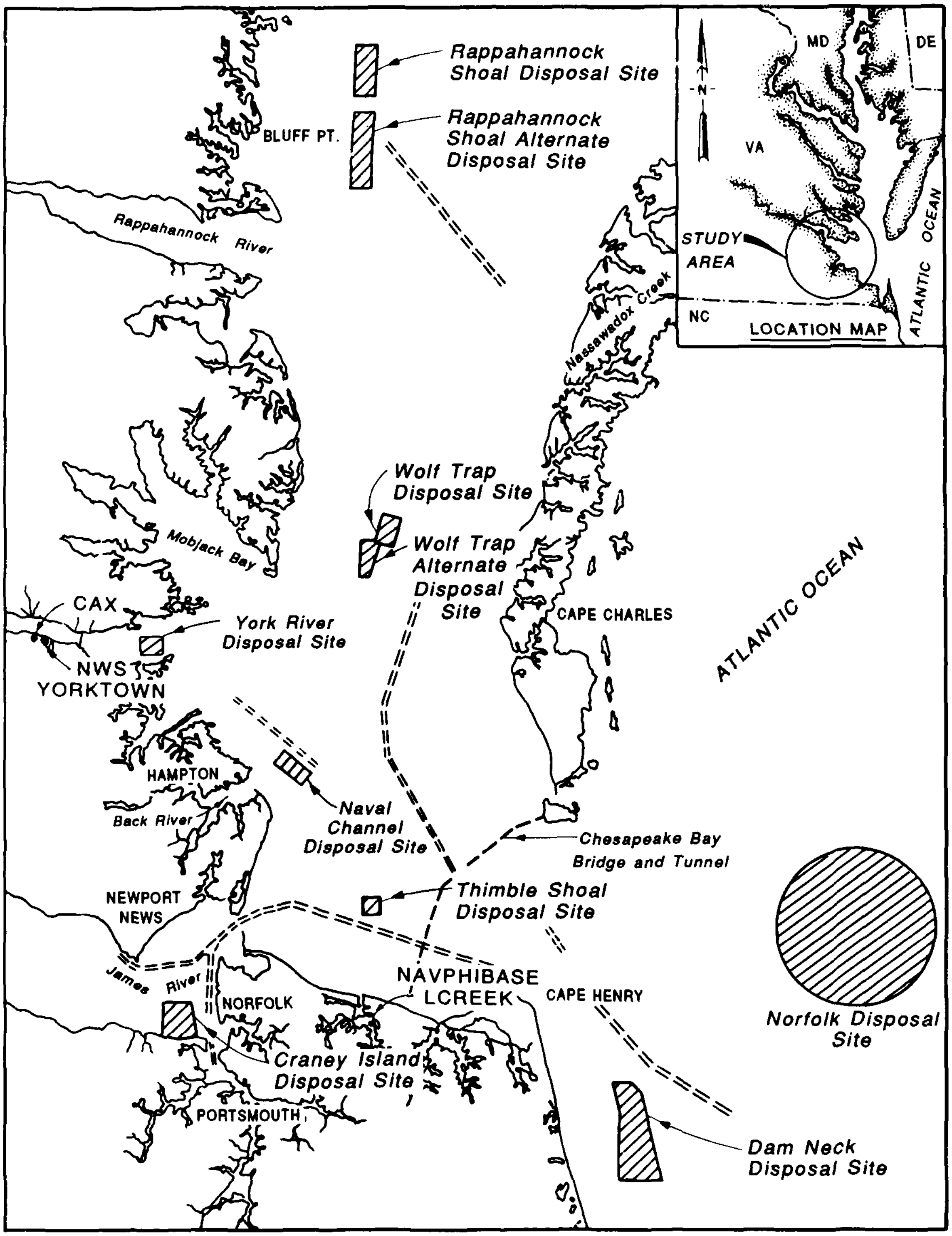

Figure 1. Locations of Naval Weapons Station, Yorktown; Naval Supply Center, Cheatham Annex; Naval Amphibious Base, Little Creek; and open-water disposal sites

defined to accommodate a period of up to 50 years for defining project purposes and management options.

Purpose and Scope

4. The purpose of this report is to document an evaluation of existing management options and data for disposal of dredged material for NWS Yorktown, CAX, and NAVPHIBASE LCREEK. This evaluation includes a review of dredging volumes and frequencies, dredging and disposal equipment and techniques, environmental resources, and management options presently available. This evaluation is Phase I of a more comprehensive approach in developing a workable LTMS.

PART II: LONG-TERM MANAGEMENT STRATEGY APPROACH

Definition of LTMS

5. Locating suitable sites for the long-term management of dredged material is a major problem for navigation projects (US Congress, Office of Technology Assessment 1987). Many dredging projects, and in some cases, the project beneficiaries, routinely rely on cycle-to-cycle location of disposal sites. This approach often results in significant project delays, increased costs, and sometimes, recurring needs to invoke emergency dredging procedures for nationally sensitive navigation projects.

6. In 1978, the US Army Corps of Engineers (USACE) Dredged Material Research Program concluded that long-term dredged material management plans would offer greater potential for providing required environmental protection at reduced project costs, and would meet with greater public acceptance once they had been adopted and implemented (Saucier et al. 1978). More recently, a number of prominent scientific and engineering groups have strongly recommended that the USACE develop the concept of a LTMS for navigation projects (Klesch 1987). The approach being used in development of the LTMS for NWS Yorktown, CAX, and NAVPHIBASE LCREEK is based on the USACE nationwide approach to LTMS development (Francingues and Mathis 1989) and is described in the following paragraphs.

7. The purpose of a LTMS is to provide a consistent, logical procedure by which alternatives can be identified, evaluated, screened, and recommended so that the dredged material placement operations are conducted in a timely and cost-effective manner. A workable LTMS for NWS Yorktown, CAX, and NAVPHIBASE LCREEK should meet the following criteria:

a. A 50-year time frame should be the established target or goal, while recognizing that project-specific circumstances may, in certain projects, dictate a shorter time frame.

b. Development of the LTMS must include all foreseeable new work and maintenance activities.

c. Unless specifically prohibited by statute, LTMS development must incorporate full and equal consideration of all dredging and dredged material management alternatives. No one management option can be considered as optimal for dredged material, nor can it be ruled out in the initial plan formulation process other than for sound economic, environmental, and engineering reasons.

d. The LTMS development must be timely, technically feasible, cost effective, and environmentally acceptable, as dictated by established standards, criteria, and regulations.

Conceptual Process for LTMS Development

8. The conceptual process for LTMS development is an orderly, sequential process that (a) identifies project needs and performs a preliminary assessment of these dredging needs versus the existing/available site capacity; (b) formulates alternatives, where necessary, to offset project shortfalls; (c) applies detailed screening procedures based on engineering, economic, and environmental considerations to arrive at a preferred alternative; (d) develops procedural, administrative, and management plans for LTMS implementation; and (e) provides for periodic review and updating of the LTMS plan to maintain viable long-term project operations.

9. The conceptual process of developing and implementing a LTMS for NWS Yorktown, CAX, and NAVPHIBASE LCREEK is presented in the five phases shown in Figure 2. Each phase consists of a series of steps or essential activities that lead to a certain level of decision making before progressing to the next phase. A description of each phase follows.

Phase I - evaluation of existing management options and data

10. The Phase I evaluation of existing data and options involves the tasks listed below.

a. Gather and review existing data on dredging equipment, capabilities, and requirements (volumes, shoaling rate, sediment physical characteristics, etc.). Data should also include information on water and sediment quality.

b. Identify all, as appropriate, historically used open-water (in-water) and confined disposal facilities (CDFs) and their preliminary capacities, and identify potential new sites within limits of LTMS boundaries and their general capacities.

c. Compare future dredging/disposal needs with potential existing disposal site capacity(s) and establish shortfall(s).

d. Gather and review available data/information on physical and contaminant characteristics at dredging and potential disposal sites and identify data gaps. Relate these data to anticipated dredging and disposal equipment to identify potential environmental effects of a dredging operation.

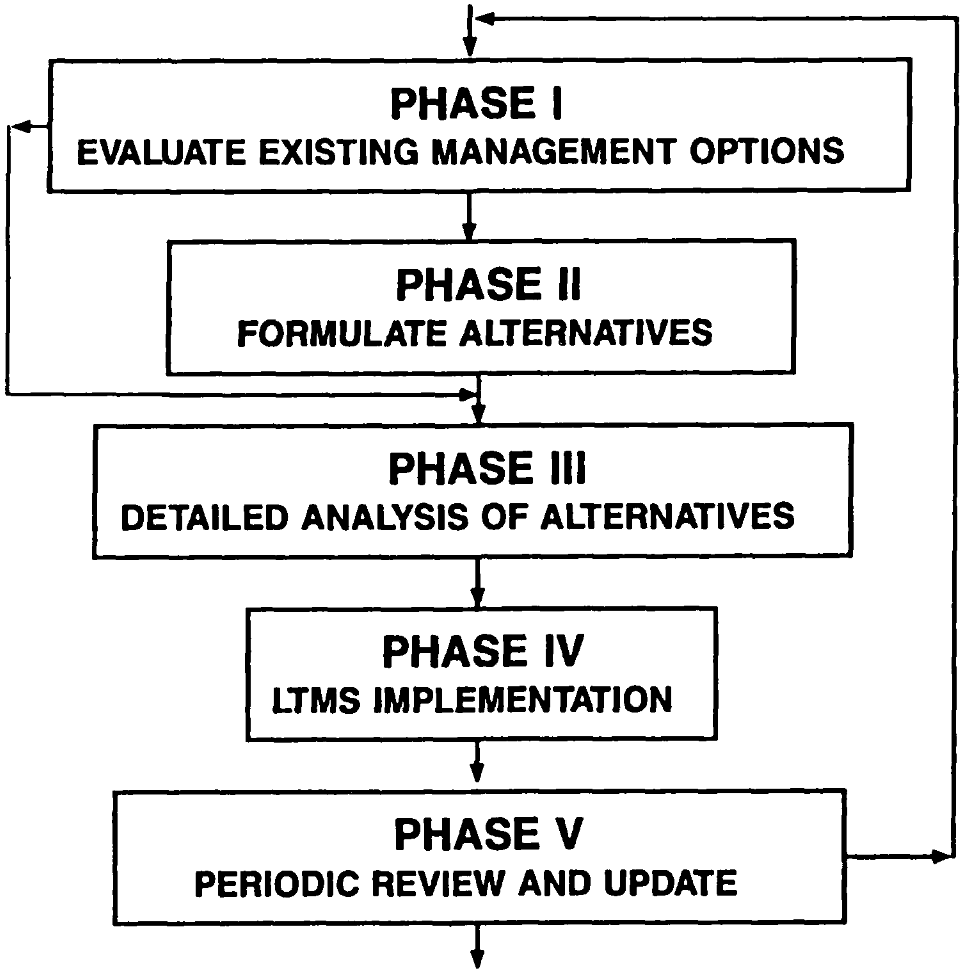

Figure 2. Phases of the Long-Term Management Strategy process

e. Gather and review data/information on existing environmental resources at dredging and potential disposal sites. Determine temporal and seasonal relation of resource to study area.

f. Identify special technical or environmental problems to be considered during the dredging or disposal operations. Review existing reports and data on endangered species, benthic invertebrates, and resource agency concerns and positions.

g. Identify potential beneficial uses for dredged material.

h. Refine study objectives and boundaries (spatial and temporal) for the LTMS.

i. Define management options.

j. Prepare summary report identifying specific recommendations for Phase II studies to fill data gaps.

11. Phase I for this LTMS has been completed and is documented in this report.

Phase II - Formulation of alternatives

12. Activities associated with the formulation of appropriate LTMS alternatives are conducted in Phase II. Details regarding the type and scope of specific engineering and environmental studies should be developed based upon the results of Phase I. The following tasks are envisioned as necessary to complete Phase II, although they may require some modifications. (Additional recommendations for Phase II of this LTMS are presented in Part VII.)

a. Develop environmental, engineering, and economic criteria for dredging and disposal based on results of Phase I data review.

b. Coordinate with appropriate resource agencies and local interest groups to identify their concerns related to proposed dredging and disposal operations. As appropriate, incorporate their substantiated concerns into the environmental criteria.

c. Provide central point of coordination/discussion with resource agencies to establish means of resolution of environmental and technical issues raised prior to and during LTMS process.

d. Identify alternative dredging techniques and disposal options that meet the LTMS study objectives. Those options should be prioritized according to projected disposal requirements (both volumetrically and temporally).

e. Determine the need for further investigations such as sediment and water quality, hydraulic and sediment transport, and other areas of interest relative to selection of dredging methods, transportation systems, and disposal options. Prioritize the needs based on value to project and costs.

f. Perform environmental and engineering studies necessary to evaluate each dredging and disposal option.

Phase III - Analysis of alternatives and selection of a LTMS

13. Alternatives are analyzed and a LTMS is selected in Phase III. Specific tasks to be conducted during Phase III should include, but may not be limited to, the following:

a. Develop alternatives by combining appropriate dredging and disposal options.

b. Eliminate inappropriate alternatives by comparing them to criteria developed in Phase II. (Determine potential environmental impacts and impacts to cultural/historic resources and recreation use. Conduct engineering and economic analyses of alternatives.)

c. After initial screening alternatives, hold coordination meetings with appropriate public and private interest groups to solicit input for decision making.

d. Retain best alternatives and gain concurrence from interested and impacted groups.

e. Perform detailed analysis and screening of viable alternatives and prepare a LTMS report.

14. Actions necessary to acquire necessary permits and other regulatory approvals that would be needed to implement the LTMS should also be conducted concurrently with preparation of the LTMS documentation. This would make the LTMS a complete package ready for implementation.

Phase IV - LTMS implementation

15. The purpose of Phase IV is to develop the LTMS operations plan for implementing the appropriate portion(s) of the selected LTMS. Considerations in developing this implementation plan should include administrative, procedural, management, and monitoring requirements. Operational considerations for implementation would include the following:

a. Environmental documentation for life of the plan.

b. Long-term permits.

c. Regional permits/authorizations.

d. Formalized regional mitigation strategies.

e. Special Area Management Plans (e.g., regional plans with established zones favoring development versus resource protection).

f. Implementation of site management requirements.

Phase V - Periodic review and update

16. The final phase in the LTMS process is a periodic reevaluation of the LTMS plan, based on changing regulatory, economic, and environmental conditions and technological advances. This process ensures that decision makers will maintain a viable implementation strategy that reflects changing times and project conditions, thereby avoiding the pitfalls of "crisis management." In the final analysis, the loop is closed, allowing the dredging manager to anticipate and accommodate changes in dredged material management needs to document the validity of the technical, economic, and environmental long-term management decisions.

17. As part of any innovative approach to developing a long-term solution, there is a potential for developing many "lessons learned," which could result in significant overall benefits. Potential benefits may include

a. Reduced dredging costs over the time frame of the LTMS.

b. Reduced time needed for periodic project maintenance.

c. Increased efficiency in regulatory coordination and permitting.

d. Improved implementation of environmental quality and potential beneficial use project features.

e. Improved long-range implementation plans for use by the Navy in the scheduling and contracting of dredging.

f. Enhanced potential for long-term dredging and disposal management agreements.

18. As part of this phase of study, therefore, a record should be kept to document those initiatives and procedures that were particularly productive and those that were not. In addition, all the steps of the study should be examined to determine how to streamline procedures to reduce time and cost. After completing the LTMS, information relating to lessons learned should be synthesized and a separate report prepared containing a critique of the study procedures and recommendations for more efficient procedures for future LTMS developmental efforts by the Navy. The report should emphasize useful methodologies as well as potential pitfalls that result in nonproductive time and cost expenditures.

PART III: PROJECT DESCRIPTIONS

19. This part of the report describes the characteristics of NWS Yorktown, CAX, and NAVPHIBASE LCREEK as they pertain to dredging and dredged material disposal.

Naval Weapons Station, Yorktown

20. The purpose of the NWS Yorktown is to receive, store, and provide Naval and Marine Operating Forces with conventional ammunition, missiles, underwater weapons, and special weapons.

21. The NWS Yorktown is located in southeastern Virginia in York and James City Counties (see Figure 1). The NWS Yorktown is about 1.5 miles* upstream of Yorktown, VA, on the west bank of the York River. The US Department of the Interior, National Park Service, and the US Navy occupy property to the north and south of NWS Yorktown. The Colonial National History Park and CAX are to the north, and the Yorktown Battlefield and Cemetery are to the south. The NWS Yorktown's property contains several roadways and buildings, as well as wooded areas, ponds, and creeks. Limited portions of NWS Yorktown's property are used for training and recreation.

22. The Colonial National Historical Parkway runs parallel to the York River shoreline and over the entrance to the main loading facility at Pier R-3. Other nearby roadways are Interstate 64 and Virginia State Route 143 to the south and Virginia State Route 238 to the east. A layout of NWS Yorktown is shown in Figure 3.

23. Dredging at NWS Yorktown is required to maintain navigable depths adjacent to Pier R-3, located in northeast corner of the station. Pier R-3 extends approximately 2,000 ft into the York River with the outboard side of the pier approximately 2,200 ft long. In 1979 and 1980 the outboard side of the pier was dredged to a depth of 42 ft below mean low water (mlw), plus a 2-ft overdepth. In 1987 the inboard side of the pier, or the Barge Basin, was dredged to a depth of 18 ft below mlw, plus a 2-ft overdepth. A history of dredging at NWS Yorktown is given in Table 1. Access to the Barge Basin is

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* A table of factors for converting non-SI units of measurement to SI (metric) units is presented on page 3.

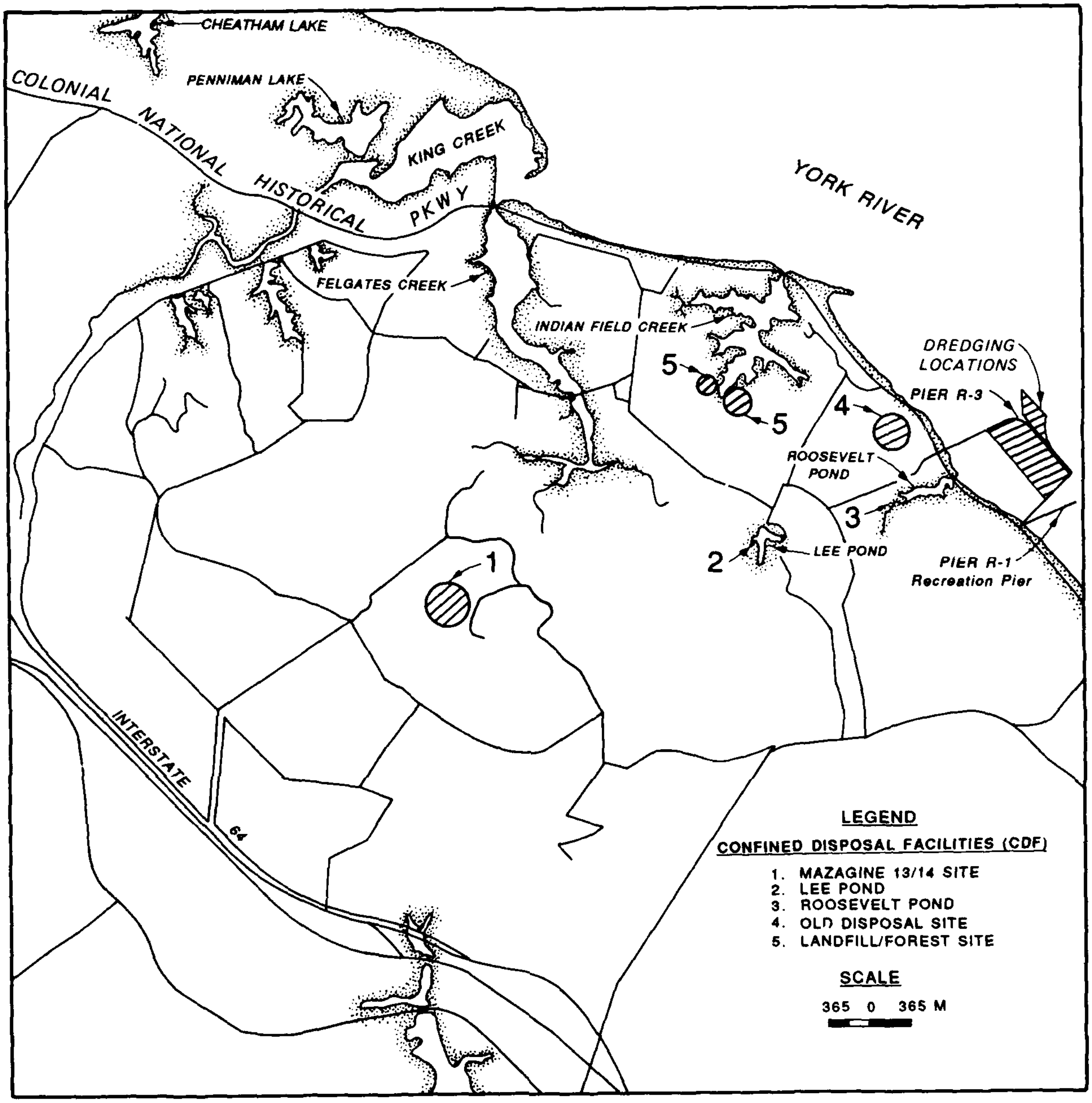

Figure 3. Naval Weapons Station, Yorktown, and confined disposal facilities

Table 1

Naval Weapons Station at Yorktown, Dredging History

Contract Number	Date Completed	Location	Material Quantity cu yd	Bottom Depth (mlw) ft	Dredge Type	Disposal Site	Information Source**
64-115	1965	Barge basin	169,535	18 + 1	Hydraulic pipeline	CDF (NWS)	US Navy Bureau of Yards and Docks 1965;† US Naval Facilities Engineering Command 1988††
69-509	1966	Outboard side	74,860	36	--*	Open water (York River)	US Navy letter, 1965; Steele 1989; US Naval Facilities Engineering Command 1988††
80-0125	1979	Outboard side	545,500	42 + 2	Hopper	CDF (Craney Island)	US Army Engineer District, Norfolk, letter, 1978; US Army Engineer District, Norfolk, DF, 1970; US Army Engineer District, Norfolk, Public Notice, 1978; Steele, 1989; US Naval Facilities Engineering Command 1980‡
80-0125	1980	Outboard side	155,040	42 + 2	Clamshell	CDF (Craney Island)	
84-4426	1987	Barge basin	168,387	18 + 2	Clamshell	CDF (Craney Island)	US Army Engineer District, Norfolk, DF, 1986; US Army Engineer District, Norfolk, Public Notice 1986; Steele 1989; US Naval Facilities Engineering Command 1988††

* No information available.
** See Bibliography.
† See Y and D Drawing Nos. 1060071-1060074, 19 Feb 1965.
†† See NAVFAC Drawing Nos. 4100958, 4100960, and 4100962, 3 Feb 1988.
‡ See NAVFAC Drawing Nos. 4036307-4036312, 15 Nov 1980.

provided through a lift bridge on the northeast side of the pier. The areas commonly dredged at NWS Yorktown are shown in Figure 3.

24. Pier R-1, a recreation pier, is located on the southeast side of Pier R-3. Pier R-1 extends approximately 1,200 ft into the river at about a 60-deg angle from the shoreline. In addition, the shoreline adjacent to Piers R-1 and R-3 is protected by a riprap revetment.

Naval Supply Center, Cheatham Annex

25. The purpose of CAX is to maintain and operate a material handling stock point for receiving, storing, packing, and shipping of material under the cognizance of the Naval Supply Center, Norfolk, VA.

26. The CAX is located in southeastern Virginia in York County (see Figure 1). The CAX is about 4.5 miles upstream of Yorktown, VA, on the west bank of the York River. The Colonial National Historical Parkway runs through the southwestern part of CAX.

27. The US Department of the Interior, National Park Service, and the US Navy occupy property to the north and south of CAX. Camp Peary is to the north, and the Colonial National Historical Park and NWS Yorktown are to the south.

28. The CAX property contains several roadways and buildings, as well as wooded areas, ponds, and creeks. Portions of CAX property are used for training and recreation. Cheatham and Penniman Lakes, Jones and Hipps Ponds, and Queen and King Creeks are all located at CAX. A layout of CAX is shown in Figure 4.

29. Dredging at CAX is required to maintain navigable depths adjacent to the supply pier. The pier is located just west of Penniman Spit in the northeast corner of CAX. The supply pier extends approximately 2,500 ft into the York River with the north side of the pier approximately 1,200 ft long. In 1981 the south (Area B) and east (Area C) sides of the pier were dredged to a depth of 20 ft below mlw, plus a 2-ft overdepth. In 1988 the north side (Area A) of the pier was dredged to a depth of 35 ft below mlw, plus a 2-ft overdepth. A history of dredging at CAX is given in Table 2. The areas normally dredged at CAX are shown in Figure 4.

30. Approximately 1,500 ft downstream of the supply pier is a fuel pier that is no longer in use. The fuel pier runs parallel to the supply pier and

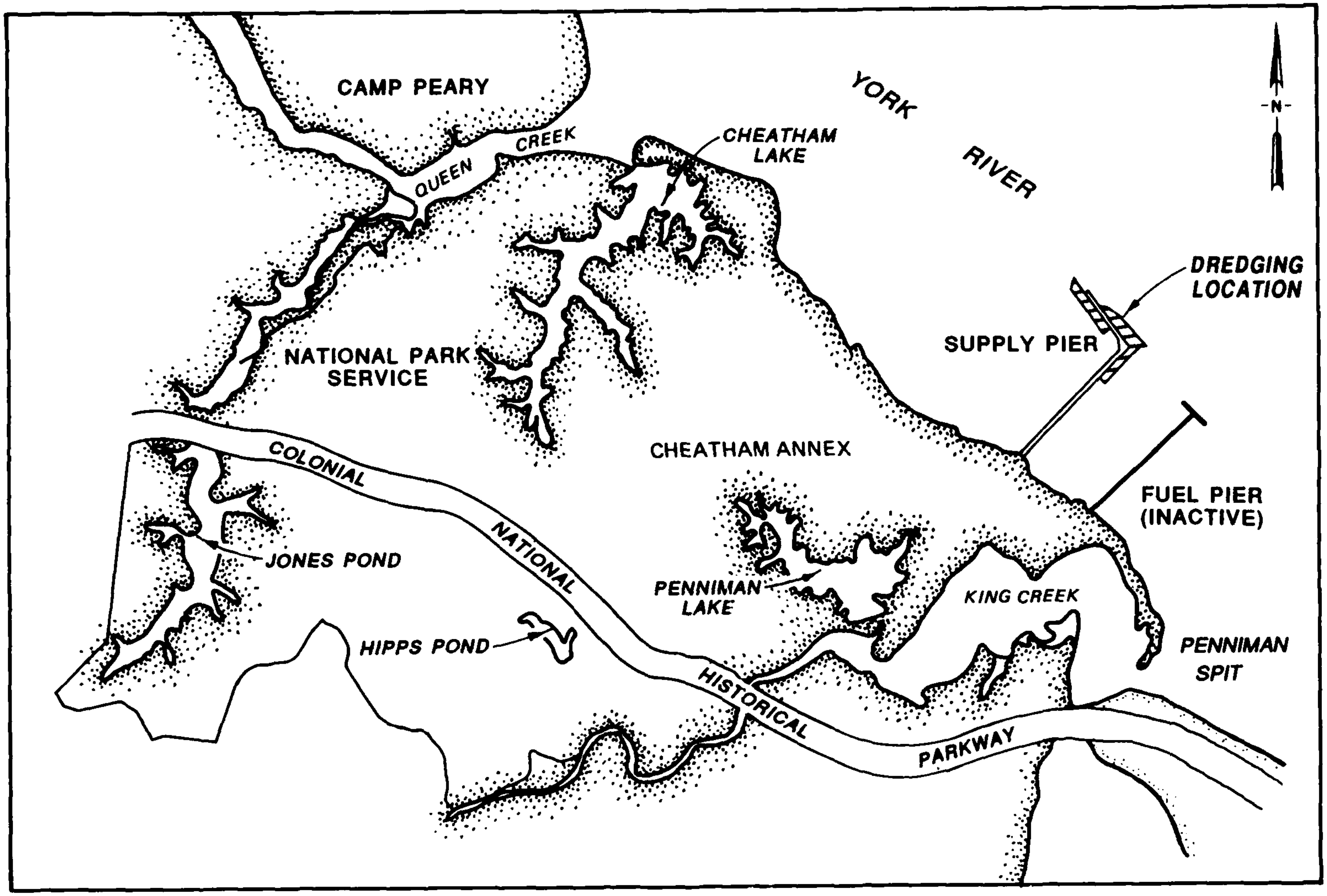

Figure 4. Naval Supply Center, Cheatham Annex, and confined disposal facilities

Table 2

Naval Supply Center at Cheatham Annex, Dredging History

Contract Number	Date Completed	Location	Material Quantity cu yd	Bottom Depth (mlw) ft	Dredge Type	Disposal Site	Information Source**
69-509	1966	Supply pier	99,995	--*	Clamshell	Open water (York River)	US Navy Letter, 1965; Steele 1989; US Naval Facilities Engineering Command 1988†
		Fuel pier	26,325	--	Clamshell	Open water (York River)	
80-0578	1981	Supply pier	33,178	20 + 2 to 35 + 2	Clamshell	CDF (Craney Island)	US Army Engineer District, Norfolk, Finding of Fact, 1981a; US Army Engineer District, Norfolk, Public Notice, 1981; Steele 1989; US Naval Facilities Engineering Command 1981††
85-5153	1988	Supply pier	24,766	35 + 2	Clamshell	CDF (Craney Island)	US Army Engineer District, Public Notice, 1986; Steele 1989; US Naval Facilities Engineering Command 1988†

* No information available.
** See Bibliography.
† See NAVFAC Drawing Nos. 4100959, 4100961, and 4100963, 8 Feb 1988.
†† See NAVFAC Drawing Nos. 4056110-4056112, 9 Sep 1981.

extends approximately 2,500 ft into the York River. Dredging was last performed at the fuel pier in 1966. In addition, the shoreline adjacent to the supply and fuel piers experiences some erosion; however, rubble and old antisubmarine netting provide some protection.

Naval Amphibious Base, Little Creek

31. The Naval Amphibious Base at Little Creek is the primary amphibious training support base of the US Atlantic Fleet. The NAVPHIBASE LCREEK is located in southeastern Virginia (Figure 1). The base is located on the southern shore of the Chesapeake Bay, south of Thimble Shoal Channel. The NAVPHIBASE LCREEK is situated around Little Creek Inlet, with piers, docking facilities, and cargo-loading facilities in the inlet.

32. The NAVPHIBASE LCREEK is within the city limits of Virginia Beach and Norfolk, VA, and is surrounded by commercial and residential properties. The NAVPHIBASE LCREEK is located northeast of US Highway 60, and the Chesapeake Bay Bridge Tunnel/US Highway 13 is about 3 miles east of the base. The NAVPHIBASE LCREEK covers over 12,393 acres, 300 of which are covered by water. The NAVPHIBASE LCREEK property contains Chubb and Varian Lakes, Lake Bradford, and Lakes 1, 2, 3, and 4. Lakes Whitehurst, Smith, and Lawson are located south of the base. Portions of NAVPHIBASE LCREEK property are used for training and recreation and contain several roadways and buildings.

33. The NAVPHIBASE LCREEK property also contains Anzio, Sicily, Normandy, and Salerno Beaches along the Chesapeake Bay shoreline. These beaches extended from Little Creek Channel's east jetty to north of Chubb Lake. Most of the beaches are used for training; however, Sicily and Salerno Beaches are used for recreation during the summer months. The layout of NAVPHIBASE LCREEK is shown in Figure 5.

34. Little Creek Inlet provides a sheltered harbor for military, commercial, and private vessels. It is used primarily by NAVPHIBASE LCREEK; however, a rail ferry, the US Coast Guard, private marinas, and several industrial companies make use of the inlet. Little Creek Inlet consists of Little Creek Channel flowing to the north and Fisherman's, Desert, and Little Creek Coves as tributaries. Little Creek Channel contains a main channel that is maintained by the Norfolk District. Fisherman's Cove, also known as the western branch of Little Creek and Pretty Lake, forms the western tributary, and

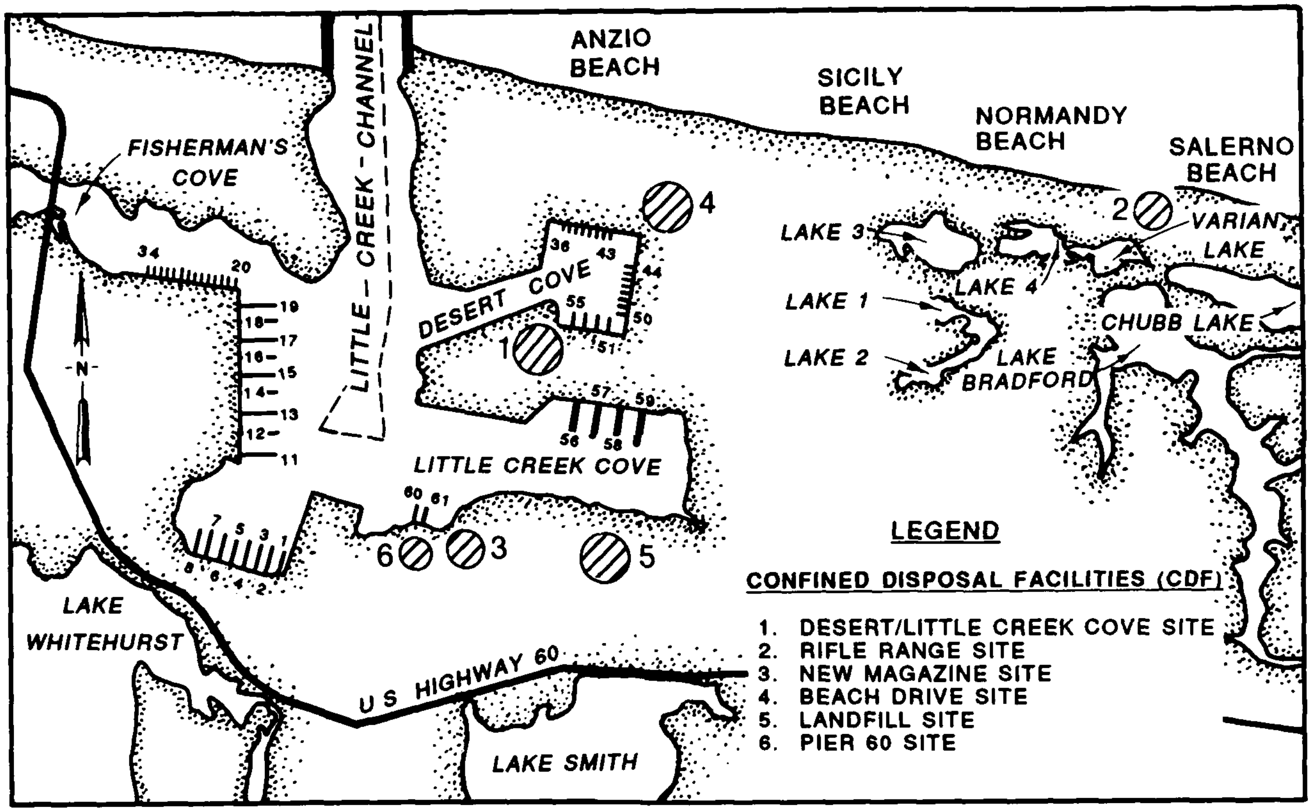

Figure 5. Naval Amphibious Base, Little Creek, and confined disposal facilities

Desert and Little Creek Coves form the eastern tributaries. Barrier beaches are located to the east and west of the Little Creek Channel entrance. Crab Point is located on the northern corner of the intersection of Fisherman's Cove and Little Creek Channel.

35. The entrance to Little Creek Inlet is protected by two stone jetties about 350 yd apart. Timber bulkheads run from the base of the jetties to 600 ft along the east shore and 1,200 ft along the west shore of Little Creek Channel. Other bulkheaded areas in Little Creek Inlet are Desert Cove, north Little Creek Cove, Little Creek Channel (south and southwest parts), and southeast Fisherman's Cove. A riprap revetment is presently being constructed along part of the northwest bank of Little Creek Channel and Crab Point.

36. The NAVPHIBASE LCREEK occupies Desert and Little Creek Coves, the south bank of Fisherman's Cove (about halfway to the US Highway 60 bridge), and the majority of Little Creek Channel's banks. The northwestern bank and part of the extreme southern bank of Little Creek Channel are not occupied by the Navy.

37. Desert Cove contains Piers 36-55. Little Creek Cove contains an ammunition-handling quaywall, Piers 56-61, and a flotilla pier. Southwest Little Creek Channel contains Piers 1-8, Piers 11-19, and a floating dry dock (AFDL). Southeast Fisherman's Cove contains Piers 20-34.

38. Dredging in Little Creek Inlet is required to maintain navigable depths in the inlet. Norfolk District maintains the main Little Creek Channel from the Chesapeake Bay to 1 mile into Little Creek Inlet. In 1984, the main Little Creek Channel was dredged to a depth of 22 ft below mlw, plus a 1-ft overdepth, and a channel width of 500 to 550 ft, plus a turning basin. A history of dredging at NAVPHIBASE LCREEK is given in Table 3.

39. The NAVPHIBASE LCREEK and private interests maintain the remainder of the Little Creek Inlet. Desert Cove was dredged to a depth of 10 ft below mlw in 1953. The flotilla pier was dredged to a depth ranging from 5 to 20 ft below mlw in 1961. In 1965, Piers 1-8 were dredged to a depth of 18 ft below mlw, plus a 2-ft overdepth, and Pier 9 was dredged to a depth of 10 ft below mlw, plus a 2-ft overdepth. In 1975, Piers 56-59 and 14-19 were dredged to a depth of 20 ft below mlw, and AFDL was dredged to a depth of 30 ft below mlw. In 1976, Piers 11-14 were dredged to a depth of 25 ft below mlw, and Pier 59 and the quaywall were dredged to a depth of 20 ft below mlw. In 1981, Piers 20-35 and their approaches were dredged to a depth of 10 ft below mlw,

Table 3

Naval Amphibious Base at Little Creek, Dredging History

Contract Number	Date Completed	Location	Material Quantity cu yd	Bottom Depth (mlw) ft	Dredge Type	Disposal Site	Information Source**
--*	1943	Little Creek Cove (flotilla pier)	--	5 to 17	--	--	US Navy Bureau of Yards and Docks 1961†
--	1943	Little Creek Channel	--	20	--	--	EnviroPlan, Inc. 1974
--	1953	Little Creek Inlet improvements	--	10 to 30	--	--	Knappen, Tippetts, Abbett Engineering Co. 1957††
--	1961	Little Creek Cove (flotilla pier)	112,600	5 to 20	--	CDF (NAB)‡	US Navy Bureau of Yards and Docks 1961†
--	1961	Little Creek Cove (quaywall and Piers 56-59)	--	--	--	--	US Navy Bureau of Yards and Docks 1961†
--	1965	Little Creek Channel (Piers 11-19)	277,696	20 to 25	--	--	US Navy Bureau of Yards and Docks 1964‡‡

(Continued)

* No information available.

** See Bibliography.

† See Y and D Drawing Nos. 881893 and 882609, 18 Jul 1961, and DPWD Drawing Nos. 57101 and 57102, 21 Aug 1961.

†† See Y and D Drawing Nos. 577240, 577243, and 577244, 17 Jun 1953, and Y and D Drawing Nos. 511636-511638, 18 Oct 1957.

‡ NAVPHIBASE LCREEK.

‡‡ See Y and D Drawing Nos. 1059942 and 1087620 and LANTDOCKS Drawing No. 63243, 23 Dec 1964.

Table 3 (Continued)

Contract Number	Date Completed	Location	Material Quantity cu yd	Bottom Depth (mlw) ft	Dredge Type	Disposal Site	Information Source
--	1965	Little Creek Cove (quaywall and Piers 56-59)	--	20	--	--	US Navy Bureau of Yards and Docks 1965*
--**	1965	Little Creek Channel (Piers 1-9)	126,416	10 to 18	--	Open water (Thimble Shoal)	US Navy Bureau of Yards and Docks 1965†
74-1385	1975	Little Creek Channel and Crab Point	803,970	20+2	Hydraulic pipeline	Beach replenishment	EnviroPlan, Inc. 1974; US Naval Facilities Engineering Command 1975††
74-1717	1975	Little Creek Cove (Piers 56-59) Little Creek Channel (Piers 14-19 and AFDL)	101,945	20 to 30	Clamshell	CDF (Craney Island)	Steele 1989
75-5389	1976	Little Creek Channel (Piers 11-14) Fisherman's Cove (Piers 20-34) Little Creek Cove (Pier 59 and quaywall)	81,245	10 to 25	Clamshell	CDF (Craney Island)	Steele 1989

(Continued)

* See LANTDOCKS Drawing No. 63244, 26 May 1965.
** No information available.
† See Y and D Drawing Nos. 1089084 and 1089085 and LANTDOCKS Drawing Nos. 63459 and 63460, 24 Nov 1965.
†† See LFD Drawing Nos. 86043 and 86044, 30 Jun 1975.

Table 3 (Concluded)

Contract Number	Date Completed	Location	Material Quantity cu yd	Bottom Depth (mlw) ft	Dredge Type	Disposal Site	Information Source
80-0258	1981	Fisherman's Cove (Piers 20-34 and widen approach)	12,753	10+1	Hydraulic pipeline	CDF (NAB)	US Navy letter, 1981; US Army Engineer District, Norfolk, letter, 1981; US Army Engineer, Norfolk, Finding of Fact 1981b; Steele 1989; US Naval Facilities Engineering Command 1981*
81-1664	1982	Chubb Lake training area	3,826	4+1 to 6+1	Hydraulic pipeline	CDF (NAB)	Steele 1989; US Naval Facilities Engineering Command 1982**
81-1361	1984	Little Creek Channel (Chesapeake Bay)	(Total = 645,882) 260,607	22+1	Hydraulic pipeline	Beach replenishment (NAB)	Commonwealth of Virginia 1983; US Army Engineer District, Norfolk, Statement of Findings 1983; Steele 1989; US Naval Facilities Engineering Command 1982†
		(Part of Chesapeake Bay and Little Creek Inlet)	385,275	22+1	Clamshell	CDF (Craney Island)	

* See NAVFAC Drawing Nos. 4056100-4056102, 4 Jan 1981.
** See NAVFAC Drawing Nos. 4056128-4056130, 24 Nov 1982.
† See NAVFAC Drawing Nos. 4078156-4078160 and 4078191-4078204, 28 Dec 1982.

plus a 1-ft overdepth. In 1982, the Chubb Lake Training Area was dredged to a depth of 6 ft below mlw in the channel and 4 ft below mlw at the boathouse. In 1984, Little Creek Cove, west of Pier 56, was dredged to a depth of 22 ft below mlw, plus a 1-ft overdepth.

PART IV: DREDGING REQUIREMENTS AND MATERIAL CHARACTERISTICS

40. This part of the report describes dredging equipment and techniques that have been used at NWS Yorktown, CAX, and NAVPHIBASE LCREEK. Dredged volumes and physical and chemical characteristics of the materials dredged are also described. Future dredging requirements for the facilities are estimated from past dredging histories.

Previous Dredging and Disposal Operations

41. Information on previous dredging and disposal operations was obtained from available LANTNAVFACENGCOM and Norfolk District dredging records. These records included environmental impact statements, before-and-after dredging surveys, public notices, correspondence between interested parties, and a summary of dredging contracts administered by the Navy. With few exceptions, records were not available for work conducted prior to the 1960s.

Naval Weapons Station, Yorktown

42. Dredging has been performed on both the inboard (barge basin) and outboard sides of Pier R-3 at various times. Records show that previous dredging at the NWS Yorktown consisted of maintenance and new work dredging the barge basin of Pier R-3 and on the outboard side of Pier R-3 (see Figure 3). Table 1 summarizes the dredging history of NWS Yorktown.

43. Pier R-3 (barge basin). New work dredging was completed in the barge basin in 1965. The need for dredging at this location was created by the construction of the Pier R-3 extension. The contract required the removal of 169,535 cu yd of material by hydraulic pipeline dredge. The dredged material was disposed at the Old Disposal Site (see Figure 3). This contract created a barge basin with a depth of 18 ft below mlw, plus a 1-ft overdepth. (See Table 1 for information sources.)

44. Maintenance dredging of the barge basin was completed in 1987. The contract required the removal of 168,387 cu yd of material by clamshell dredge. The dredged material was disposed at the Craney Island Facility (see Figure 1). This contract maintained the barge basin at a depth of 18 ft below mlw, plus a 2-ft overdepth.

45. Pier R-3 (outboard side). New work dredging on the outboard side of Pier R-3 was completed in 1966. The need for dredging at this location was

created by the construction of the Pier R-3 extension. The contract required the removal of 74,860 cu yd of material with disposal of the dredged material at the York River open-water site (Figure 1). This contract deepened the outboard side of the Pier R-3 to a depth of 36 ft below mlw.

46. Additional new work on the outboard side of Pier R-3 was conducted in 1979 and 1980. The first portion of the contract was completed in 1979 and required the removal of 545,500 cu yd of material by hopper dredge. The second portion of the contract was completed in 1980 and required the removal of 155,040 cu yd of material by clamshell dredge. The material dredged for this contract was disposed at the Craney Island Facility (Figure 1). This contract deepened the outboard side of Pier R-3 to a depth of 42 ft below mlw, plus a 2-ft overdepth.

Naval Supply Center, Cheatham Annex

47. Records show that previous dredging at CAX consisted of maintenance dredging at the supply and fuel piers (see Figure 4). Dredging was performed on the north, south, and east sides of the supply pier at various times. Since the fuel pier is currently inactive, only one dredging contract was completed there. There were no available records of new work dredging at the supply or fuel piers. (See Table 2 for a history of dredging at the CAX.)

48. Supply and fuel piers. Maintenance dredging completed in 1966 required the removal of 99,995 cu yd of material from the supply pier and 26,325 cu yd of material from the fuel pier by clamshell dredge. The dredged material was disposed at the York River open-water site (Figure 1). The records did not show the exact location of the dredging, but indicated that the depths varied from 20 to 35 ft below mlw.

49. Supply pier. Maintenance dredging was conducted at the supply pier in 1981. The contract required the removal of 33,178 cu yd of material by clamshell dredge. The dredged material was disposed at the Craney Island Facility (Figure 1). This contract maintained the depth of the south (Area B) and east (Area C) sides of the supply pier at 20 ft below mlw, plus a 2-ft overdepth, and at 35 ft below mlw, plus a 2-ft overdepth, on the north side (Area A) of the supply pier.

50. Maintenance dredging was again conducted in 1988. The contract required the removal of 24,766 cu yd of material by a clamshell dredge. The dredged material was disposed at the Craney Island Facility (Figure 1). This

contract maintained the depth on the north side (Area A) of the supply pier at 35 ft below mlw, plus a 2-ft overdepth.

Naval Amphibious Base, Little Creek

51. Previous dredging at NAVPHIBASE LCREEK consisted of both maintenance and new work dredging. Records show that dredging was performed at the main Little Creek Channel, Little Creek and Fisherman's Coves, southwest Little Creek Channel, and Chubb Lake. However, the majority of dredging activity has been in Little Creek Cove and Little Creek Channel. (See Table 3 for a history of dredging at NAVPHIBASE LCREEK.) Information about dredging at NAVPHIBASE LCREEK before 1974 came primarily from postdredging survey plans; therefore, the available information on these contracts is limited.

52. Little Creek Cove. In 1943, the flotilla pier was dredged to a depth ranging from 5 to 17 ft below mlw. In 1961, dredging at the flotilla pier required the removal of 112,600 cu yd of material with disposal at a CDF on NAVPHIBASE LCREEK. The contract brought the depth adjacent to the flotilla pier to a depth ranging from 5 to 20 ft below mlw. Also in 1961, an undetermined quantity was dredged at the quaywall and Piers 56-59.

53. In 1965, dredging at the quaywall and Piers 56-59 brought the depth at these locations to 20 ft below mlw. Dredging was conducted in 1975 in Little Creek Cove and southwest Little Creek Channel. Work in Little Creek Cove consisted of dredging Piers 56-59 to depths ranging from 20 to 30 ft below mlw. The contract required the removal of 101,945 cu yd of material from both locations by clamshell dredge. The dredged material from both locations was disposed at the Craney Island Facility (Figure 1).

54. In 1976, dredging was conducted in Little Creek Cove, southwest Little Creek Channel, and Fisherman's Cove. Work in Little Creek Cove consisted of dredging Pier 59 and the quaywall to depths ranging from 10 to 25 ft below mlw. The contract required the removal of 81,245 cu yd of material from the three locations by clamshell dredge. The dredged material from all three locations was disposed at the Craney Island Facility.

55. Southwest Little Creek Channel. Dredging conducted in 1965 at Piers 11-19 required the removal of 277,696 cu yd of material to create pier depths ranging from 20 to 25 ft below mlw. Also in 1965, dredging at Piers 1-9 required the removal of 126,416 cu yd of material with disposal at the Thimble Shoal open-water site (see Figure 1). This contract created pier depths ranging from 10 to 18 ft below mlw.

56. Dredging was conducted in 1975 in Little Creek Cove and southwest Little Creek Channel. Work in southwest Little Creek Channel consisted of dredging Piers 14-19 to depths ranging from 20 to 30 ft below mlw. The contract required the removal of 101,945 cu yd of material from both locations by clamshell dredge. The dredged material from both locations was disposed at the Craney Island Facility.

57. Dredging conducted in 1976 included Little Creek Cove, southwest Little Creek Channel, and Fisherman's Cove. Work in southwest Little Creek Channel consisted of dredging Piers 11-14 to depths ranging from 10 to 25 ft below mlw. The contract required the removal of 81,245 cu yd of material from the three locations by clamshell dredge. The dredged material from all three locations was disposed at the Craney Island Facility.

58. Fisherman's Cove. Dredging conducted in 1976 included Little Creek Cove, southwest Little Creek Channel, and Fisherman's Cove. Work in Fisherman's Cove consisted of dredging Piers 20-34 to depths ranging from 10 to 25 ft below mlw. The contract required the removal of 81,245 cu yd of material from the three locations by clamshell dredge. The dredged material from all three locations was disposed at the Craney Island Facility.

59. In 1981 dredging was conducted at Piers 20-34, and additional material was removed to widen their approaches. The contract required the removal of 12,753 cu yd of material by hydraulic pipeline dredge. The dredged material was disposed at the Desert/Little Creek CDF site (see Figure 5). This contract brought the depths of the piers and their approaches to 10 ft below mlw.

60. Chubb Lake training area. In 1982, dredging was conducted in the Chubb Lake training area. The contract required the removal of 3,826 cu yd of material by hydraulic pipeline dredge. The dredged material was disposed at the Rifle Range CDF site (see Figure 5). The depth in the Chubb Lake training area ranged from 4 to 6 ft below mlw, plus a 1-ft overdepth, at the completion of this contract.

61. Main Little Creek Channel. Records show that the main Little Creek Channel was dredged to a depth of 20 ft below mlw in 1943. New work dredging completed in 1975 called for the removal of a portion of Crab Point and the widening of the main Little Creek Channel. The contract required the removal of 803,970 cu yd of material by a hydraulic pipeline dredge. The material was used to replenish the NAVPHIBASE LCREEK beach from the Little Creek Channel

east jetty to several thousand feet east. This contract made the depth in the main Little Creek Channel (from the jetties to the old Crab Point) 20 ft below mlw, plus a 2-ft overdepth, and 550 to 600 ft wide.

62. New work dredging completed in 1984 called for the deepening of the main Little Creek Channel. The contract required the removal of 645,882 cu yd of material. A hydraulic pipeline dredge removed 260,607 cu yd of material, and a clamshell dredge removal 385,275 cu yd of material. Of the 645,882 cu yd of dredged material, 260,607 cu yd from part of the channel fairway was used to replenish a 600-ft section of beach west of the west jetty and a 4,120-ft section of beach northwest of Chubb Lake. The remaining 385,275 cu yd of dredged material was disposed at the Craney Island Facility. This contract made the depth in the main Little Creek Channel 22 ft below mlw, plus a 1-ft overdepth, and 500 to 550 ft wide, plus a turning basin.

Material Characteristics

63. This section describes the characteristics of the dredged material at NWS Yorktown, CAX, and NAVPHIBASE LCREEK. Information on the material characteristics was obtained from available LANTNAVFACENGCOM and Norfolk District dredging records and included physical characteristics, sediment chemical inventories, and standard elutriate test results. The available records did not indicate that reference sediment chemical concentrations were compared with the chemical concentrations of sediments from the project dredging areas. Similarly, the records did not indicate any comparison of standard elutriate results with standards or criteria.

64. The physical and chemical properties reported here are an average of all the locations sampled at a given time. In some cases, sediment chemical concentrations were above the detection limit at some locations and below the detection limit at others. In this case, samples found to be below detection were considered equal to the detection limit when computing the average values.

Naval Weapons Station, Yorktown

65. Sampling and testing. In December 1975, sediment borings were taken at four locations on the outboard side of Pier R-3 (NWS Yorktown 1977). The borings were taken using a gravity corer with a plastic liner. The average length of the borings was 1.25 ft. The sediment from the four borings

was analyzed for physical and chemical characteristics. In addition, elutriate tests were conducted on the samples.

66. In October 1984, sediment borings were taken at five locations on the inboard side (barge basin) of Pier R-3 (JTC Environmental Consultants, Inc. 1984; McCallum Testing Laboratories, Inc. 1984). The average depth of the borings was 6.8 ft. The sediment from the borings was analyzed for physical and chemical characteristics. No elutriate tests or biological tests were conducted.

67. Sediment physical characteristics. Physical characteristics of sediment samples taken from NWS Yorktown are shown in Table 4. Grain size analysis, according to the phi class, was performed on the 1975 sediment samples. The sediment was composed of approximately 11 percent sand and 89 percent silt and clay. The mean particle size of the sediment was 8.48 phi or 0.0028 mm (one phi equals the negative log, to the base 2, of the particle diameter, in millimetres).

68. Grain size distribution, Atterberg limits, and Unified Soil Classification System (USCS) classification were determined for the 1984 sediment samples. An average of 97 percent of the sediment passed the No. 200 sieve. The average liquid limit of the sediment was 117 percent, and the average plasticity index was 88 percent. These analyses resulted in a USCS classification of highly plastic clay (CH) for the sediment from all five borings.

69. Sediment chemical inventory. The results of the sediment chemical inventory of samples taken from the NWS Yorktown are shown in Table 4. The sediment samples from the 1975 borings were analyzed for percent moisture, percent volatiles, oil and grease, total Kjeldahl nitrogen, total phosphorus, mercury, lead, zinc, and cadmium. Cadmium was below the detection limit. Sediment from one of the boring locations was analyzed for kepone content, but none was detected. Sediment from seven samples was analyzed for trinitrotoluene (TNT) and cyclonite (RDX), but none was detected.

70. The sediment samples from the 1984 borings were analyzed for total and volatile solids, oil and grease, total Kjeldahl nitrogen, lead, cadmium, copper, chromium, zinc, nickel, toxaphene, methoxychlor, endrine, lindane, and polychlorinated biphenyls (PCBs). Oil and grease, toxaphene, methoxychlor, endrine, lindane, and PCBs were below the detection limit.

71. Elutriate testing. The results for the elutriates are shown in Table 5. Standard elutriate tests were performed on sediment from the 1975

Table 4

Naval Weapons Station, Yorktown, Average Sediment Characteristics

Parameter	Sample Value	
	December 1975*	October 1984**
Percent sand	10.62	--†
Percent silt and clay	89.38	--
Percent clay	--	--
Liquid limit	--	117
Plasticity index	--	88
Class (USCS)	--	CH
Percent moisture	64.53	--
Total Kjeldahl nitrogen, mg/kg	2,698.4	340
Total phosphorus, mg/kg	0.0357	--
Oil and grease, mg/kg	33.3	<5
Cadmium, mg/kg	<0.5	1.0
Chromium, mg/kg	--	20.4
Copper, mg/kg	--	7.2
Lead, mg/kg	20.0	8.2
Mercury, mg/kg	11.9	0.11
Nickel, mg/kg	--	8.1
Zinc, mg/kg	110.0	86.7
Kepone, mg/kg	<0.001	--
TNT, mg/kg	<0.01	--
RDX, mg/kg	<0.01	--
Toxaphene, mg/kg	--	<0.04
Methoxyclor, mg/kg	--	<0.02
Endrine, mg/kg	--	<0.004
Lindane, mg/kg	--	<0.002
PCB, mg/kg	--	<0.04

* Average of four cores taken on outboard side of Pier R-3.
** Average of five cores taken on the inboard side (barge basin) of Pier R-3.
† Not analyzed.

Table 5

Naval Weapons Station, Yorktown, Elutriate Concentrations

Parameter	1975 Elutriate Samples*	Acute Water Quality for Marine Life**
Nitrates, mg/ℓ	--†	--
Total Kjeldahl nitrogen, mg/ℓ	--	--
Total phosphorus, mg/ℓ	--	--
Total suspended solids, mg/ℓ	--	--
Oil and grease, mg/ℓ	2.2	--
Cadmium, mg/ℓ	<0.01	0.043
Lead, mg/ℓ	0.04	0.1400
Mercury, mg/ℓ	0.006	0.0021
Zinc, mg/ℓ	0.05	0.095

* Average of elutriates using 1975 core samples (see Table 4).
** US Environmental Protection Agency (1986).
† Not analyzed.

borings. Water samples were taken from near-bottom at the same locations as the borings in order to perform the elutriate tests. Depth profiles of temperature, salinity, and dissolved oxygen were also determined at the dredging site.

72. The elutriates were analyzed for mercury, lead, zinc, cadmium, and oil and grease. Elutriate contaminant concentrations were below Federal water quality criteria for all constituents except mercury. This will require consideration of mixing.

Naval Supply Center, Cheatham Annex

73. Sampling and testing. Seven sediment borings were taken in October 1985 in the vicinity of the supply pier (James R. Reed and Associates, Inc. 1985). The borings were taken using a 2-in. inside diameter (ID) ballcheck corer equipped with a lexan nose cone and plastic sample tubes. The length of the samples varied in depth from 12 to 24 in. Two borings were made on the north side (Area A) of the supply pier, two on the south side (Area B), and one on the east side (Area C). Two borings were also made between the supply

and fuel piers, adjacent to the shoreline in an area proposed as a confined disposal site. The sediment from the seven borings was analyzed for various physical and chemical characteristics.

74. Sediment physical characteristics. Physical characteristics of sediment samples taken from CAX are shown in Table 6. The sediments from all seven borings were described based on visual examination and manual tests. Sediments on the north, south, and east sides of the supply pier were described as medium to highly plastic silts and/or clays with a dark brown to black color. One of the borings on the north side of the supply pier had an organic odor, and the boring on the east side of the supply pier had a trace of very fine shell fragments. The sediment near the shoreline between the supply and fuel piers (proposed as a disposal area) was described as brown to dark gray, poorly graded sand with 5 to 12 percent silt and a trace of very fine to fine shell fragments. The sand particles ranged in size from fine to medium.

75. A washed sieve analysis was performed on the sediment from the north and south sides of the supply pier. An average of 73 percent of the sediment passed the No. 200 sieve.

76. Sediment chemical inventory. The sediment from all seven CAX borings was analyzed for total solids, volatile solids, oil and grease, total Kjeldahl nitrogen, PCBs, lead, cadmium, copper, chromium, zinc, nickel, mercury, endrin, lindane, methoxychlor, toxaphene, 2,4-D, 2,4,5 TP-Silvex, and aromatic hydrocarbons. The results shown in Table 6 reflect the average of the five borings taken in the area dredged. The levels of PCB, pesticides, and aromatic hydrocarbons at all locations were below the detection limit.

Naval Amphibious Base, Little Creek

77. Sampling and testing. Sediments from the NAVPHIBASE LCREEK have been sampled on four occasions. Twenty-four borings were taken in April 1974 at various locations in the main Little Creek Channel (EnviroPlan, Inc. 1974). The borings were taken with a Phleger core and were analyzed for various physical and chemical characteristics. These borings were associated with the widening of Little Creek Channel. Therefore, the majority of the samples were taken along the sides of the old channel. The sediment samples were analyzed for physical and chemical composition.

78. In January 1978, three sediment borings were taken in the southeast part of Little Creek Cove (Naval Amphibious Base, Little Creek 1979). These

Table 6

Naval Supply Center, Cheatham Annex, Average Sediment Characteristics

Parameter	1985 Borings*
Percent sand	--**
Percent silt and clay	73.0
Percent clay	--
Percent total solids	94.28
Percent volatile solids	8.87
Total Kjeldahl nitrogen, mg/kg	2,377
Oil and grease, mg/kg	1,615
Cadmium, mg/kg	1.3
Chromium, mg/kg	35.3
Copper, mg/kg	23.6
Lead, mg/kg	38.8
Mercury, mg/kg	0.16
Nickel, mg/kg	29.1
Zinc, mg/kg	142.2
PCB, mg/kg	<0.001
Endrin, mg/kg	<0.001
Lindane, mg/kg	<0.001
Methoxychlor, mg/kg	<0.001
Toxaphene, mg/kg	<0.001
2,4-D, mg/kg	<0.001
2,4,5 TP-Silvex, mg/kg	<0.001
Aromatic hydrocarbon, mg/kg	<0.01

* Average of five borings taken on either side of the supply pier.
** Not analyzed.

borings were associated with the proposed construction of an ammunition handling wharf. The borings averaged 20.3 ft in depth and were analyzed for various physical and chemical properties. Elutriate tests were performed on four sediment samples from each of the three borings.

79. In November 1979, two shallow borings were taken adjacent to Piers 16 and 17 in southwest Little Creek Channel (Soils Engineering Analysis, Inc. 1979; Jennings Laboratories, Inc. 1979). Samples were taken at the sediment surface and at a depth 7 ft below the sediment surface. The sediment from both borings was analyzed for various physical and chemical properties. Elutriate tests were performed on two sediment samples from each of the two borings.

80. In August 1982, 26 sediment borings were taken at various locations in the Little Creek Channel and Little Creek Cove (Froehling and Robertson, Inc. 1982). The borings were taken using a 3-in. ID, 4-ft-long plastic core barrel. A scuba diver inserted the plastic core barrel into the bottom to an average depth of approximately 2 ft. The borings were then divided into sections, about 4 to 6 in. long, and analyzed for various physical characteristics. The sediment from all 26 borings was analyzed for total solids and volatile matter. Borings that were selected for additional chemical analyses were split longitudinally, and half of the upper and lower sections was used in the analysis.

81. Sediment physical characteristics. The 1974 and 1978 borings indicated that the sediments within Little Creek Channel were a mixture of sands, silts, and clays. The two 1979 borings indicated a clayey silt at the sediment surface underlain by a fine to medium sand. The 1982 cores indicated that the surficial sediments were a mixture of sands, silts, and clays.

82. In general, sediments, in the southern portion of the Little Creek Channel and Little Creek Cove are predominantly fine-grained, while the sediments near the mouth of the Little Creek Channel out to a distance of approximately 10,000 ft are predominantly sands (with from 2 to 20 percent passing the No. 200 sieve). Sediments in the channel fairway further north are predominantly fine-grained.

83. Sediment chemical inventory. The results of the sediment chemical inventory of samples taken from NAVPHIBASE LCREEK are shown in Table 7. The sediment from the 1974 borings was analyzed for various chemical characteristics, such as total solids, volatile solids, chemical oxygen demand, total

Table 7

Naval Amphibious Base, Little Creek, Average Sediment Characteristics

Parameter	1974 Borings*	1978 Borings**	1982 Borings
Percent sand	--	--	--
Percent silt	--	--	--
Percent clay	--	--	--
Percent total solids	71.5	--	62.23
Percent volatile solids	1.84	--	3.7
Total Kjeldahl nitrogen, mg/kg	434	225.46	0.09
Total phosphorus, mg/kg	120	--	--
Oil and grease, mg/kg	1,164	--	236
Cadmium, mg/kg	0.19	--	0.005
Chromium, mg/kg	17.2	--	0.05
Copper, mg/kg	12.1	--	0.12
Lead, mg/kg	7.25	--	0.05
Mercury, mg/kg	0.12	--	0.0007
Nickel, mg/kg	--	--	0.045
Zinc, mg/kg	35	--	2.55
Aldrin, mg/kg	--	--	0.0002
Dieldrin, mg/kg	--	--	0.0008
Endrin, mg/kg	--	--	0.0008
Heptachlor, mg/kg	--	--	0.0002
Heptachlor-epoxide, mg/kg	--	--	0.0003
o,p' DDT, mg/kg	--	--	0.0009
o,p' TDE, mg/kg	--	--	0.0008
p,p' DDE, mg/kg	--	--	0.0004
p,p' DDT, mg/kg	--	--	0.0010
p,p' TDE, mg/kg	--	--	<0.0007
PCB, mg/kg	--	--	0.125
Kepone, mg/kg	--	<0.01	--
BHC, mg/kg	--	--	<0.0001
Lindane, mg/kg	--	--	<0.0001

* Average of 24 borings.
** Average of composite samples from three borings.
Average of six core samples, except total and volatile solids (average of 26 cores).
Not analyzed.

Kjeldahl nitrogen, total phosphorus, zinc, copper, lead, cadmium, chromium, mercury, and oil and grease.

84. The sediment samples from the 1978 borings were composited and analyzed for total Kjeldahl nitrogen and kepone. Kepone was found to be below detection.

85. Sediment samples from the 1979 borings were analyzed for pesticides and PCBs, but all were found to be below detection (<0.001 mg/kg).

86. The sediment samples from 6 of the 26 1982 cores were analyzed for mercury, cadmium, chromium, copper, lead, zinc, nickel, oil and grease, total Kjeldahl nitrogen, PCBs, and pesticides such as BHC, lindane, heptachlor, aldrin, heptachlor-epoxide, p,p' DDE, o,p' TDE, dieldrin, o,p' DDT, endrin, p,p' DDT, and p,p' TDE. These cores were all in the southern portion of the channel and within the cove.

87. Elutriate testing. The results for the elutriate tests are shown in Table 8. The standard elutriates were analyzed for total phosphorus, total

Table 8

Naval Amphibious Base, Little Creek, Elutriate Concentrations

Parameter	1978 Elutriate	1979 Elutriate	Acute Water Quality for Marine Life*
Total Kjeldahl nitrogen, mg/ℓ	--**	15.73	--
Total organic carbon, mg/ℓ	--	34.0	--
Total phosphorus, mg/ℓ	--	0.11	--
Oil and grease, mg/ℓ	7.32	<1.0	--
Cadmium, mg/ℓ	0.03	0.05	0.043
Chromium, mg/ℓ	--	0.01	0.0103
Copper, mg/ℓ	0.13	0.04	0.0029
Lead, mg/ℓ	0.07	0.005	0.140
Mercury, mg/ℓ	0.000004	0.0584	0.0021
Zinc, mg/ℓ	0.04	0.17	0.095

* US Environmental Protection Agency (1986).
** Not analyzed.

Kjeldahl nitrogen, oil and grease, mercury, lead, zinc, chromium, copper, and cadmium.

88. The elutriate concentrations for some parameters exceeded the Federal acute water quality criteria. Consideration of mixing would be required for these parameters.

Dredging Requirements

89. No extensive investigation of shoaling rates has been conducted at any of the projects; therefore, a determination of dredging requirements must be based on a history of past dredging operations. However, it is difficult to determine the future dredging requirements at NWS Yorktown, CAX, and NAVPHIBASE LCREEK from the dredging records since the facilities have been dredged only a few times and the time interval between dredging has been inconsistent. Determining future dredging requirements has been further complicated by the fact that new work dredging was necessary at some locations before any maintenance dredging was undertaken.

Naval Weapons Station, Yorktown

90. Records show that four dredging contracts were completed at Pier R-3 between 1965 and 1987 (see Table 1). The dredging quantities versus time are shown in Figure 6. Two of the contracts were in the barge basin, and two were on the outboard side of the pier.

91. The barge basin had one new work and one maintenance dredging contract between 1965 and 1987. A quantity of 169,535 cu yd of new work material was removed in 1965 and, 22 years later, in 1987, 168,387 cu yd of maintenance material was removed.

92. The outboard side of the pier had two new work contracts between 1965 and 1987. A quantity of 74,860 cu yd of material was removed in 1966 and, 13 years later, in 1979 and 1980, 700,540 cu yd of material was removed to deepen the outboard side of the pier to 42 ft mlw. Some of this material may have been maintenance work.

93. No definite plans for future new work dredging at NWS Yorktown are known. Therefore, considering only the new work contracts in 1965/1966, the 1970/80 new work contract, and the 1987 maintenance contract, there were basically three dredging contracts over the 22-year period between 1965 and 1987. Hence, a dredging frequency of approximately 7 years was assumed. The

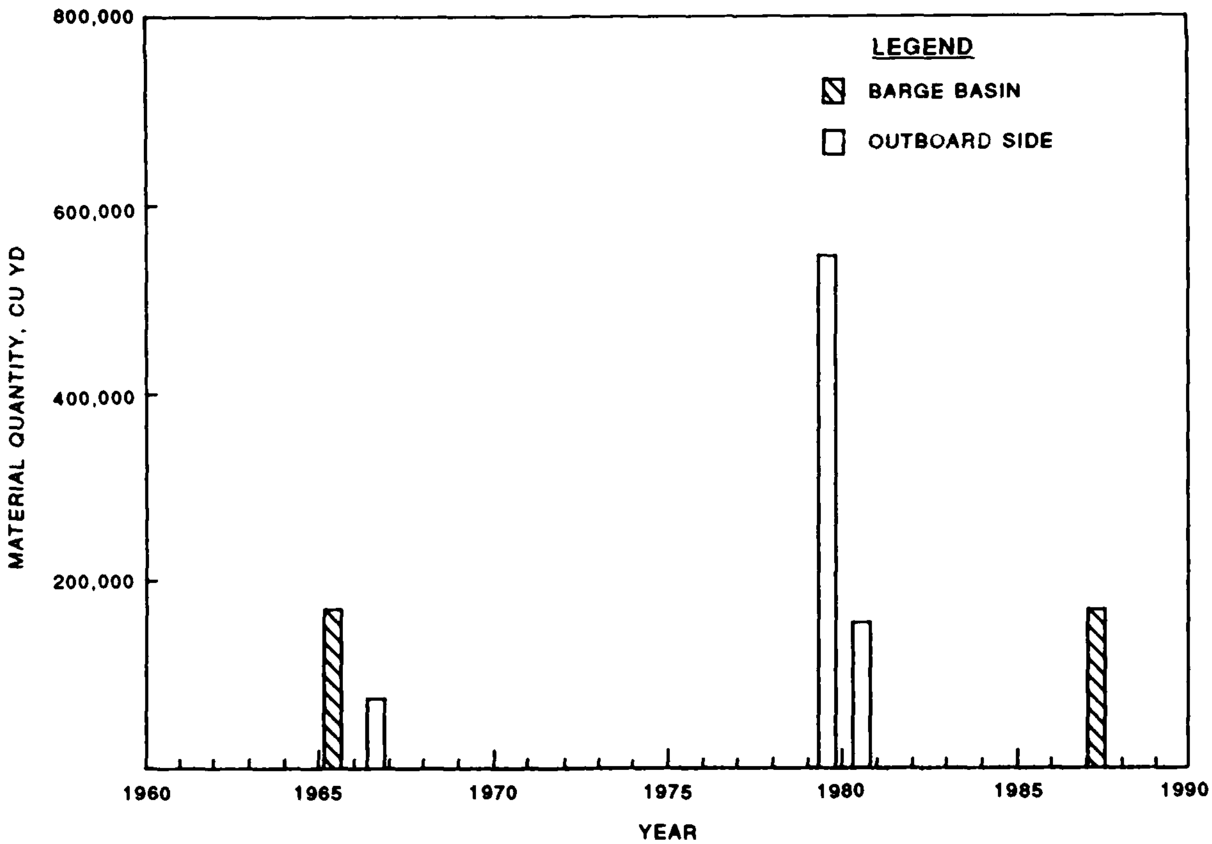

Figure 6. Naval Weapons Station, Yorktown, dredged material quantities

1965/66 new work quantities and the 1987 maintenance quantities were averaged to give a dredging requirement of approximately 200,000 cu yd. Therefore, the dredging requirement of NWS Yorktown is assumed to be 200,000 cu yd every 7 years (see Table 9).

Naval Supply Center, Cheatham Annex

94. Records show that three maintenance dredging contracts were completed at the supply pier between 1966 and 1988 (see Table 2). The dredging quantities versus time are shown in Figure 7. These maintenance dredging contracts included the removal of 99,995 cu yd of material in 1966, 33,178 cu yd in 1981, and 24,766 cu yd in 1988.

95. Dredging in FY 90 at CAX will include dredging to a 20-ft depth on the south (Area B) and east (Area C) sides of the supply pier with disposal at Craney Island. Dredging on the south side of the supply pier is necessary to free a large supply ship that presently is sitting on the York River bottom

Table 9

Dredging Requirements for the Naval Weapons Station, Yorktown, Naval Supply Center, Cheatham Annex, and Naval Amphibious Base, Little Creek

Location	Material Quantity, cu yd	Dredging Frequency years
NWS Yorktown	200,000	7
CAX	30,000	5
NAVPHIBASE LCREEK	140,000 (tributaries)	4
	300,000 (channel)	10

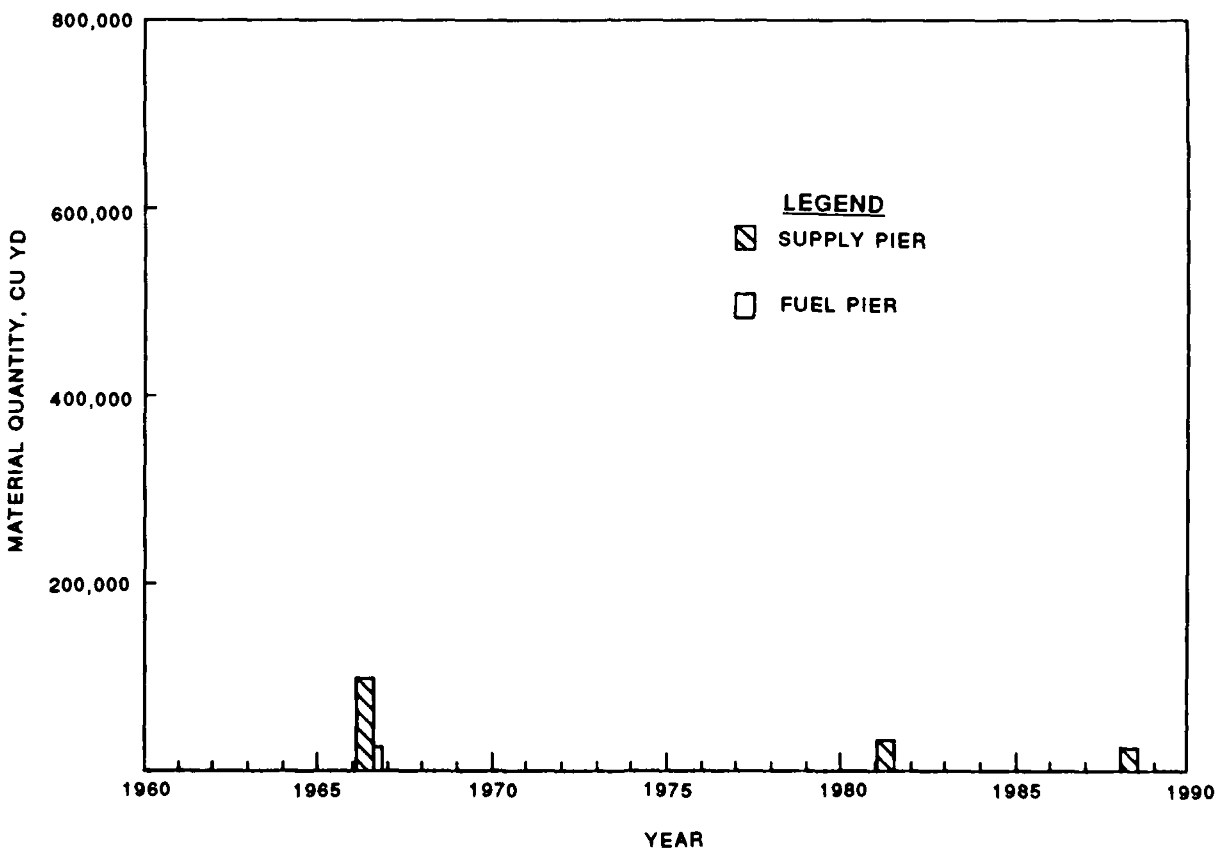

Figure 7. Naval Supply Center, Cheatham Annex, dredged material quantities

(Powell, 1989).* The Navy has plans to build a marina on the northwest bank of King Creek to accommodate pleasure crafts.

96. In a dredging plan dated 1 November 1980, the Navy noted that the average dredging requirement at the supply pier was approximately 135,000 cu yd of material every 10 years (US Naval Facilities Engineering Command 1980). Based on the dredging completed to date, this volume estimated seems high. Averaging the three maintenance dredging contracts that have been completed and considering potential new work gives a dredging volume requirement of approximately 60,000 cu yd every 10 years. However, the Navy has indicated that the dredging frequency may accelerate to every 5 to 7 years due to anticipated increases in the supply pier activity (US Navy, letter, 1989).* Therefore, the assumed dredging requirement of the CAX is 30,000 cu yd every 5 years (see Table 9).

Naval Amphibious Base, Little Creek

97. Records show nine dredging contracts with documented quantities between 1961 and 1984 (see Table 3). The dredging quantities versus time are shown in Figure 8. Additional dredging contracts were completed between 1943 and 1965; however, information on the quantities involved was unavailable. Of the nine dredging contracts with documented quantities, six were in the Little Creek tributaries, one was in Chubb Lake, and two were in Little Creek Channel. Since the quantity of dredging at Chubb Lake is so small and the frequency of dredging is unknown, Chubb Lake can be omitted from the dredging requirement calculations. Since the main Little Creek Channel is maintained by the Norfolk District and the Little Creek tributaries are maintained by the US Navy, these dredging requirements will be considered separately.

98. The six dredging contracts for the Little Creek tributaries in 23 years results in a dredging frequency of approximately 4 years. The documented dredging quantities include 112,600 cu yd in 1961, 277,696 and 126,416 cu yd in 1965, 101,945 cu yd in 1975, 81,245 cu yd in 1976, and 12,753 cu yd in 1981. Taking the average of these quantities, plus an allowance for new work, yields a dredging requirement of 140,000 cu yd. Therefore, the assumed dredging requirement of the Little Creek tributaries is 140,000 cu yd every 4 years (Table 9).

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* See Bibliography.

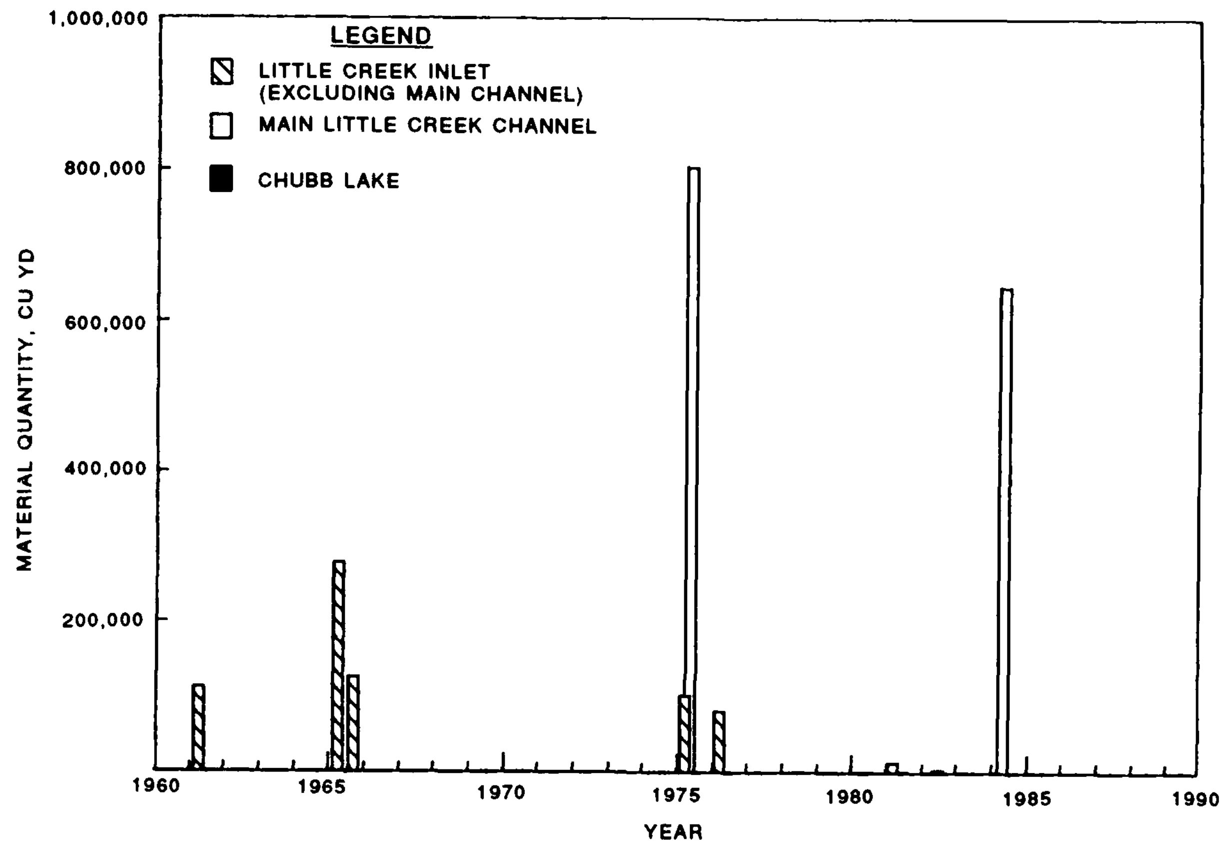

Figure 8. Naval Amphibious Base, Little Creek, dredged material quantities

99. The two dredging contracts for the main Little Creek Channel in 23 years result in a dredging frequency of approximately 20 years. The average quantity of the new work contracts in the Little Creek Channel is 724,926 cu yd. Due to the fact that all the contracts completed in the main Little Creek Channel included new work, it is difficult to determine the amount of maintenance dredging necessary in the channel. Considering the two previous new work contracts and some potential new work, a conservative dredging requirement of 300,000 cu yd is assumed. Therefore, the assumed dredging requirement of Little Creek Channel is 300,000 cu yd every 10 years (Table 9).

PART V: DESCRIPTION OF ENVIRONMENTAL RESOURCES

100. This part of the report provides an overview of the biotic resources that may be affected by dredging or disposal operations conducted at NWS Yorktown, CAX, and NAVPHIBASE LCREEK. The area of coverage includes the lower portion of the York River from just above Yorktown and the lower Chesapeake Bay. The information summarized here, unless indicated otherwise, is taken from previous draft environmental assessment reports (and references cited therein) for the York River (Naval Weapons Station, Yorktown 1977; USAED, Norfolk 1986) and Little Creek area of Chesapeake Bay (EnviroPlan, Inc. 1974; Naval Amphibious Base, Little Creek 1979). Much of the information about major categories of organisms discussed below covers habitats found along the lower river and the immediate area of the bay near its mouth. Additional information is given for resources of the open-water habitats of lower Chesapeake Bay, which may be affected by open-water disposal activities. Discussions of endangered species and temporal/seasonal considerations and concerns are also included.

York River

Shorelines

101. Thirty percent of the York County shoreline is under jurisdiction of the Federal Government. The shoreline in this area is high bluff with moderate erosion. The public beach, 1.5 miles downstream of NWS Yorktown, has undergone extensive erosion in the past, leaving most of the shoreline with high narrow beaches, bluffs, and sparse vegetation (Getchell 1989).

Intertidal wetlands

102. The vegetated intertidal wetland habitats along the York River and lower Chesapeake Bay include low-, middle-, and high-elevation marshes, the vegetation characteristics of which are determined by the degree of tidal inundation. Low marshes, which are flooded daily, are dominated by saltmarsh cordgrass (*Spartina alterniflora*), sea lavender (*Limonium nashii*), and saltmarsh aster (*Aster tenuifolius*). Along creek and river banks, this type of marsh commonly occurs as narrow bands a few metres wide. Marshes located at slightly higher elevations are composed of saltgrass (*Distichlis spicata*), saltmeadow hay (*Spartina patens*), black needlerush (*Juncus roemerianus*),

saltmarsh bulrush (*Scirpus robustus*), and, in lower salinity areas, big cordgrass (*Spartina cynosuroides*). High marshes include groundsel bush (*Baccharis halimifolia*), marsh elder (*Iva frutescens*), sea oxeye (*Borrichia frutescens*), saltmarsh fimbristylis (*Fimbristylis spadicea*), and switchgrass (*Panicum virgatum*). These habitats serve as major sources of primary and secondary productivity for adjacent systems and the estuarine system as a whole. They also function as essential habitat for a large array of estuarine-dependent organisms, including economically important fish and shellfish.

103. The shoreline directly in front of the NWS Yorktown has slight erosion and a well-established narrow fringe of saltmarsh. The saltmarsh is a mixture of big cordgrass and common reed (*Phragmites communis*) in the upper zone and saltmarsh cordgrass, saltgrass, and saltmeadow hay in lower areas. The shoreline at CAX is undergoing moderate erosion, and the Navy has placed large piles of antisubmarine netting along the shore to abate the loss of land. Small stands of saltmarsh cordgrass inhabit portions of the shore. There does not appear to be any submersed aquatic vegetation offshore (Getchell 1989).

104. Unvegetated mud flats, which are regularly exposed at low tide, occur along the York River and shallow shoreline areas within the bay. These habitats support assemblages of benthic invertebrates, algal mats, and diatoms, providing important nursery, spawning, and foraging habitat for shellfish, fish, and birds.

Freshwater wetlands

105. A previously used disposal site, the Old Disposal Site located on the NWS Yorktown (see Figure 3), currently supports a freshwater marsh flora dominated by common reed and cattails (*Typha latifolia*). The preponderance of reed is likely due to the past use of this swale for dredged material disposal (Getchell 1989). The drier edges of the site contain marsh elder, groundsel, and bayberry (*Myrica cerifera*) shrubs. Additional description of this site is given in Part VI (see paragraph 131).

106. A ravine site is located just downstream of Pier R-3 at the NWS Yorktown. At its upper reaches, it is composed of a hardwood swamp. American sycamore (*Platanus occidentalis*), sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), and shell bark hickory (*Carya raciniosa*) dominate. The lower reaches transit to a freshwater wetlands (Getchell 1989).

Submersed aquatic vegetation

107. When overboard disposal is considered for any of the projects, beds of submersed aquatic vegetation should be avoided. Submersed aquatic vegetation is considered a sensitive resource in the Chesapeake Bay and necessary to the support of much of its recreational and commercial fishery (Getchell 1989).

108. Two species of submersed aquatic plants that form grass beds occur within Chesapeake Bay (usually in parts of the bay where salinity remains above 10 ppt): eelgrass (*Zostera marina*) and widgeon grass (*Ruppia maritima*). While there have been drastic declines in these habitats since the 1970s, beds still exist along the shorelines of the lower bay in the vicinity of the York River (Figure 9). These habitats support considerable assemblages of invertebrates, which in turn support a large array of natant organisms that frequent these beds.

Plankton

109. The phytoplankton assemblage of the York River consists mainly of diatoms and flagellates with diatoms dominating in winter and early spring and flagellates in summer. The zooplankton assemblage of the river is dominated by the copepods *Acartia tonsa* and *Eurytemora affinis*, mysid shrimp (*Neomysis americana*), and the amphipods *Monoculodes edwardii* and *Gammarus* sp.

Benthos and shellfish

110. The macrobenthic assemblages of the lower York River-Chesapeake Bay area have been extensively studied to investigate distributions along the salinity gradient associated with the river. In general, these assemblages are composed primarily of polychaetes and molluscs. Boesch (1971) reported on 360 species from the area and showed, based on similarity of assemblages, that these communities were basically continuous along the estuarine gradient and that species were generally distributed independently. Community complexity was highest in the high-salinity (polyhaline) zone, decreasing through the middle-salinity (mesohaline) and low-salinity (oligohaline) zones. Many of the species that comprise these assemblages are characterized by having high reproductive rates and great dispersive abilities. Economically important members of the benthic assemblages include the American oyster (*Crassostrea virginica*) and the hard clam (*Mercenaria mercenaria*), extensive beds of which occur along the lower York River and Chesapeake Bay (see Figure 10).

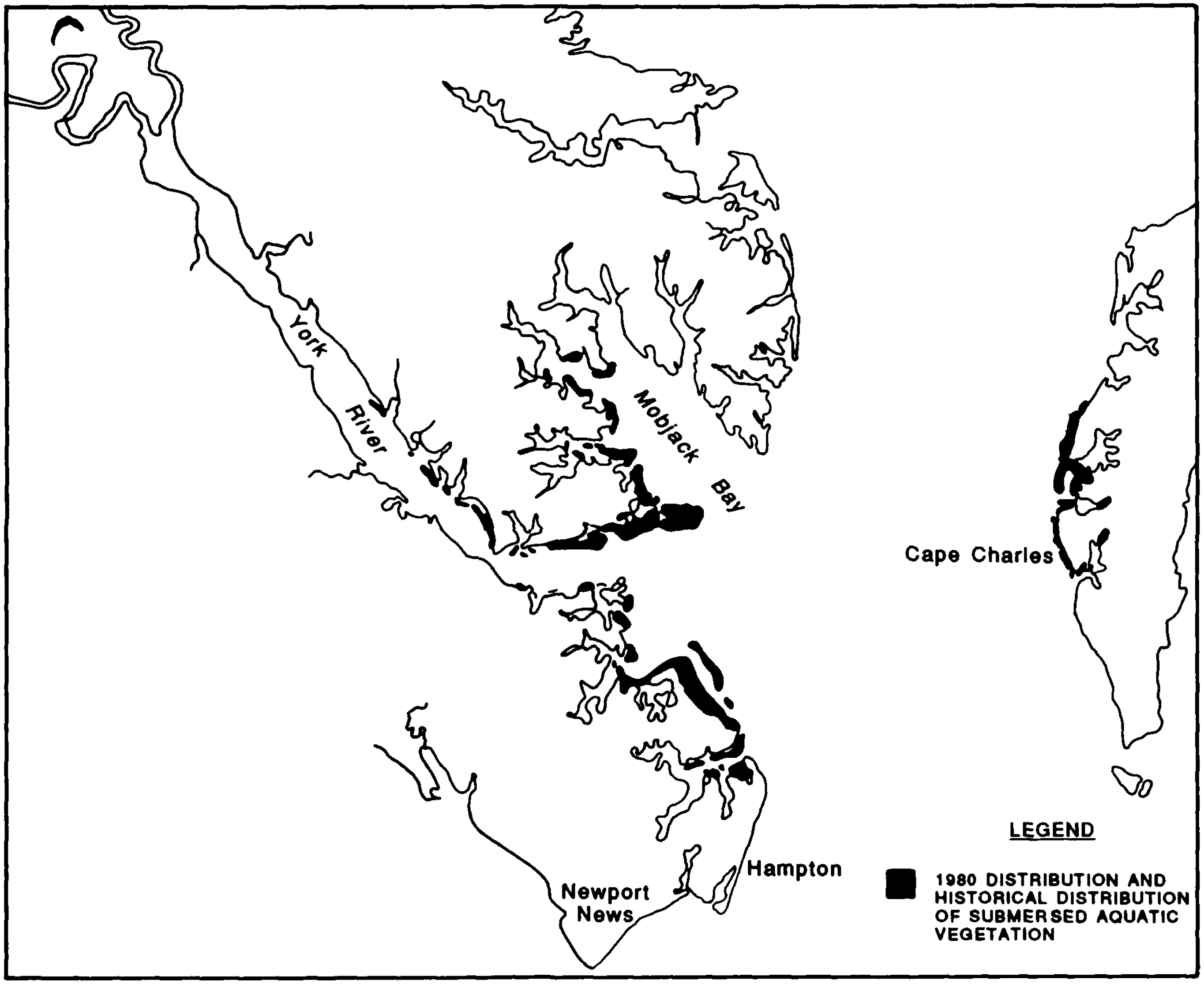

Figure 9. Historical and 1980 distribution of submersed aquatic vegetation within potential impact area (after USAED, Norfolk 1986)

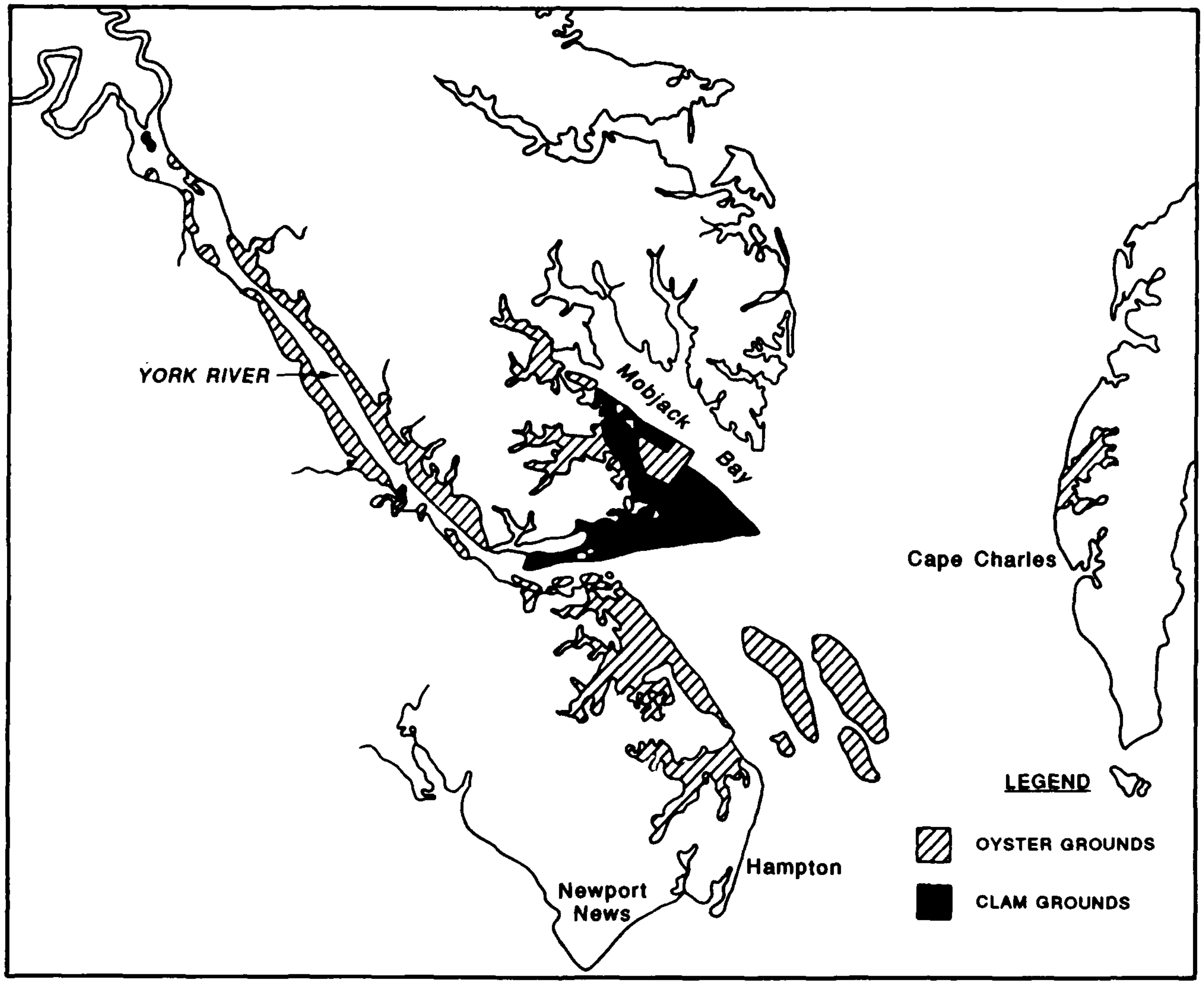

Table 10. Lower Chesapeake Bay and the York and Poquoson Rivers and Mobjack Bay, indicating the distribution of public and leased oyster grounds and public clam grounds (after USAED, Norfolk 1986)

Nekton

111. The York River and adjacent portions of the Chesapeake Bay support a large number of resident and transient fish and crustacean species. Studies reporting sample data collected over the past 30 years have listed over 40 species of fishes, many of which occur in these areas year round. As part of the Chesapeake estuarine complex, these areas are particularly important as nursery grounds for both resident and transient species. Some of the more commonly encountered species include the hogchoker (*Trinectes maculatus*), white perch (*Morone americana*), spot (*Leiostomus xanthurus*), oyster toadfish (*Opsanus tau*), striped bass (*Morone saxatilis*), weakfish (*Cynoscion regalis*), bay anchovy (*Anchoa mitchilli*), and Atlantic croaker (*Micropogonias undulatus*). At times during the year, combinations of these common species can comprise from 50 to 90 percent of fish abundance or biomass. A number of additional ecologically and economically important species also occur seasonally. Important among these are the anadromous species of herrings and shad that migrate upriver to spawn, including the blueback herring (*Alosa aestivalis*), alewife (*Alosa pseudoharengus*), hickory shad (*Alosa medocris*), and American shad (*Alosa sapidissima*). Important commonly encountered crustaceans from this area include blue crab (*Callinectes sapidus*) and white and brown shrimp (*Penaeus setiferus* and *Penaeus aztecus*), which also use the estuary as a nursery area.

Little Creek

Beach-dune habitat/intertidal wetlands

112. The beach habitat in the vicinity of Little Creek Inlet is typical of coastal beach-dune systems, grading from an initial community of beach grasses and herbaceous vegetation through increasingly dense stands of shrubs and small trees to stands of scrub live oak, wax-myrtle, and other shrubs. A large proportion of these communities are wetland or transitional areas. Intertidal marshes are also present in the area of Little Creek and are similar to those previously described for the York River.

113. The shoreline extending eastward from the Little Creek entrance jetties is characterized by a wide sandy foreshore and seashore with an extensive system of primary and secondary dunes. The dunes nearest the jetties have been modified with paths and other structures and have sparse stands of

sea oats (*Uniola paniculata*), American beach grass (*Ammophila breviligulata*), seaside golden rod (*Solidago graminifolia*), groundsel bush (*Baccharis halimifolia*), and loblolly pine (*Pinus taeda*). These species increase in density toward Normandy Beach, where human activity is minimal (Getchell 1989).

Plankton/benthos and shellfish

114. The plankton assemblages of the Little Creek area are, in general similar to those previously described for the York River. The phytoplankton is dominated by diatoms and the zooplankton by copepods (particularly the ubiquitous *Acartia tonsa*). The benthic assemblages within Little Creek itself are composed of similar groups of organisms as previously described for the York River (polychaetes and molluscs) but have been described as being depauperate, limited to the most tolerant species. The heavy use of the channels within the Little Creek area acts to disturb the bottom muds and associated organisms. The area of Chesapeake Bay lying offshore of Little Creek inlet is a wintering area for blue crab (*Calloninectus sapidus*) and supports commercial hard clams (*Mercenaria mercenaria*). Clamming beds are situated offshore at various locations; however, the area approximately 1 mile offshore and to the east and west of the Little Creek jetties has been condemned for the taking of shellfish (Getchell 1989).

Nekton

115. The fish and crustacean assemblage in the vicinity of Little Creek is characterized by many of the same species of estuarine-dependent species identified for the York River but includes several additional species typical of more saline conditions. Some of these include bluefish (*Pomatomus saltatrix*), flounder (*Paralichthys* spp.), speckled trout (*Cynascion nebulosus*), menhaden (*Brevoortia tyrannus*), American eel (*Anguilla rostrata*), and sea mullet (*Mugil cephalus*).

Chesapeake Bay

116. The benthic assemblages at the Wolf Trap and Rappahannock Shoals area of Chesapeake Bay were studied by Diaz et al. (1985) as part of predisposal baseline data collection for the Baltimore Harbor and Channel Project. Both sites were numerically dominated by polychaetes (61 to 77 percent), with molluscs and crustaceans making up 10 to 27 percent and 6 to 9 percent of the assemblages, respectively. At the time samples were collected, the faunal

composition of the Wolf Trap site was indicative of a mature, advanced successional stage (i.e., composed of large, long-lived species), while the Rappahannock site was characterized as an early successional stage community (i.e., small, short-lived species). Faunal composition of the early stage communities at the Rappahannock site varied greatly with sediment type.

Threatened/Endangered Species

117. The following threatened or endangered species may be found in the vicinity of the York River-Lower Chesapeake Bay area: bald eagle (*Haliaeetus leucocephalus*), green sea turtle (*Chelonia mydas*), leatherback sea turtle (*Dermochelys coriacea*), Kemp's Ridley sea turtle (*Lepidochelys kempii*), loggerhead sea turtle (*Caretta caretta*), and small whorled pogonia (*Isotria medeoloides*). The following species are either being considered for Federal listing or are listed as of special concern within Virginia: river otter (*Lutra canadensis*), piping plover (*Charadrius melodus*), osprey (*Pandion haliaetus*), Long's bittercress (*Cardamine longii*), sensitive jointvetch (*Aeschenomene virginica*), and Nuttall's micranthemum (*Micranthemum micranthemoides*).

118. Green, leatherback, Kemp's Ridley, and loggerhead sea turtles have been sighted at various locations in the Chesapeake Bay between May and October. A bald eagle's nest is located at Camp Peary, just north of CAX. Although these species may frequent the area at various times, dredging operations should not adversely impact their territory (Getchell 1989).

Environmental Concerns

119. Direct burial and/or removal of benthos at either the dredging or disposal site and the suspension of sediments into the water column during dredging or disposal operations are the most often cited environmental concerns (National Research Council 1985, Lunz and LaSalle 1986, Barr 1987). The effects of sediment suspension can be broadly grouped into two categories: water quality alterations and direct effects on organisms by the sediments. Water quality concerns center on reductions in dissolved oxygen concentrations or on the release of sediment contaminants. Other water quality concerns, including the release of naturally occurring sediment compounds (e.g.,

sulfates, nutrients, etc.) and changes in pH, light transmission, temperature, and other water variables, while of potential significance in certain cases, are generally unimportant (McCauley, Hancock, and Parr 1976; National Research Council 1985; Barr 1987).

120. Suspended sediments, at concentrations similar to those around disposal operations (≥500 mg/ℓ), have been shown to affect the health and survival of aquatic organisms. Lethal and sublethal effects on all life stages of aquatic organisms include burial, clogging of respiratory organs, membrane abrasion, impairment of feeding and other activities, and deleterious effects on survival and growth of critical egg and larval stages (Sherk, O'Connor, and Neumann 1975; Peddicord and McFarland 1978; Stern and Stickle 1978; National Research Council 1985; Barr 1987; LaSalle et al., in preparation). Effects on behavior (mating, feeding, migration) and synergistic effects of two or more factors have been suggested to be important but are not established (Gibson 1987; Manooch 1987; LaSalle et al., in preparation). In the case of submersed aquatic vegetation, the effect of shading for long periods of time has been cited as a concern.

Seasonal Considerations

121. Major seasonal considerations that could minimize environmental impacts on biotic resources would include avoidance of the spawning seasons of the major nekton species in the system (early spring/summer), although in the case of small-scale operations, the degree of impact would be expected to be minor for the system as a whole. Site-specific conditions, however, are an important consideration. If a major concern is for recovery of benthic assemblages, operations could be scheduled just prior to the spawning period of the major benthic species (early spring/summer), thereby facilitating early colonization of the impacted area.

PART VI: DISPOSAL RESOURCES AND ALTERNATIVES

122. This part of the report describes the potential disposal alternatives that exist for material dredged from NWS Yorktown, CAX, and NAVPHIBASE LCREEK. Confined and open-water disposal, as well as beneficial uses of the dredged material, are potential disposal alternatives that will be considered. Information on the historically used disposal sites was obtained from available LANTNAVFACENGCOM and Norfolk District dredging records, as well as field inspections conducted by personnel of the Navy, Norfolk District, and WES on 18 October 1988, 23 February 1989, and 6 July 1989.

Confined Disposal

123. Confined disposal facilities are diked areas used to retain dredged material solids while allowing the carrier water to be released from the site. The two objectives of a CDF are to provide adequate storage capacity to meet dredging requirements and to attain the highest possible efficiency in retaining solids during the disposal operation in order to meet effluent suspended solids requirements. These considerations are interrelated and depend upon the effective design, operation, and management of the CDF (US Army Corps of Engineers 1987a).

124. The use of a CDF for dredged material disposal is limited by various environmental and economic considerations. For example, NWS Yorktown, CAX, and NAVPHIBASE LCREEK are located in a historically significant area of the Commonwealth of Virginia. The NWS Yorktown and CAX are located on the Colonial National Historical Parkway and a few miles from the historic cities of Yorktown and Williamsburg, VA. The NAVPHIBASE LCREEK is located within the city limits of Virginia Beach and Norfolk, VA. In addition, the use of the NWS Yorktown, CAX, and NAVPHIBASE LCREEK properties for base operations and training has limited the space available for the construction of CDF sites.

125. Considering the relatively small volumes of material dredged from NWS Yorktown, CAX, and NAVPHIBASE LCREEK and the likely objection of using historical or developed lands adjacent to the facilities, identification of potential sites for new CDFs outside the facility properties was not considered necessary. Therefore, only CDF sites that have received previous consideration and are located on the NWS Yorktown, CAX, and NAVPHIBASE LCREEK

properties were considered as potential disposal sites. Records show that several potential CDF sites exist at NWS Yorktown and NAVPHIBASE LCREEK, and one at the CAX.

126. Because the Craney Island Facility has been used for disposal of material dredged from NWS Yorktown, CAX, and NAVPHIBASE LCREEK on several occasions in the past, a brief description of the Craney Island site is included in the discussion that follows.

NWS Yorktown sites

127. General. Records show that five potential CDF sites exist at the NWS Yorktown: the Magazine 13/14, Lee Pond, Roosevelt Pond, Old Disposal, and Landfill/Forest sites (see Figure 3). In 1978 and 1985, all of these locations were considered to be unacceptable disposal sites by either the US Environmental Protection Agency (USEPA), the US Fish and Wildlife Service (USFWS), the National Marine Fisheries Service, or the US Navy. These agencies conducted several investigations of the NWS Yorktown property in an attempt to locate additional CDF sites; however, no readily acceptable sites were located (US Navy, letter, 1978a,b; US Army Engineer District, Norfolk, DF, 1986).*

128. Magazine 13/14 site. The Magazine 13/14 site is located south of Turkey Road between Magazine Groups 13 and 14. The pumping distance from Pier R-3 to this site is approximately 4.17 miles. This site has an area of 21.4 acres. The effluent from this site would flow into Felgates Creek. This site was investigated by the USFWS in 1978 and was considered to be an environmentally unacceptable disposal site because of nearby spring-fed streams and freshwater wetlands. A review of this site in 1985 indicated that it was in the same ecological state as in 1978 (US Naval Facilities Engineering Command, 1978; US Navy, letter, 1978a,b; US Navy, letter, 1985).*

129. Lee Pond site. The Lee Pond site is located south of the intersection of Indian Field and Lee Roads. The pumping distance from Pier R-3 to this site is approximately 2.5 miles. This site has an area of 32.7 acres. The effluent from this site would flow into Felgates Creek. This site was investigated by the USFWS in 1978 and was considered to be an environmentally unacceptable disposal site because of nearby spring-fed streams and freshwater wetlands. A review of this site in 1985 indicated that it was in the same

ecological state as in 1978 (US Naval Facilities Engineering Command, 1978; US Navy, letter, 1978a,b; US Navy, letter, 1985).*

130. Roosevelt Pond site. The Roosevelt Pond site is located south of Pier R-3 near the intersection of Roosevelt Road and Colonial National Historical Parkway. In 1978 this site was considered to be an unacceptable disposal site by NWS Yorktown due to the nearby weapons storage facilities that would be very difficult to relocate, from both the economic and security points of view. In addition, this site was used extensively for recreation, although recreation at this site was discontinued in 1988 (Naval Weapons Station, Yorktown 1977) (see also US Naval Facilities Engineering Command, 1978; US Navy, letter, 1978a,b; US Navy, letter, 1989*).

131. Old Disposal Site. The Old Disposal Site is located just west of Pier R-3 on the south side of the Colonial National Historical Parkway. The pumping distance from Pier R-3 to this site is approximately 4,000 ft. This site has an area of approximately 18 acres and contains about 8.5 ft of previously dredged material. The effluent from this site would flow into the York River. This site was used in 1965 to dispose of material dredged from the barge basin of Pier R-3. However, the USEPA investigated this site in 1978 and considered it to be an environmentally unacceptable disposal site due to the presence of freshwater wetlands that developed on the previously disposed dredged material. A review of this site in 1985 indicated that it was in the same ecological state as in 1978 (Naval Weapons Station, Yorktown 1977) (see also, US Environmental Protection Agency, letter, 1978*).

132. Landfill/Forest Site. This site is located on the southern tip of Indian Field Creek and consists of two areas. The first area consists of 7 acres on an old landfill site; the second consists of 13 acres on forested land that was harvested and replanted around 1985. As previously discussed, five borings were taken in the barge basin of Pier R-3 in 1984, and the sediments from all five borings were found to be highly plastic clays with a USCS classification of CH. The Navy considered the development of a CDF at this site to be an economic disposal alternative; however, they felt that the impermeable characteristics of material from the barge basin would cause the material to remain in a semiliquid state if it were deposited at this site. Based on this, the Navy decided not to use this site (US Navy, letter, 1985*).

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* See Bibliography.

CAX site

133. In 1985, the Navy considered disposal of material dredged from the supply pier in a CDF to be constructed between the supply and fuel piers at CAX (James R. Reed and Associates, Inc. 1985). However, this material was eventually disposed at the Craney Island CDF (see Table 2).

NAVPHIBASE LCREEK sites

134. General. Records show that there are six potential CDF sites on NAVPHIBASE LCREEK: Desert/Little Creek Cove, Rifle Range, New Magazine, Beach Drive, Landfill, and Pier 60 (see Figure 5). At least two of these sites have been used in recent years; however, records were not available to determine if the other four sites were actually ever used. With NAVPHIBASE LCREEK's wetlands sheltered by environmental concerns, less than 275 acres of land is available for base operations and training. This has limited the number of potential CDF sites at the NAVPHIBASE LCREEK (US Navy, letter, 1980).*

135. Desert/Little Creek Cove site. The Desert/Little Creek Cove site is located just southwest of Pier 55 on the strip of land between Desert and Little Creek Coves. This site has an area of 3.6 acres with a 5-ft earthen berm. The effluent from this site would flow into Desert Cove. This site was used in 1981 to dispose of material dredged from Piers 20-34 and their approaches (US Navy 1981).

136. Rifle Range site. The Rifle Range site is located northwest of the NAVPHIBASE LCREEK rifle range, north of Varian Lake, and west of Salerno Beach. This site has an area of approximately 3 acres with a 3-ft earthen berm. The effluent from this site would flow into a canal that in turn flows into Varian Lake. This site was used in 1982 to dispose of material dredged from the Chubb Lake Training Area (see Table 3).

137. New Magazine site. The New Magazine site is located west of the New Magazine area, north of Niles and Ricker Roads. Records show that use of this site was planned in association with the proposed dredging at Building T-1 (located in southwest Little Creek Cove) in 1986. This disposal site was to have an area of 10,000 sq ft surrounded by 2.25-ft-high straw bales. The effluent from this site would flow into Little Creek Cove (US Navy 1986).

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* See Bibliography.

138. Beach Drive site. The Beach Drive site is located north of 11th Street and south of Beach Drive, or northeast of Desert Cove. This site has an area of approximately 20 acres. Of this area, 8 acres was used by the Hampton Roads Sanitation District for a sewage sludge disposal area; the other 12 acres is used as a driver training area. Use of this site would require the construction of dikes to contain the dredged material (EnviroPlan, Inc. 1974; Naval Amphibious Base, Little Creek 1979).

139. This site was proposed as an alternate disposal site on two occasions--in 1975 for the widening of the main Little Creek Channel, and in 1979 for the proposed construction of an ammunition handling wharf in Little Creek Cove. However, the prior use of this site for disposal of sewage sludge may present complications for its use as a CDF site.

140. Landfill site. This site is located northwest of the old sanitary landfill site or south of Little Creek Cove. A drainage ditch runs under US Highway 60, through the proposed disposal site and into Little Creek Cove. The proposed disposal site was divided into three sections, one on the west side and two on the east side of the drainage ditch. Portions of all three sections have been used as dredged material disposal sites, so part of this area is diked off. This site contains about 4 acres of marshland. In addition, a 100- to 150-ft-wide marsh, with an area of approximately 6.2 acres, is located outside this site on the south bank of Little Creek Cove. In 1979 this site was the proposed disposal site for the material dredged from the construction of an ammunition handling wharf; however, this wharf was not constructed (Naval Amphibious Base, Little Creek 1979).

141. Pier 60 site. The Pier 60 site is located just southeast of Pier 60. In 1988 this was the proposed disposal site for material dredged from the improvements to be made at Pier 60. The site was to have an area of approximately 12,500 sq ft, with a silt fence on the western corner. The dredged material was to be deposited to form a 2.5-ft-high mound with 5:1 side slopes and the effluent flowing into Little Creek Cove (US Navy 1988).

Craney Island Facility

142. The Craney Island Facility has an area of 2,500 acres and is located near Norfolk, VA (see Figure 1). Plans for the site were developed in the early 1940s to provide a long-term disposal area for material dredged from the channels and ports in the Hampton Roads area. Construction of dikes at Craney Island was initiated in August 1954 and completed in January 1957.

Since then, material has been placed almost continuously into the disposal area using both direct pipeline discharge and hopper and barge pumpout (Palermo, Shields, and Hayes 1981).

143. In recent years, the US Navy has been granted special permission to use the Craney Island site to dispose of material dredged from NWS Yorktown, CAX, and NAVPHIBASE LCREEK. This use of the Craney Island site was allowed because the Navy was unable to locate suitable disposal sites, and dredging at these naval bases is necessary for the security of the United States. However, concern regarding the amount of capacity remaining at the Craney Island Facility has increased in recent years. Therefore, use of the Craney Island site by NWS Yorktown, CAX, and NAVPHIBASE LCREEK will be prohibited in future years.

144. The sediment at NWS Yorktown, CAX, and NAVPHIBASE LCREEK has been dredged using hopper dredges or clamshell dredges and barges, and then transported to the Craney Island rehandling basin or hydraulically pumped into the Craney Island Facility, depending on the type of dredge used. The approximate haul distances from NWS Yorktown, CAX, and NAVPHIBASE LCREEK to the Craney Island rehandling basin are given in Table 10.

Open-Water Disposal

145. Open-water disposal consists of placing dredged material into a body of water using hopper dredges, or dredge scows or barges, and allowing the material to settle into a stable mound on the bottom. The use of an open-water site for the disposal of dredged material may be limited by various environmental and economic constraints. Open-water disposal of material dredged from NWS Yorktown, CAX, and NAVPHIBASE LCREEK has been considered in the past; however, due to economic considerations and concerns regarding the suitability of the sediments for open-water disposal, this alternative was determined to be infeasible.

146. Considering the difficulty in locating a new open-water disposal site and the relatively small volumes of material dredged from NWS Yorktown, CAX, and NAVPHIBASE LCREEK, only historically used open-water disposal sites, in the vicinity of the lower Chesapeake Bay, were considered as potential disposal sites. These sites include the Dam Neck, Norfolk, Thimble Shoal, Naval Channel, Wolf Trap, Wolf Trap alternate, Rappahannock Shoal,

Rappahannock Shoal alternate, and York River sites (see Figure 1). The approximate haul distances from NWS Yorktown, CAX, and NAVPHIBASE LCREEK to these sites are given in Table 10.

Table 10

Haul Distances* from Naval Weapons Station, Yorktown, Naval Supply Center, Cheatham Annex, and Naval Amphibious Base, Little Creek, to Open-Water Sites

Open-Water Disposal Site	Haul Distance from NWS Yorktown nautical miles	Haul Distance from CAX nautical miles	Haul Distance from NAVPHIBASE LCREEK nautical miles
Craney Island (rehandling basin)	54	58	16
Dam Neck	41	45	19
Norfolk	47	51	25
Thimble Shoal	24	28	6
Naval Channel	16	20	11
Wolf Trap	28	31	34
Wolf Trap alternate	23	27	30
Rappahannock Shoal	51	55	58
Rappahannock Shoal alternate	41	45	47
York River	8	11	38

Source: Steve Powell, USAED, Norfolk.
* Distance from NWS Yorktown, CAX, and NAVPHIBASE LCREEK boundary.

Dam Neck site

147. The Dam Neck site is an ocean site located approximately 3 nautical miles southeast of Virginia Beach, VA, and 7 miles south of the Chesapeake Bay mouth. This site is located on the nearshore continental shelf and is surrounded by productive marine waters. In addition, this site is located within a US Navy firing range. On 31 March 1988 this site was designated by the USEPA as an approved open-water disposal site. The site has an area of 10 square miles and an average water depth of approximately 40 ft mlw. In

1985 this site was expanded to a length of 30,000 ft and a width that tapers from 13,000 to 6,000 ft (US Environmental Protection Agency 1988).

148. This site was first used in 1967 for the construction of the Thimble Shoal channel and has since been used by the Corps of Engineers for new work and maintenance dredging from the Thimble Shoal, Cape Henry, and Atlantic Ocean channels. Between 1967 and 1985 about 20.4 million cubic yards of dredged material was deposited at this site. The material deposited ranged in size from silt to coarse sand. Monitoring at this site has indicated that no significant environmental effects can be attributed to previous disposal of dredged material at this site (US Army Engineer District, Norfolk 1985).

149. The current capacity of this site is approximately 65 million cubic yards, with fill to the 35-ft contour. This site is expected to last 50 years, if only material dredged from the Thimble Shoal, Cape Henry, and Atlantic Ocean channels is placed at the site. However, this site is expected to last only 10 years if the material dredged from the three channels and the Norfolk Harbor Project is placed at this site (Powell, 1989).*

Norfolk site

150. The Norfolk site is an ocean site located approximately 17 nautical miles east of the mouth of the Chesapeake Bay. This site is being studied by the USEPA to classify it as a designated open-water disposal site. This site is circular in shape and covers an area of approximately 65 square miles (radius = 24,000 ft) with an average water depth of 70 ft. This site has a capacity of approximately 1.34 billion cubic yards, assuming a fill elevation of 50 ft (US Army Engineer District, Norfolk 1985; Maryland Port Administration 1988).

Thimble Shoal site

151. The Thimble Shoal site is located in the Chesapeake Bay approximately 7 miles north of the entrance to Little Creek inlet or just northwest of the intersection of the Chesapeake Bay Bridge-Tunnel and Thimble Shoal channel. The area of this site is approximately 1 square mile. In 1965 this site was used for the disposal of material dredged from Piers 1-9 at the NAVPHIBASE LCREEK (see Table 3).

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* See Bibliography.

Naval Channel site

152. The Naval Channel site is located in the Chesapeake Bay on the southeast end of the York River entrance channel. This site has an area of 1,056 acres and is relatively flat, with water depths ranging from 32 to 37 ft mlw. In October 1984, 10 sediment samples were taken from this site using a Petersen grab sampler. The sediment from this site was generally a sandy soil with some clay fines. Seven of the ten samples had a USCS classification of SC, two samples had a classification of SP-SC, and one sample had a classification of CH.

153. This site was used in 1951-52 during the construction of the York River channel. In 1986, this site was the proposed disposal site for an estimated 1,780,000 cu yd of material to be dredged from the York River entrance channel and an additional 1.2 million cubic yards of maintenance material every 15 years for the next 50 years.

154. The USFWS reported in a February 1986 Planning Aid Report that this site was in one of the productive winter crab harvesting areas of the lower Chesapeake Bay. However, this site is only 1,056 acres of the 296,000 acres of productive winter crab harvesting area, and use of this site in the past has had no significant long-term environmental effects to the area (US Army Engineer District, Norfolk 1986).

Wolf Trap site

155. The Wolf Trap site is located in the Chesapeake Bay approximately 3 nautical miles northwest of the York Spit channel. This site is 10,250 ft wide by 17,850 ft long, with an average water depth of 39 ft and a flat bottom contour. As of July 1986, this site had a capacity of approximately 61 million cubic yards, with fill to the 30-ft contour. This site and west to Mobjack Bay and Rigby and Gwynn Islands is a major production and harvesting area for soft and hard-shelled clams, oysters, and blue crab* (see also, US Army Engineer District, Baltimore, undated).**

156. The NWS Yorktown and CAX proposed the use of this site in 1985; however, it was decided not to use this site due to the perceived unsuitability of the sediment for open-water disposal and because the cost of monitoring the site was too high. This site was previously used for dredged material

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* Personal Communication, 1989, Steve Powell, Dredged Material Management Branch, US Army Engineer District, Norfolk, Norfolk, VA.

** See Bibliography.

disposal; however, postdisposal monitoring of the environmental effects of the disposal was limited. Therefore, when the use of the site for the Baltimore Harbor and Channels Deepening Project was proposed around 1982, predisposal monitoring was necessary. The results of this monitoring suggested that a nearby alternate open-water disposal site should be located. This resulted in the selection of the Wolf Trap alternate site (US Army Engineer District, Baltimore 1974; Batty 1985; Blama 1985) (see also, US Army Engineer District, Norfolk, DF, 1986; US Army Engineer District, Baltimore, Memorandum, 1985; US Army Engineer District, Norfolk, Statement of Findings, undated).*

Wolf Trap alternate site

157. The Wolf Trap alternate site is located in the Chesapeake Bay southwest of the Wolf Trap site and slightly overlaps it. The dimensions of this site are approximately 2 by 4 nautical miles, with an average water depth of 39 ft and a flat bottom contour. As of July 1986, this site had a capacity of approximately 64.7 million cubic yards, with fill to the 30-ft contour. This site will be used for the disposal of 20.7 million cubic yards of material dredged from the York Spit channel as part of the Baltimore Harbor and Channels Deepening Project (Blama 1985, Powell**) (see also, US Army Engineer District, Baltimore, undated).*

Rappahannock Shoal site

158. The Rappahannock Shoal site is located in the Chesapeake Bay approximately 2 nautical miles northwest of the Rappahannock Shoal channel and east of Bluff Point. This site is 4,861 ft wide by 15,864 ft long with a water depth of 55 ft on the southeast end and 95 ft on the northwest end, or an average water depth of 80 ft. This site is sloped from both east to west and north to south. As of 1986, this site had a capacity of approximately 137.1 million cubic yards, with fill to the 30-ft contour. Similar to the Wolf Trap site, predisposal monitoring for the Baltimore Harbor and Channels Deepening Project suggested that an alternate open-water site be located. This resulted in the selection of the Rappahannock Shoal alternate site (US Army Engineer District, Baltimore 1974; Batty 1985; Blama 1985; Powell**) (see also, US Army Engineer District, Baltimore, undated).*

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* See Bibliography.

** Personal Communication, 1989, Steve Powell, Civil Programs Branch, US Army Engineer District, Norfolk, Norfolk, VA.

Rappahannock Shoal alternate site

159. The Rappahannock Shoal alternate site is located in the Chesapeake Bay approximately 2 nautical miles south of the Rappahannock Shoal site. It measures approximately 1 by 5 nautical miles with an average water depth of 40 ft. This site is slightly sloping from east to west and relatively flat from north to south. As of 1986, this site had a capacity of approximately 56.6 million cubic yards, with fill to the 30-ft contour. This site will be used for the disposal of 8.2 million cubic yards of material dredged from the Rappahannock Shoal channel as part of the Baltimore Harbor and Channels Deepening Project (Blama 1985, Powell*) (see also, US Army Engineer District, Baltimore, undated).**

York River site

160. The York River site is located in the York River just upstream of Sandy and Tue Points and the York River mouth. The approximate center of this site is located 300 yd southeast of Nun Buoy 24. In 1965, material dredged from CAX and NWS Yorktown was disposed at this site (US Navy, letter, 1965; US Army Engineer District, Norfolk, letter, 1965).**

Beneficial Uses

161. Beneficial uses of the dredged material should always be a priority in developing a LTMS. Beneficial uses for material dredged from NWS Yorktown, CAX, and NAVPHIBASE LCREEK might include habitat development, uses in construction projects, beach nourishment, and shoreline stabilization. In recent years, the Navy has proposed that suitable material be used for beach nourishment and shoreline stabilization (US Army Corps of Engineers 1987b).

Beach nourishment

162. General. The use of dredged material for beach nourishment serves two beneficial purposes: disposal of the material and restoration of the eroding beach. However, the use of dredged material for beach nourishment is limited by various environmental and economic considerations.

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* Personal Communication, 1980, Steve Powell, Dredged Material Management Branch, US Army Engineer District, Norfolk, Norfolk, VA.

** See Bibliography.

163. The Commonwealth of Virginia encourages beach nourishment as a disposal alternative, provided the material meets applicable environmental and engineering criteria. Providing the material is suitable, all proposed shoreline disposal sites may have merit since all undergo some erosion (Getchell 1989).

164. Naval Amphibious Base. Beaches to the east and west of the Little Creek Inlet jetties have been used for the disposal of material dredged from the main Little Creek Channel on two occasions (see Figure 5). In 1975, all the material dredged from the main Little Creek Channel was placed on nearby beaches. Some of the material dredged from the channel contained silt, and this resulted in several complaints regarding the quality of the beach sand (US Army Engineer District, Norfolk, 1980).* Therefore, when the Little Creek Channel was dredged in 1984, only select material from the channel fairway was used for disposal on nearby beaches. Approximately one third of the material dredged from the main Little Creek Channel has been used for beach nourishment.

Shoreline stabilization

165. General. The use of dredged material for shoreline replenishment serves two beneficial purposes: disposal of the material and restoration of the eroding shoreline. However, the use for shoreline replenishment is limited by various environmental and economic considerations.

166. Naval Weapons Station and Naval Supply Center. The use of dredged material for shoreline replenishment has been proposed at both NWS Yorktown and CAX (Powell, 1989).* The shoreline adjacent to Pier R-3 at NWS Yorktown (Figure 3) and the supply and fuel piers at CAX (Figure 4) are potential sites for shoreline disposal of material dredged from nearby sites. Shoreline replenishment at Pier R-3 may not be possible due to the security requirements in this area. However, shoreline replenishment at the supply and fuel piers has the potential to alleviate problems this area is experiencing with shoreline erosion.

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* See Bibliography.

PART VII: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

167. This part of the report presents a discussion of the findings and conclusions made as a result of the Phase I effort. Recommendations for Phase II are also presented.

Summary and Conclusions from Phase I Effort

Geographic limits and time frame for LTMS

168. Dredging is required to maintain navigation at NWS Yorktown, CAX, and NAVPHIBASE LCREEK. Most of the dredged material from these Naval facilities has been placed in the Craney Island Facility in the recent past, but this facility will not be available in the long term. Therefore, a Long-Term Management Strategy for dredged material disposal is required for these facilities. Considering the locations of the dredging areas and the potential disposal areas, the geographic limits for the LTMS should encompass the lower York River and lower Chesapeake Bay. A 50-year disposal capacity was assumed as the time frame for the LTMS.

Dredging requirements

169. Dredging required for NWS Yorktown and CAX is limited to the immediate vicinity of piers located in the York River at each of the respective facilities. Dredging is required at the NAVPHIBASE LCREEK in the main Little Creek Channel and in the tributaries of Little Creek Inlet. Previous dredging for all three facilities has been conducted, mostly with clamshell dredges, with material barged to the Craney Island Facility.

170. No information was available on shoaling rates for any of the facilities; therefore, the dredging volume requirements must be estimated from the historical dredging records. However, this is difficult since the projects have been dredged only a few times, the time interval between dredging has been inconsistent, and new work dredging was performed at some locations before maintenance dredging was necessary.

171. Considering the previous dredging performed at the NWS Yorktown, CAX, and NAVPHIBASE LCREEK, the dredging requirements are assumed as follows:

- a. At the NWS Yorktown, 200,000 cu yd of material every 7 years.
- b. At CAX, 30,000 cu yd of material every 5 years.

c. At NAVPHIBASE LCREEK, 140,000 cu yd of material every 4 years from the tributaries of Little Creek Inlet and 300,000 cu yd of material every 10 years from the main Little Creek Channel.

172. Over the 50-year life of this LTMS, the total dredging requirement that must be accommodated is approximately 4,880,000 cu yd (see Figure 11).

Material characteristics

173. Previous physical testing showed that sediment from NWS Yorktown, CAX, and the tributaries of NAVPHIBASE LCREEK was primarily fine-grained silt or clay, while sediment from the NAPHIBASE LCREEK's main channel was primarily sand. Previous chemical analyses performed on the sediments indicated that metals and some organic contaminants were present, but concentrations were low. Elutriate tests performed with the sediments indicated that some parameters exceeded the Federal acute water quality criteria. Consideration of mixing would be required for these parameters. No biological testing was conducted to determine the acceptability of the materials for open-water disposal.

Environmental resources

174. Environmental resources of concern for this LTMS are those typical of the lower York River and lower Chesapeake Bay. Low-, middle-, and high-elevation marshes, areas of submersed aquatic vegetation, and oyster and clam grounds are areas of special significance. Several threatened or endangered species are found in this area, including the bald eagle, the green, leatherback, Kemp's Ridley, and loggerhead sea turtles, and the small whorled pogonia.

175. Environmental concerns most often cited for dredging and open-water disposal in this area are direct burial of aquatic organisms and suspension of sediment in the water column. Release of contaminants has generally not been a major issue.

Disposal alternatives

176. Disposal alternatives identified as available options during Phase I include confined disposal, open-water disposal, and beneficial uses. A summary of the disposal site capacities is shown in Table 11. The following constraints on available disposal options or sites were assumed:

a. Considering the historical and aesthetic significance of upland areas located adjacent to the dredging areas and the required use of the Naval facilities for base operations, only previously identified CDF sites on the Navy facilities property were considered as available options. In addition, it

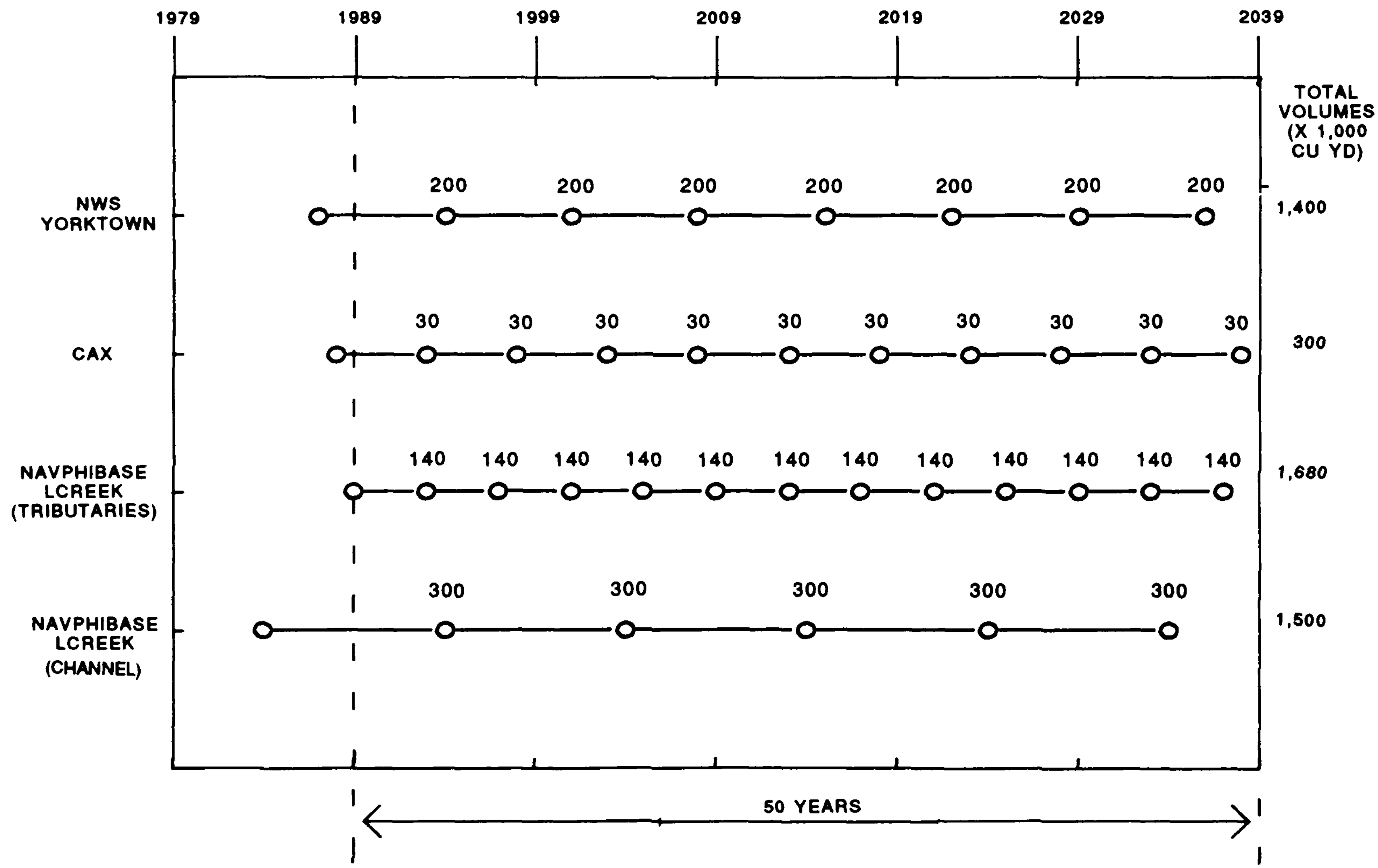

Figure 11. Dredging requirements over the 50-year life of the Long-Term Management Strategy

Table 11

Capacities Remaining at Potential Confined Disposal Facilities and Open-Water Disposal Sites

Site Location	Confined Disposal Facility Capacity* cu yd	Open-Water Disposal Site Capacity cu yd
Naval Weapons Station, Yorktown**	613,067	--
Naval Supply Center, Cheatham Annex	NA	--
Naval Amphibious Base, Little Creek†	429,147	--
Dam Neck	--	65,000,000
Norfolk	--	1,340,000,000
Thimble Shoal	--	NA
Naval Channel	--	NA
Wolf Trap	--	61,000,000
Wolf Trap alternate	--	64,700,000
Rappahannock Shoal	--	137,100,000
Rappahannock Shoal alternate	--	56,600,000
York River	--	NA
Total	1,042,214	1,724,400,000

* Assumed 10-ft disposal height over entire area of the site.
** Includes Old Disposal and Landfill/Forest sites.
† Includes Desert/Little Creek Cove, Rifle Range, and Beach Drive sites.

was assumed that material dredged from a particular facility could only be disposed at a CDF located on that facility.

b. Considering the relatively small dredging volumes and the difficulty in designating or selecting a new-open water site, only previously used or presently active open-water sites were considered as potential options.

177. Confined disposal. Several sites at NWS Yorktown, CAX, and NAVPHIBASE LCREEK have the potential to function as CDF sites for dredged material, as well as the proposed CDF site located between the supply and fuel piers at the CAX.

178. Finding a suitable CDF site on NWS Yorktown or NAPHIBASE LCREEK is complicated by various environmental concerns, such as the presence of wetlands and spring-fed streams. The NWS Yorktown, CAX, and NAVPHIBASE LCREEK have expressed concern over locating new CDF sites on their property because base operations and training activities would be disrupted.

179. The Old Disposal and Landfill/Forest sites at NWS Yorktown, as well as the Desert/Little Creek, Rifle Range, Beach Drive, and Landfill sites at NAVPHIBASE LCREEK, have the potential to be suitable CDF sites. The New Magazine and Pier 60 sites at NAVPHIBASE LCREEK also have the potential to function as CDF sites; however, these sites are of insufficient area to handle significant volumes of dredged material.

180. Assuming that each of the above sites can handle an additional 10 ft of fill over their entire area, the maximum capacity of these sites would be approximately 1,042,000 cu yd (Table 11). Since the surface area of the Landfill site was unavailable, the capacity of this site was not included.

181. Open-water disposal. Five open-water sites offer potential for use by NWS Yorktown, CAX, and NAVPHIBASE LCREEK. These include the Dam Neck and Norfolk ocean sites and the Naval Channel, Wolf Trap alternate, and Rappahannock Shoal alternate sites.

182. Two potential problems associated with disposal at these sites are the cost of monitoring the potential environmental effects of disposal and potential conflicts with the disposal plans for the Norfolk and Baltimore Harbors and Channels Deepening Projects.

183. The Thimble Shoal and York River sites may have the potential to serve as disposal sites; however, they have not been used since 1965. In addition, some sites in the York River may be available for disposal of material dredged from NWS Yorktown and CAX.

184. The haul distances from each of the facilities to one or more of the available disposal sites is comparable to the haul distance to the Craney Island Facility. Considering the fact that rehandling of the material would not be required for open-water disposal at any of the identified sites, the transportation costs should be lower for open-water disposal than for placement at Craney Island.

185. While approximately 1.72 billion cubic yards of disposal capacity is remaining in the Dam Neck, Norfolk, Naval Channel, Wolf Trap alternate, and Rappahannock alternate disposal sites, much of the remaining capacity at these sites will be used by the Baltimore and Norfolk Harbors and Channels Deepening Projects (see Table 11). However, considering the relatively low volumes of material dredged from NWS Yorktown, CAX, and NAVPHIBASE LCREEK over the 50-year life of this LTMS, there would appear to be a sufficient amount of capacity remaining at these sites to allow the disposal of the material from NWS Yorktown, CAX, and NAVPHIBASE LCREEK.

186. Beneficial uses. Beach nourishment has been used in the past for the disposal of material dredged from the main Little Creek Channel. However, only about one third of the material dredged from NAVPHIBASE LCREEK's main channel is suitable for beach nourishment.

187. Shoreline replenishment has been considered at NWS Yorktown and CAX in the past. Assuming that some of the material dredged from either NWS Yorktown or CAX would be suitable for shoreline stabilization, this form of disposal should be considered.

Comparison of dredging requirements and disposal resources

188. The total dredging requirement for all three facilities for a 50-year period is approximately 4,880,000 cu yd. This exceeds the maximum total available volumetric capacity of 1,042,000 cu yd of all the prime candidate confined disposal sites (Table 11). Only a portion of the material at NAPHIBASE LCREEK is suitable for beach nourishment. Based on these considerations, placement of a significant fraction of the materials from these facilities at open-water disposal sites must be considered for the long term. Several historically used or active open-water disposal sites are located within haul distances equivalent to those for previous disposal at the Craney Island Facility. Although some of these sites are serving other Federal

navigation projects in the area, the available volumetric capacity of the sites should not be a constraint.

189. The LTMS for these facilities will likely involve a combination of open-water disposal, confined disposal, and beneficial uses. Beneficial uses should be considered as a high priority for any material that meets the economic, engineering, and environmental criteria for the given use. Open-water disposal should be considered as the prime option for disposal of materials found to be acceptable for such disposal. Confined disposal should be considered as the prime option for materials found to be unacceptable for open-water disposal because of environmental constraints.

Recommendations for Phase II Activities

190. Phase II activities for the LTMS process are associated with the formulation of appropriate alternatives. The requirements for specific engineering and environmental studies should be determined. Based on the results of this Phase I effort, the following specific activities are recommended for Phase II:

a. Determine environmental, engineering, and economic criteria for dredging and disposal. Acceptability of material for open-water disposal is especially critical to this LTMS. Other environmental criteria would include those for spatial and temporal proximity to ecologically sensitive areas or endangered species, acceptability of material for beach nourishment or other beneficial uses, and decision points for implementation of control measures for contaminated materials. The criteria previously used for delineation of wetland areas on Naval property should be reassessed in light of the newly developed delineation criteria adopted by concerned Federal agencies. Engineering criteria would include those regarding operational limitations on dredging equipment (pumping/haul distances), physical behavior of dredged material at disposal sites, and potential for contaminant transport. An economic analysis should be conducted to compare costs of available alternatives with previous practices.

b. Determine an appropriate forum and a central point of contact for coordination of the LTMS process with appropriate resource agencies and local interest groups. Solicit their comments on the results of the Phase I effort, and identify any additional concerns related to proposed dredging and disposal options. Incorporate, as appropriate, their substantiated concerns into the LTMS. The process used by the Norfolk District for coordination of Federal projects should be considered as a vehicle for this coordination effort.

c. Identify alternative dredging techniques and disposal options that meet the LTMS study objectives. Those options should be prioritized according to projected disposal requirements for each of the facilities.

d. Determine the need for further investigations such as sediment and water quality, hydraulic and sediment transport, and other areas of interest relative to selection of dredging methods, transportation systems, and disposal options. Prioritize the needs based on value to project and costs.

e. Perform appropriate environmental and engineering studies necessary to evaluate each dredging and disposal option. For example, obtain additional data on sediment and water samples and assess characteristics and disposal needs, more cultural/historic resource data based upon identified management options, and data related to dredged material physical properties for evaluation of the range of dredging-induced environmental alternatives, beneficial uses, or other options. Conduct site studies for hydraulic analyses, upland surface and ground-water evaluations, and environmental impact of dredged material disposal. The Management Strategy outlined by the Corps of Engineers (Francingues and Mathis 1989) should be used as a guide to the types of testing/evaluation that may be required based on a site-specific evaluation conducted in Phase I. Testing requirements for dredged material evaluation should be consistent with the Corps' Regulatory Guidance* and the Federal standard (33 CFR 335-338) (see Engler et al. 1988).

* BG Peter Offringa, Deputy Director of Civil Works, 19 August 1987, "Testing Requirements for Dredged Material Evaluations," Regulatory Guidance Letter, Washington, DC.

REFERENCES

Barr, B. W. 1987. "Dredging Handbook: A Primer for Dredging in the Coastal Zone of Massachusetts," Massachusetts Coastal Zone Management Publication, Boston, MA.

Batty, Eugene R. 1985. "Overview of Two Disposal Area Plans Associated with Dredging York Spit and Rappahannock Shoal Channels, Baltimore Harbor and Channels Deepening Project," Chesapeake Bay Dredging: Technology Linked with Environmental Appreciation, US Army Engineer District, Norfolk, Norfolk, VA.

Blama, Robert N. 1985. "Baltimore Harbor and Deepening Project and Related Monitoring Studies," Chesapeake Bay Dredging: Technology Linked with Environmental Appreciation, US Army Engineer District, Norfolk, Norfolk, VA.

Boesch, D. F. 1971. "Distribution and Structure of Benthic Communities in a Gradient Estuary," Ph.D. dissertation, Virginia Institute of Marine Science, Gloucester Point, VA.

Diaz, R. J., Schaffner, L. C., Byrne, R. J., and Gammisch, R. A. 1985. "Baltimore Harbor and Channel, Aquatic Benthos Inventories," Final Technical Report, US Army Engineer District, Baltimore, Baltimore, MD.

Engler, R. M., Wright, T. D., Lee, C. R., and Dillon, T. M. 1988 (Aug). "Corps of Engineers' Procedures and Policies on Dredging and Dredged Material Disposal (The Federal Standard)," Environmental Effects of Dredging Technical Notes, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

EnviroPlan, Inc. 1974. "Candidate Environmental Impact Statement for Dredging at the Naval Amphibious Base, Little Creek," College Park, MD.

Francingues, N. R., and Mathis, D. B. 1989. "Long-Term Management Strategy for the Corps Navigation Dredging Program," Proceedings of the XIIth World Dredging Congress, World Organization of Dredging Associations, Orlando, FL.

Froehling and Robertson, Inc. 1982 (22 Sep). "Naval Amphibious Base at Little Creek, Little Channel, Physical and Chemical Sediment Analysis," No. NJ-61-245, Virginia Beach, VA.

Getchell, Terry. 1989 (29 Mar). "Environmental Considerations for US Navy Projects in the Vicinity of Hamptons Roads, Virginia," Enclosure to Memorandum, Civil Programs Branch, US Army Engineer District, Norfolk, Norfolk, VA.

Gibson, M. R. 1987. "Disparities Between Observed and Expected Stock Dynamics in American Shad Exposed to Dredging Operations," Research Reference Document s7/6, Rhode Island Division of Fish and Wildlife, West Kingston, RI.

James R. Reed and Associates, Inc. 1985 (31 Dec). "Laboratory Services Report, Naval Supply Center at Cheatham Annex and Naval Weapons Station at Yorktown, Chemical and Physical Sediment Analysis."

Jennings Laboratories, Inc. 1979 (12 Nov). "Report of Analysis, Naval Amphibious Base at Little Creek, Chemical Sediment Analysis and Elutriate Tests, Piers 16 and 17," Virginia Beach, VA.

JTC Environmental Consultants, Inc. 1984 (14 Dec). "Naval Facilities Engineering Command, Norfolk, Virginia, Maintenance Dredging Pier R-3, Chemical Sediment Analysis," Data Report No. 84-124.

Klesch, W. L. 1987. "Long-Term Management Strategy (LTMS) for the Disposal of Dredged Material: Corps-wide Implementation," Environmental Effects of Dredging Information Exchange Bulletin, Vol D-87-4, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

LaSalle, M. W., Homziak, J., Lunz, J. D., Clarke, D. G., and Fredette, T. J. "Seasonal Restrictions on Dredging and Disposal Operations," Technical Report (in preparation), US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Lunz, J. D., and LaSalle, M. W. 1986. "Physicochemical Alterations of the Environment Associated with Hydraulic Cutterhead Dredging," American Malacological Bulletin, Special Edition No. 3, pp 31-36.

Manooch, C. S., III. 1987. "Impacts of Dredging on Anadromous Fish," Transcript of Presentations at a Workshop, Raleigh, North Carolina, September 18-19, 1987, NOAA Technical Memorandum NMFS-SEFC-210, Silver Spring, MD.

Maryland Port Administration. 1988. "Dredged Material Management Master Plan," Port of Baltimore, Baltimore, MD.

McCallum Testing Laboratories, Inc. 1984 (1 Nov). "Maintenance Dredging Pier R-3, Naval Weapons Station at Yorktown, VA, Physical Sediment Analysis," Chesapeake, VA.

McCauley, J. E., Hancock, D. R., and Parr, R. A. 1976. "Maintenance Dredging and Four Species of Polychaete Worms," Proceedings of the Specialty Conference on Dredging and Its Environmental Effects, January 26-28, 1976, Mobile, Alabama, P. A. Krenkel, J. Harrison, and J. C. Burdick III, eds., American Society of Civil Engineers, New York, NY.

National Research Council. 1985. "Dredging Coastal Ports: An Assessment of the Issues," National Academy of Science Press, Washington, DC.

Naval Amphibious Base, Little Creek. 1979. "Draft Environmental Impact Statement for Construction of Wharf, Associated Access Dredging and Upland Disposal of Dredged Material," Virginia Beach, VA.

Naval Weapons Station, Yorktown. 1977. "Draft Environmental Impact Statement for Dredging Pier R-3 at the Naval Weapons Station, Yorktown," Yorktown, VA.

Palermo, M. R., Shields, F. D., and Hayes, D. F. 1981. "Development of a Management Plan for Craney Island Disposal Area," Technical Report EL-81-11, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Peddicord, R. K., and McFarland, V. A. 1978. "Effects of Suspended Dredged Material on Aquatic Animals," Technical Report D-78-29, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Saucier, R. T., et al. 1978. "Executive Overview and Detailed Summary; Synthesis of Research Results, Dredged Material Research Program," Technical Report DS-78-22, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Sherk, J. A., O'Connor, J. M., and Neumann, D. A. 1975. "Effects of Suspended and Deposited Sediments on Estuarine Environments," Estuarine Research, Vol II, E. L. Cronin, ed., Academic Press, New York.

Soils Engineering Analysis, Inc. 1979 (1 Nov). "Naval Amphibious Base at Little Creek, Physical Sediment Analysis, Piers 16 and 17," Virginia Beach, VA.

Stern, E. M., and Stickle, W. B. 1978. "Effects of Turbidity and Suspended Material in Aquatic Environments," Technical Report D-78-21, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

US Army Corps of Engineers. 1987a. "Confined Disposal of Dredged Material," Engineer Manual 1110-2-5027, Washington, DC.

__________. 1987b. "Beneficial Uses of Dredged Material," Engineer Manual 1110-2-5026, Washington, DC.

US Army Engineer District, Baltimore. 1974. "Environmental Statement for Operation and Maintenance of Baltimore Harbor and Associated Channels," Baltimore, MD.

US Army Engineer District, Norfolk. 1985. "Final Supplement I to the Final Environmental Impact Statement for the Norfolk Harbor and Channels, Virginia Deepening and Disposal," Norfolk, VA.

__________. 1986. "Detailed Project Report and Environmental Assessment of York and Pamunkey Rivers, Virginia," Draft Report, Norfolk, VA.

US Congress, Office of Technology Assessment. 1987 (Apr). "Wastes in Marine Environments," OTA-0-334, US Government Printing Office, Washington, DC.

US Environmental Protection Agency. 1986 (May). "Quality Criteria for Water - 1986," EPA 440/5-86-001, Washington, DC.

__________. 1988. "Ocean Dumping: Designation of Dam Neck Site," Federal Register, Vol 53, No. 62, Washington, DC.

US Naval Facilities Engineering Command, Atlantic Command. 1978. "Dredging Pier R-3, US Naval Weapons Stations at Yorktown, VA," Memorandum for Code 09A21 from Design Division, Norfolk, VA.

__________. 1980 (1 Nov). "Proposed Dredging, York River, Cheatham Annex Supply Depot, Site Plan, Section, and Notes," Norfolk, VA.

US Navy. 1981 (25 Feb). "Site Plan, Proposed Dredging at Naval Amphibious Base in Little Creek Inlet at Virginia Beach," Naval Facilities Engineering Command, Atlantic Division, Norfolk, VA.

__________. 1986 (23 Jul). "Site Plan, Dredging Boat Bay, Bldg T-1, Little Creek Cove," Naval Amphibious Base at Little Creek, Engineering Division, Virginia Beach, VA.

__________. 1988 (3 Aug). "Site Plan, Proposed Bulkhead, Boat Ramp, Wet Slip, Dredging, and Fill in Little Creek Channel To Berth and Maintain Small Crafts, Naval Amphibious Base at Little Creek, Virginia Beach, VA," Naval Facilities Engineering Command, Norfolk, VA.

BIBLIOGRAPHY

Commonwealth of Virginia, Marine Resources Commission. 1983 (25 Jan). "Dredging in the Little Creek Channel and Fairway at the Naval Amphibious Base at Little Creek," Application No. 82-0407-1-S, Richmond, VA.

Hatch, MG H. J. 1986 (23 Dec). Policy Guidance letter, Directorate of Civil Works, Washington, DC.

Powell, Steve. 1989 (15 Mar). "Trip Report to Naval Supply Center at Cheatham Annex," Civil Programs Branch, US Army Engineer District, Norfolk, Norfolk, VA.

Steele, Paul. 1989. "Naval Weapons Station at Yorktown, VA, Naval Supply Center at Cheatham Annex, and Naval Amphibious Base at Little Creek; Dredging Contracts Summary," US Naval Facilities Engineering Command, Atlantic Division, Norfolk, VA.

US Army Engineer District, Baltimore. Memorandum, 1985 (17 May), from Chief, Operations Division, Baltimore District, to Chief of Permits Section, Norfolk District. Subject: Permit Application Number 84-0875-01.

__________. Undated. "Scope of Work for Monitoring Program for Dredged Material Spread from Open Water Disposal Operations at the Wolf Trap and Rappahannock Disposal Sites, Baltimore Harbor and Channels," Baltimore, MD.

__________. 1980 (12 May). "Beach Nourishment at the Naval Amphibious Base at Little Creek," Transmittal Slip.

US Army Engineer District, Norfolk. Disposition Form, 1979 (12 Jun), from Waterways and Harbors Section to Operations and Maintenance Branch. Subject: Naval Weapons Station at Yorktown, VA, After Dredging - Maintenance.

__________. Disposition Form, 1986 (18 Feb), from Permits Section to District Counsel. Subject: Use of Craney Island Facility by US Navy at Yorktown.

__________. Dredging Permit, 1981 (12 May), from District Engineer to Commander, Atlantic Division, Naval Facilities Engineering Command. Subject: Dredging in Fisherman's Cove at the Naval Amphibious Base at Little Creek. COL Douglas L. Haller, District Engineer.

__________. Finding of Fact, 1981a (13 Mar), Permit Application No. 80--745-03, Dredging at the Supply Pier at the Naval Supply Center at Cheatham Annex, COL Douglas L. Haller, District Engineer.

__________. Finding of Fact, 1981b (21 Apr), Permit Application No. 80-0281-02, Dredging at Fisherman's Cove at the Naval Amphibious Base at Little Creek, COL Douglas L. Haller, District Engineer.

__________. Letter, 1965 (12 Oct), from District Engineer to Director, Atlantic Division, Bureau of Yards and Docks, Norfolk Naval Base, Norfolk, VA. Subject: Contract NBy-69509 Dredging, Naval Supply Center at Cheatham Annex and Naval Weapons Station at Yorktown.

__________. Letter, 1978 (15 Dec), from District Engineer to Commander, Atlantic Division, Naval Facilities Engineering Command. Subject: Proposed Dredging Project at Pier R-3, US Naval Weapons Station at Yorktown, VA.

US Army Engineer District, Norfolk. Letter, 1981 (20 Apr), from District Engineer to Commander, Atlantic Division, Naval Facilities Engineering Command. Subject: Maintenance Dredging and Dredging in Fisherman's Cove at the Naval Amphibious Base in Virginia Beach, VA.

_________. Public Dredging Notice, 1978 (18 May), Dredging in the York River Adjacent to Pier R-3 at the Naval Weapons Station at Yorktown, Virginia; Applicant: Commander, Atlantic Division, Naval Facilities Engineering Command, signed by Jack G. Star, Chief, Construction-Operations Division, Norfolk, VA.

_________. Public Dredging Notice, 1981 (9 Jan), Dredging in the York River Adjacent to the Supply Pier at the Naval Supply Center at Cheatham Annex; Applicant: Commander, Atlantic Division, Naval Facilities Engineering Command, signed by Curtis W. Baskette, Jr., PE, Chief, Regulatory Functions Branch, Norfolk, VA.

_________. Public Dredging Notice, 1986 (7 Mar), Dredging in the York River Alongside the Supply Pier at the Naval Supply Center at Cheatham Annex and Adjacent to Pier R-3 at the Naval Weapons Station at Yorktown, VA; Applicant: Commander, Atlantic Division, Naval Facilities Engineering Command, signed by Bruce F. Williams, Chief, Permits Section, Norfolk, VA.

_________. Statement of Findings, 1983 (16 Feb), Permit Application No. 82-0407-06, Dredging at the Little Creek Channel and Fairway at the Naval Amphibious Base at Little Creek, signed by Floyd H. Cawood, PE, Chief, Constructions-Operations Division, Norfolk, VA.

_________. Statement of Findings, undated, Permit Application Number 86-0167-01, Norfolk, VA.

US Environmental Protection Agency, Region III. Letter, 1978 (27 Mar), from Chief, EIS and Wetlands Review Section to Commander, Atlantic Division, Naval Facilities Engineering Command. Subject: Proposed Disposal Area for Spoil To Be Generated by Dredging at Pier R-3 Naval Weapons Station at Yorktown, VA.

_________. 1988. "Environmental Progress and Challenges: EPA's Update," EPA 230-07-88-033, Office of Policy Planning and Evaluation, Washington, DC.

US Naval Facilities Engineering Command, Atlantic Division. 1978. "Dredging Pier R-3, US Naval Weapons Station at Yorktown, VA," Memorandum for Code 09A21, from Civil Engineering Branch, Design Division, Norfolk, VA.

US Navy. Letter, 1965 (6 Oct), from Director, Atlantic Division, Bureau of Yards and Docks, Norfolk, VA, to District Engineer, USAED, Norfolk. Subject: Contract NBy-69509 Dredging, Naval Supply Center at Cheatham Annex and Naval Weapons Station at Yorktown, VA.

_________. Letter, 1978a (13 Nov), from Commander, Atlantic Division, Naval Facilities Engineering Command, to District Engineer, USAED, Norfolk, Subject: FY 78 MCON Project P-348, Dredging Pier R-3, Naval Weapons Station, Yorktown, VA.

US Navy. Letter, 1978b (13 Dec), from Commander, Atlantic Division, Naval Facilities Engineering Command, to Chief of Naval Operations. Subject: Dredging Pier R-3, Naval Weapons Station, Yorktown, VA; Environmental Impact Statement For.

US Navy. Letter, 1980 (13 May), from Commander, Atlantic Division, Naval Facilities Engineering Command, to District Engineer, USAED, Norfolk. Subject: Dredged Material Disposal for the Naval Amphibious Base at Little Creek.

_________. Letter, 1981 (3 Mar), from Commander, Atlantic Division, Naval Facilities Engineering Command to Robert Hume, US Army Engineer District, Norfolk. Subject: Long Range Maintenance Dredging, Naval Amphibious Base at Little Creek, Virginia Beach, VA, Application Number 80-0281-1, Request for Amendment.

US Navy. Letter, 1985 (17 Jan), from Commander, Atlantic Division, Naval Facilities Engineering Command, to District Engineer, US Army Engineer District, Norfolk. Subject: Proposed Maintenance Dredging Project at Pier R-3, US Naval Weapons Station, Yorktown, VA, Permit No. 84-0875-01.

US Navy. Letter, 1989 (6 Jun), from Officer in Charge, Naval Supply Center, Cheatham Annex, Williamsburg, to Commander, Atlantic Division, Naval Facilities Engineering Command, Norfolk (Code 2032E3). Subject: Long-Term Management Strategy (LTMS) for Dredged Material Disposal.