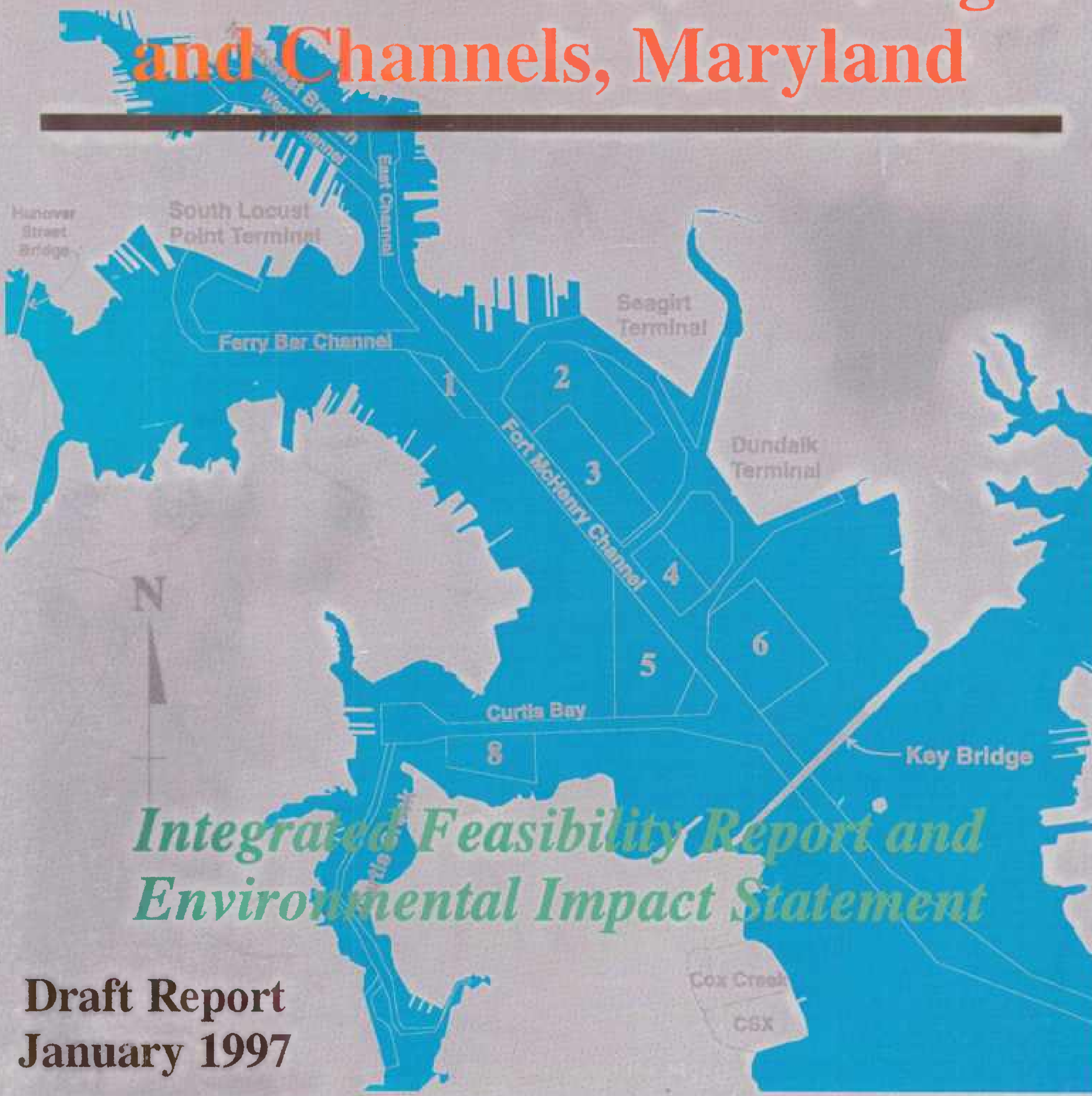
US Army Corps
of Engineers
Baltimore District

Maryland Port
Administration

Baltimore Harbor Anchorages and Channels, Maryland



Integrated Feasibility Report and Environmental Impact Statement

Draft Report
January 1997

DMB Graphics

BALTIMORE HARBOR ANCHORAGES AND CHANNELS, MARYLAND

Draft Feasibility Report and Environmental Impact Statement

EXECUTIVE SUMMARY

The Port of Baltimore is located on a 32 square mile area of the Patapsco River and its tributaries, approximately 12 miles northwest of the Chesapeake Bay. From its central location on the Chesapeake Bay nearly 150 miles inland from the Atlantic Ocean, Baltimore can easily provide service to America's Midwestern markets as well as other ports along the Atlantic coast. Since 1980, over one-half billion dollars have been spent on maritime improvements in the Port of Baltimore in efforts to meet the needs of the diverse commercial shipping market. Continuing with the Port of Baltimore's commitment to ongoing maritime improvement this study recommends: widening the West Dundalk, West Seagirt, and Seagirt-Connecting Channels to 500 feet; establishing a channel 36 feet deep and 400 feet wide in the area of the old Produce Wharf Channel at South Locust Point; deepening of the new Anchorage #3 to 42 feet deep and 2,200 feet wide by 2,200 feet long; deepening of Anchorage #4 to 42 feet deep and 1,800 feet wide by 1,800 feet long; constructing a turning basin at the head of the Fort McHenry Channel, 1,200 feet wide by 1,200 feet long, and 50 feet deep; Federal assumption of maintenance of the existing Seagirt Marine Terminal, Dundalk Marine Terminal and South Locust Point Marine Terminal channels, exclusive of berthing areas, and Federal maintenance of a 42-foot depth in the area between the Connecting Channel and the proposed Seagirt Marine Terminal Berth 4 upon completion of dredging to that depth by the State of Maryland; and deauthorization of Anchorage #1 (see Figure 6.5).

In recent years, the Port of Baltimore has shown a steady growth in commerce; nearly 2,300 vessels called on Baltimore in 1993 and waterborne commerce totaled 23 million metric tons. In 1995, waterborne commerce totaled 28 million metric tons representing almost $21 billion in value. Annual vessel calls are expected to continue to increase to 3,400 in the year 2000 and to more than 20,300 in the year 2050. Commodity activity in the Port of Baltimore is expected to increase to nearly 118 million metric tons in the year 2050.

Since 1824, the Baltimore District of the United States Army Corps of Engineers (COE) has been actively involved in constructing and maintaining a system of channels to allow large, deep draft commercial shipping vessels to call on the Port of Baltimore. In addition to the shipping channels, a number of anchorage areas have been established within the Port of Baltimore for vessels requiring layover for various reasons. The anchorage areas were initially authorized between 1909 and 1945 and were designed to accommodate the types of vessels calling on the port at that time. In recent years, however, the trend toward using larger, more efficient vessels has taken precedence over using smaller ones. For this reason, the size of the existing anchorage areas at Baltimore are not sufficient in depth or width. Large vessels requiring anchorage must anchor 25 miles south of the Port of Baltimore in naturally deep water at the

Annapolis Anchorage Grounds. This results in delays and related costs to the shipping industry.

Investigations in response to the increasing need for larger anchorage areas within the port have resulted in the identification of several other problems. Some of the branch channels which serve the public marine terminals are also insufficient to accommodate the types of vessels currently calling on Baltimore. These channels are currently maintained and operated by the Maryland Port Administration (MPA). Due to the narrow widths of the branch channels serving the Seagirt and Dundalk Marine Terminals, additional time is required for the pilots to safely maneuver ships to and from the berths. The need for other channel improvements near the Seagirt and Dundalk Marine Terminals has also been identified, including providing cutoff angles and a turning basin near the head of the Fort McHenry Channel. These improvements are oriented toward improving maneuverability in the channels and easing congestion at the head of the main shipping channel. The configuration of the South Locust Point branch channel is also inadequate for larger vessels; provision of a new channel has been proposed for this area.

During formulation of potential plans of improvement, various structural and non-structural measures were examined, including construction of sea islands, various types of single-point and multi-point moorings, channel modifications, and implementation of a vessel traffic management system. Based on a preliminary evaluation of the anchorages and branch channels, several of these alternatives were selected for further evaluation. Anchorage alternatives included free-swing anchorages, ranging from 1,500 wide and 30 feet deep to 2,200 feet wide and 44 feet deep. Alternatives for the branch channels were based on recommendations provided by the Baltimore maritime community; specific channel improvements include widening some of the channels from 300 feet to 400 feet and from 350 feet to 500 feet; providing cutoff angles; construction of a turning basin near the Seagirt and Dundalk Marine Terminals; and providing a new 400-foot-wide channel at the South Locust Point Marine Terminal. Based on an evaluation of benefits and costs, some of these alternatives were grouped together into six plans to identify a plan of improvement that contributes the most net benefits to the Nation.

All of the plans for improving the anchorages and branch channels are economically justified. Estimates indicate that construction costs for potential plans of improvement range from $5.7 million to $31.3 million. The benefit to cost ratio ranges from 3.5 to 11.4, with net benefits ranging from $2.3 million to $19.9 million. Plan 5 is the recommended plan and includes improvements to the branch channels that route vessels to South Locust Point, Seagirt, and Dundalk Marine Terminals, construction of a turning basin, and modification of Anchorage #3 and #4 to accommodate a larger percentage of the vessel classes calling on the Port of Baltimore. Plan 5 has a benefit to cost ratio of 10.7 and annual net benefits of $19.9 million. Increases in operation and maintenance dredging costs as a result of construction are expected to be minimal.

The MPA constructed improvements to the Seagirt and Dundalk branch channel system during the course of this study. The improvements included deepening the East Dundalk Channel to 42 feet, deepening the berths and access channel on the east side of Dundalk to 42 feet, constructing a flared entrance to the West Dundalk Channel, and other minor widenings at channel bends. Due to the timing of the construction, these improvements were not reflected in the analysis of the plan recommended in this report (Section 7.1), and it is unlikely that the improvements would have changed the recommended plan. The improvements will be reflected in the pre-construction, engineering and design (PED) phase of study. Since further economic analyses of the project, including updated simulation runs, were to be conducted in PED anyway, these changes will not effect the cost or schedule of the PED phase.

The Hart-Miller Island Placement Site is scheduled to be used for placement of the material dredged for construction of this project. The Hart-Miller Island site has been used since 1984 for placement of material from Baltimore Harbor. The MPA is raising the dikes at Hart-Miller Island to a height of 44 feet MLLW. This will create 30 million cubic yards of additional placement capacity. The MPA is also proceeding with plans for development of two former dredged material placement areas at CSX and Cox Creek. The MPA plans to use these sites for placement of dredged material from maintenance of inner harbor projects.

In summary, the results of the feasibility phase support Federal involvement in improving the anchorages and branch channels serving the Port of Baltimore. The non-Federal participant, MPA, agrees with the findings in this report and has indicated their intent to provide the non-Federal cooperation required for project implementation, as indicated in their letter of December 1996 (Annex A). In view of this expression of non-Federal support and the favorable results of the technical analyses, the District Engineer recommends that the feasibility report be approved and that the improvements associated with Plan 5 be authorized for construction.

Cost - benefit ratio (4.30)
confirmed
& publicized

Baltimore Harbor Anchorages and Channels
Baltimore, Maryland

Draft Integrated Feasibility Report and Environmental Impact Statement

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Baltimore Harbor Anchorages and Channels, Maryland

Draft Integrated Feasibility Report
and
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Section 1

INTRODUCTION

This document constitutes, in draft form, the final product of the Baltimore Harbor Anchorages and Channels, Maryland, feasibility study, which was initiated in June 1993. The reconnaissance report, dated April 1992, documented the results of preliminary evaluations of various harbor improvement plans for the Port of Baltimore. Work efforts during the feasibility study were oriented toward establishing existing conditions, data collection and analysis, and formulation and evaluation of plans. This report includes recommendations for plans of improvement for the anchorages and branch channels serving the Port of Baltimore, and also serves as the National Environmental Policy Act (NEPA) documentation for the proposed project improvements.

1.1 PURPOSE

The Port of Baltimore has experienced an increasing demand for improving and/or providing additional anchorages and branch channels that can accommodate the current vessel fleet calling on the port. This report details the investigations into the need for navigation-related improvements to anchorages and branch channels, which were not authorized as part of the Baltimore Harbor and Channels project. The purposes of this submission are to respond to the 1988 Congressional Resolution, to summarize the analysis of the current operational system in the Port of Baltimore and its components, to identify problems or problem areas, to present the evaluation of solutions that will enhance efficiency in the port, and to identify plans to recommend for implementation.

1.2 STUDY AUTHORITY

The study request was introduced by Senator Barbara A. Mikulski (D-Maryland) and was authorized June 23, 1988, by the Committee on Environment and Public Works, U. S. Senate. The resolution authorizing this study follows:

RESOLVED BY THE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS OF THE UNITED STATES SENATE, that the Board of Engineers for Rivers and Harbors is hereby requested to review the reports of the Chief of Engineers on Baltimore Harbor and Channels, Maryland, and Virginia, contained in House Documents Number 94-181, 94th Congress, 1st Session, and Number 86, 85th Congress, 1st Session, and prior reports, with a view to determining if further improvements for navigation, including anchorages and branch channels, are advisable at this time.

1.3 STUDY AREA

Channels serving the Port of Baltimore extend from Baltimore, Maryland, on the Patapsco River, 150 nautical miles through the Chesapeake Bay to the Atlantic Ocean at Cape Henry, and 113 nautical miles through the Chesapeake and Delaware (C&D) Canal, Delaware River, and Delaware Bay to the Atlantic Ocean (Figure 1.1). This study encompasses the 32-square-mile area of the Port of Baltimore. The port area of Baltimore includes the navigable part of the Patapsco River below Hanover Street, the Northwest and Middle Branches, and the Curtis Bay and its tributary, Curtis Creek. The Northwest Branch extends about 3 miles northwesterly from Fort McHenry to its head at the Inner Harbor in downtown Baltimore, and varies in width from 1,200 to 3,000 feet. Middle Branch extends about 1.5 miles northwesterly from Ferry Bar past the Hanover Street Bridge and varies in width from 1,000 to 4,000 feet. Curtis Bay is an estuary, about 2 miles long and 0.7 mile wide, on the southwest side of the Patapsco River, 6 miles above the river mouth. Curtis Creek empties into the head of Curtis Bay from southward on the southwest side of Curtis Bay. The harbor

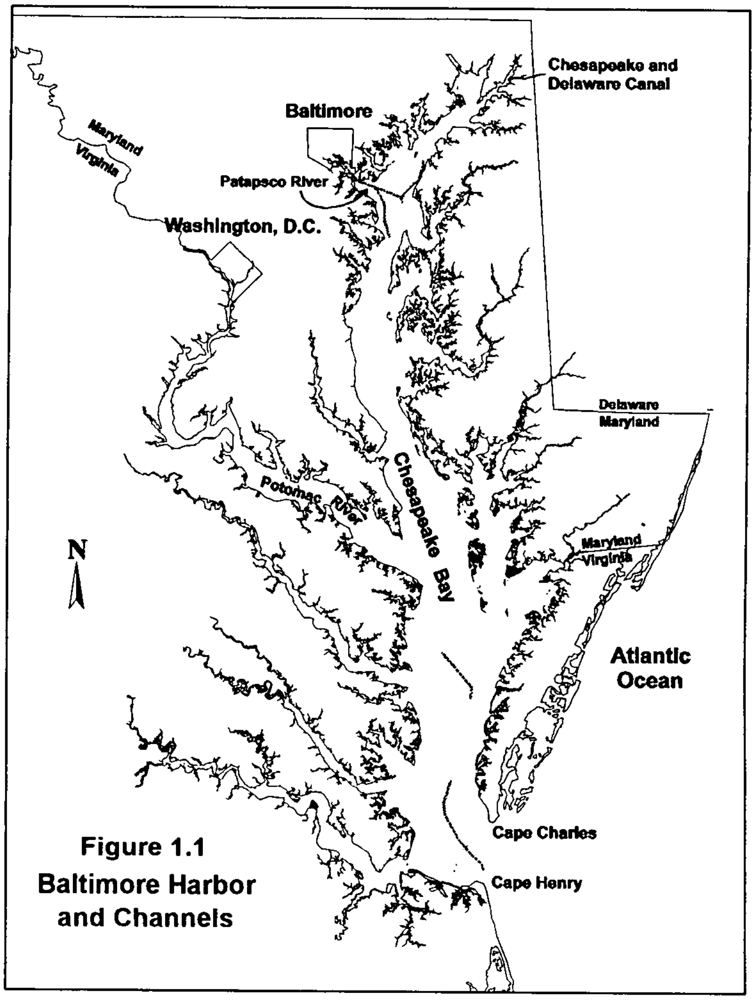


Figure 1.1
Baltimore Harbor and Channels

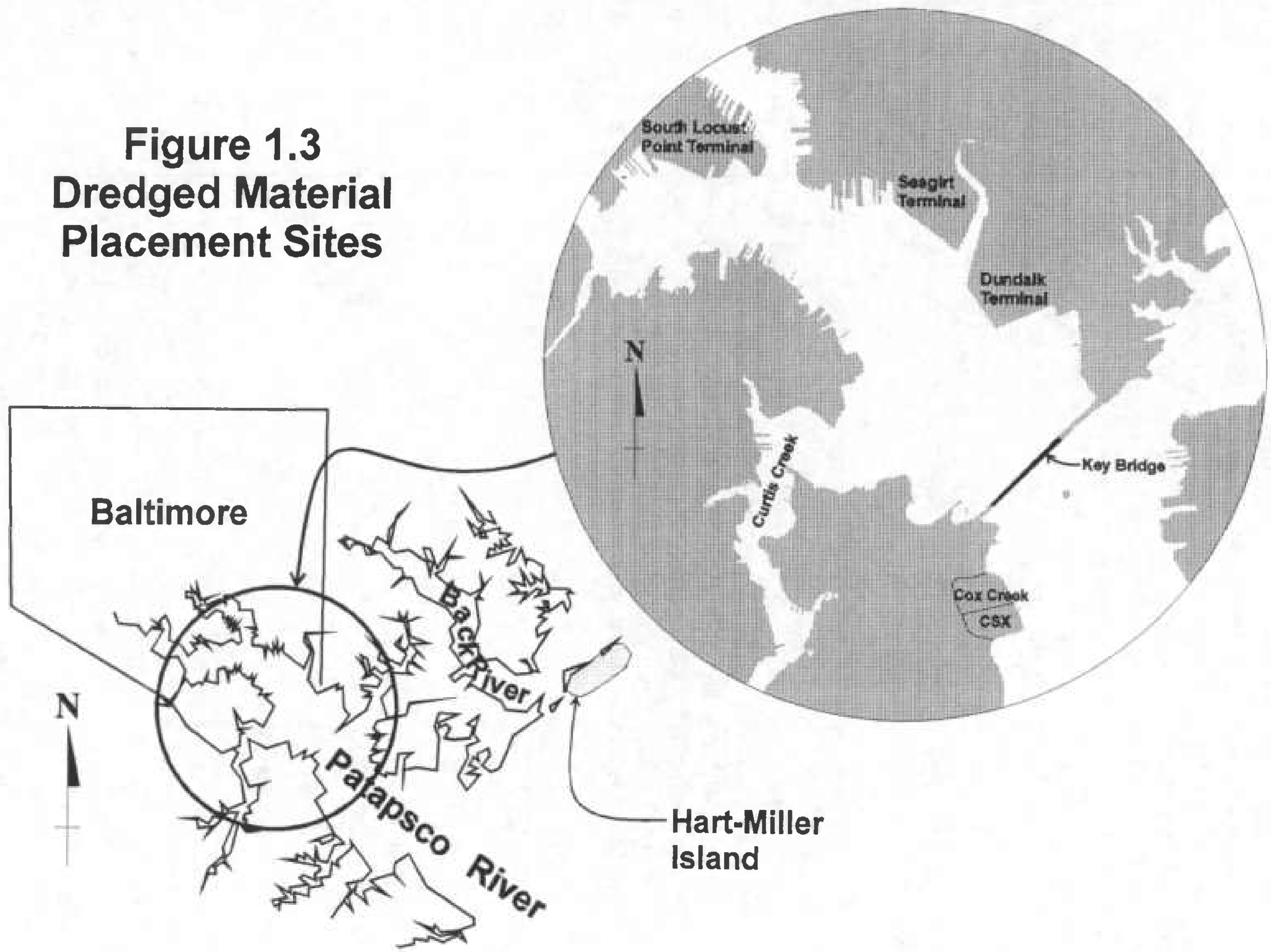


Figure 1.3 Dredged Material Placement Sites

The Baltimore District also completed the Baltimore Metropolitan Water Resources reconnaissance study in October 1994. This study was oriented towards identifying water resources-related problems in the Baltimore area, including urban flooding problems, environmental restoration, and beneficial uses of dredged material. Problems associated with shallow draft navigation (depths < 14 feet) were also investigated. The scope of the Baltimore Metro study does not overlap the Baltimore Harbor Anchorages and Channels study since the Baltimore Metro study does not address commercial deep-draft navigation. Two feasibility studies have resulted from the Baltimore Metro Reconnaissance Study and are currently underway.

In addition to these studies, the following environmental documents have been prepared by the Baltimore District:

- "Environmental Statement, Baltimore Harbor and Channels, Maryland and Virginia," Baltimore District, September 1970;
- "Final Environmental Statement, Operation and Maintenance of Baltimore Harbor and Associated Channels," Baltimore District, October 1974;
- "Proposed Plan for Completing the Navigation Improvements Authorized by the 1958 River and Harbor Act for the Baltimore Harbor and Channels, Maryland and Virginia," Baltimore District, November 1979;
- "Final Main Report and Environmental Statement," Baltimore District, August 1981.

1.6 REPORT AND STUDY PROCESS

Planning by the Corps of Engineers (COE) for Congressionally-authorized Federal water resources projects is accomplished in two phases: a reconnaissance phase and a feasibility phase. The reconnaissance phase is conducted at full Federal expense, while the cost of the feasibility phase is shared equally between the Federal government and a non-Federal sponsor(s).

1.6.1 Reconnaissance Phase

The objectives of the reconnaissance phase of the Baltimore Harbor Anchorages and Channels Study were to (1) investigate the need for potential improvements to anchorages and branch channels; (2) identify opportunities for the COE to provide Federal assistance in meeting other needs of the port; (3) estimate project costs, benefits, and other impacts in light of current conditions; (4) determine whether planning should proceed into the feasibility phase based on an appraisal of Federal interest; and (5) assess the potential non-Federal sponsor's support for potential solutions. The reconnaissance report included a discussion of investigations, results, conclusions, and recommendations, and was completed in April 1992. A summary of the reconnaissance study process and conclusions follows.

During the reconnaissance study, potential solutions to the navigation-related problems affecting the Port of Baltimore were identified through a series of meetings with the Baltimore maritime community. Several meetings were held with the Association of Maryland Pilots (AMP), steamship agents, tug operators, docking pilots, and the Maryland Port Administration (MPA) to identify the problems affecting navigation and to determine the extent of the improvements desired. The MPA was the principal agency that coordinated with the maritime community. Based on the desires of the local sponsor, various improvements were identified and evaluated, and a recommended plan was identified.

The formulation of potential plans included a screening process to evaluate the various alternatives using a set of criteria for an acceptable project. Measures and combinations of measures that addressed the study planning objectives were considered in the reconnaissance study. Consideration was given to the desires and needs of the existing fleet calling on the Port of Baltimore. Based on problems identified by the shipping agents, various public and private port facilities, local government agencies, and the pilots and tug companies, several viable alternatives were addressed. The maritime community indicated that the anchorages and branch channels are not of adequate dimension for the types of vessels presently calling on the Port of Baltimore.

1.6.1.a Anchorages. During the reconnaissance phase of study, emphasis was placed on using available data, standard engineering practices, meetings with local users, and reasonable assumptions to develop potential project alternatives. One objective of the reconnaissance study, based on the problems and needs identified, was to provide a deep draft anchorage within Baltimore Harbor that could accommodate the types of vessels calling on the port. The design vessel used in the formulation of anchorage alternatives was selected using 1989 fleet information provided by the Philadelphia District, the Baltimore Maritime Exchange, and various conversations with port users. Analysis of this information determined that an anchorage area within Baltimore Harbor to accommodate a vessel 850 feet in length could address the problems identified with the existing anchorages. Several combinations of anchorages were considered based on the size and draft of the design vessel. Based on recommendations of the AMP an anchorage designed to berth a vessel in a free-swinging motion was developed that was consistent with the anchorage design for the existing Baltimore Harbor and Channels project. The initial plan included construction of an anchorage 2,100 feet in diameter to accommodate an 850-foot vessel with 200 feet of anchor chain in a free-swinging motion. Efforts were then directed toward identifying the best location to construct the anchorage and toward maximizing the capacity of the design.

The pilots suggested that the provision of more than one large anchorage area in Baltimore Harbor would be ideal. It was determined that the cost of providing a total of three deep draft anchorages (each 2,100 feet by 2,100 feet) would greatly exceed the anticipated benefits, although two anchorages appeared to be economically feasible. In addition, costs were determined for providing a smaller, less-costly improvement at Anchorage #4 (Figure 1.2), which could berth a vessel 650 feet length over all (LOA) or less. An anchorage of this size could accommodate approximately 60 percent of the fleet calling on the port in 1989 and would also benefit the construction of a larger deep draft anchorage(s) by reducing the use of larger and deeper anchorage areas by smaller vessels.

Following an initial screening of potential sites in the harbor, two sites were selected for further evaluation. The deepest and widest anchorage area in Baltimore Harbor is Anchorage #3. This area could be expanded into moderately deep water in Anchorage #2 with minimal dredging requirements, in comparison to other areas of the harbor. From a cost perspective, this was the best option for providing a larger anchorage area in Baltimore Harbor. Similarly, Anchorage #4 was selected for further study, since it is the next-deepest area and could potentially be used for construction of a smaller anchorage, as discussed above.

The recommended plan from the reconnaissance study included construction of two free-swinging anchorages in the area of Anchorage #2 and #3. The costs to construct a smaller anchorage in the area of Anchorage #4 in addition to the two anchorage areas marginally exceeded the benefits.

1.6.1.b Curtis Creek Channel. Discussions with the AMP indicated that non-structural alternatives (such as lightering) are currently practiced for some vessels calling on Curtis Creek (Figure 1.2). The draft of these vessels prior to lightering is 41 feet; the channel is only authorized to a depth of 35 feet. Potential improvements were determined to include deepening and/or widening of the existing channel to accommodate the dimensions of the types of vessels currently calling on Curtis Creek.

The plan for improvement of the Curtis Creek Channel during the reconnaissance study was initially intended to serve multiple users. Investigations during the reconnaissance study identified only a single user - Amerada Hess - who could benefit from deepening of the Curtis Creek Channel. Based on current policy, the COE will not recommend Federal cost participation in the establishment or expansion of a Federal navigation project where the improvement will serve only a single user. The only exception is situations where, initially, a single user would be served, but a reasonable prospect exists for multiple use at some time in the near future. Efforts to identify additional users that could benefit from improvements to the Curtis Creek Channel continued during review and certification of the reconnaissance report and during the development of the scope of the feasibility study; however, based on these efforts, it was concluded that there are limited possibilities for identifying additional potential users at this time.

1.6.1.c Non-Federal Branch Channels. Discussions with the pilots and tug companies identified problems with the existing dimensions of the branch channels at South Locust Point and at the Seagirt and Dundalk terminals. Consideration was given to providing the necessary improvements to increase the efficiency and safety of vessel operation.

Based on the problems and needs identified, potential channel improvements were considered to accommodate the types of vessels currently calling on the port. The pilots indicated that the channel widths are insufficient to accommodate larger vessels. As a result, additional time is required to maneuver large vessels, and safety concerns increase. The dimensions of the channel improvements were based on the recommendations provided by the pilots, and are designed to accommodate post-panamax-size vessels with a beam of 135 feet. The following alternatives were considered and recommended:

South Locust Point:
- Provide a loop channel configuration by improving the remnant Produce Wharf Channel to 36 feet deep and 350 feet wide.

Seagirt/Dundalk:
- Widen the West Branch Channel at Dundalk from 350 feet to 500 feet.
- Widen the East Branch Channel at Dundalk from 300 feet to 400 feet.
- Provide a cutoff angle between the West Branch Channel at Dundalk and the Fort McHenry Channel;
- Widen the Connecting Channel between Seagirt and Dundalk from 350 feet to 500 feet.
- Provide a cutoff angle between the Connecting Channel and the berths on the west side of the Dundalk terminal.

Based on the conclusions of the reconnaissance report, the MPA agreed to be the non-Federal sponsor and entered into an agreement with the United States Government to share in the costs of the second phase of study, the feasibility phase.

1.6.2 Feasibility Phase

The objectives of a feasibility study are to (1) evaluate the specific engineering, environmental, and economic effects of alternative improvements compared to a without-project alternative; (2) identify the optimum project for the Port of Baltimore from both Federal and non-Federal perspectives; and (3) recommend a project for construction, if economically, environmentally, and engineeringly justified and supported by the MPA, the non-Federal sponsor. The ultimate product of the feasibility phase is the feasibility report with the appropriate environmental documentation, which is submitted to the U.S. Congress for project authorization. This report is the ultimate product of the feasibility phase of the Baltimore Harbor Anchorages and Channels study. The following sections describe in detail the efforts and conclusions of the feasibility study.

Section 2

EXISTING CONDITIONS AND AFFECTED ENVIRONMENT

Section 2 provides a description of the existing conditions in the Baltimore Harbor study area along with specific information necessary for NEPA compliance. This description of the current environment provides a basis for measuring environmental, socio-economic, and operational impacts associated with construction and use of potential improvements to the anchorages and branch channels.

2.1 BACKGROUND - PORT OF BALTIMORE

The Port of Baltimore is located on a 32-square-mile area of the Patapsco River and its tributaries, approximately 12 miles northwest of the Chesapeake Bay. The port may be reached from the Atlantic Ocean by two distinct shipping routes: from the south through the Virginia Capes and the Chesapeake Bay, or from the east through the Delaware Bay, C&D Canal, and the Chesapeake Bay.

The Patapsco River estuary has a long maritime history dating back to 1608. The port was established in 1706, more than 20 years prior to the incorporation of Baltimore Town in 1729. Settlers were attracted by the Jones Falls' natural water power and the naturally deep port at Fells Point. By the end of the Revolutionary War, Baltimore had established regularly scheduled sailing services. In the 19th century, ship building, warehouses, and piers continued to expand and multiply to meet the needs of the growing local and regional markets. By the 1830's, the Baltimore Clipper, cargo-carrying vessels, steam-powered vessels, and railroads supported the prospering Baltimore commercial market. Beginning in the 1850's, dredging of the navigation channels enabled even larger vessels to call directly on the port. Continuing into the 1990's, the Port of Baltimore remains an active commercial center.

The Port of Baltimore is a major facilitator in the thriving Baltimore-Washington megalopolis. It is a major node in the distribution networks feeding the markets of New York; Newark, New Jersey; Philadelphia; and Washington, DC. The port is the most inland seaport on the east coast, providing easy connections to America's industrial heartland. Baltimore also contributes to east coast markets as far north as Boston, Massachusetts, and as far south as Charlotte, North Carolina.

2.1.1 Port Vessel Activity

Vessels arrive at and depart from the Port of Baltimore via the southern Chesapeake Bay (Cape Henry) route or the northern Chesapeake Bay route through the C&D Canal. Vessels using the C&D canal for passage to or from the Port of Baltimore must have a sailing draft of 33 feet or less. Vessels with sailing drafts greater than 33 feet must use the main shipping channel (Cape

Henry) route into the Port of Baltimore. Deepening of this channel system to 50 feet was completed in October 1990 as part of the Baltimore Harbor and Channels 50-Foot Project.

The Port of Baltimore is one of America's busiest deep-water ports. The port's 45-mile shoreline supports many modern public and private cargo terminals which handle a wide variety of general (containerized) and bulk cargoes. Vessels calling on the Port of Baltimore include autocarriers, break bulk, containers, dry bulk, tankers, RORO (roll on-roll off) carriers, general cargo, cableships, naval ships, tugs, and tug/barge combinations. Foreign commerce is a mix of bulk, general, and specialized cargoes.

The Port of Baltimore is the third-largest handler of containerized cargo on the Eastern seaboard. It has 200 berths that were used by more than 2,200 ships, handling nearly 23 million metric tons of waterborne cargo in 1993. This increased to more that 28 million metric tons of cargo in 1995 representing almost $21 billion in value. The port is one of the largest coastal facilities on the East Coast for loading and unloading of dry bulk commodities. Baltimore benefits from its proximity to the Midwestern markets, with a 150-mile inland advantage over its Atlantic port neighbors.

For container business, the Port of Baltimore ranked 33rd in 1989 and 40th in 1990 of the top 100 Global Container ports. Within the United States, the Port of Baltimore ranked 12th in 1994 and 10th in 1995 for total foreign waterborne tonnage. For 1995, the Port of Baltimore ranked 10th in the nation for total value of foreign waterborne cargo which was a 7.5 percent increase over the value of 1994 tonnage.

The level of international trade has varied in the last 10 years and is a topic under review in both the public and private sectors of the commercial shipping industry. These trade flows contribute to the diverse nature of commodities at the port.

2.1.2 Historic Vessel and Trade Route Data

The Port of Baltimore is situated in a sheltered harbor and is accessible by major American and foreign ports. This combination attracts manufacturing industries profiting from the inexpensive shipment of bulk raw materials. Since the turn of the 20th century, the types of bulk commodities moving through the port have remained the same. Imports of iron ore from Chile and Canada feed Bethlehem Steel and coal exports from West Virginia provide fuel for around the world. In addition, large flows of grain have continued to move out of the port to various global destinations. The port's proximity to Eastern and Midwestern markets is an added attraction to manufacturers. The geographical advantages of this area have aided Baltimore in making the difficult transition from a manufacturing-based economy to a trade- and service-based economy. Once heavily dependent on large manufacturing industries (American Can, Western Electric), the Baltimore region's economy has become quite diversified.

comprises approximately 45 miles of waterfront area encompassing nearly 1,600 acres of sheltered waters (Figure 1.2).

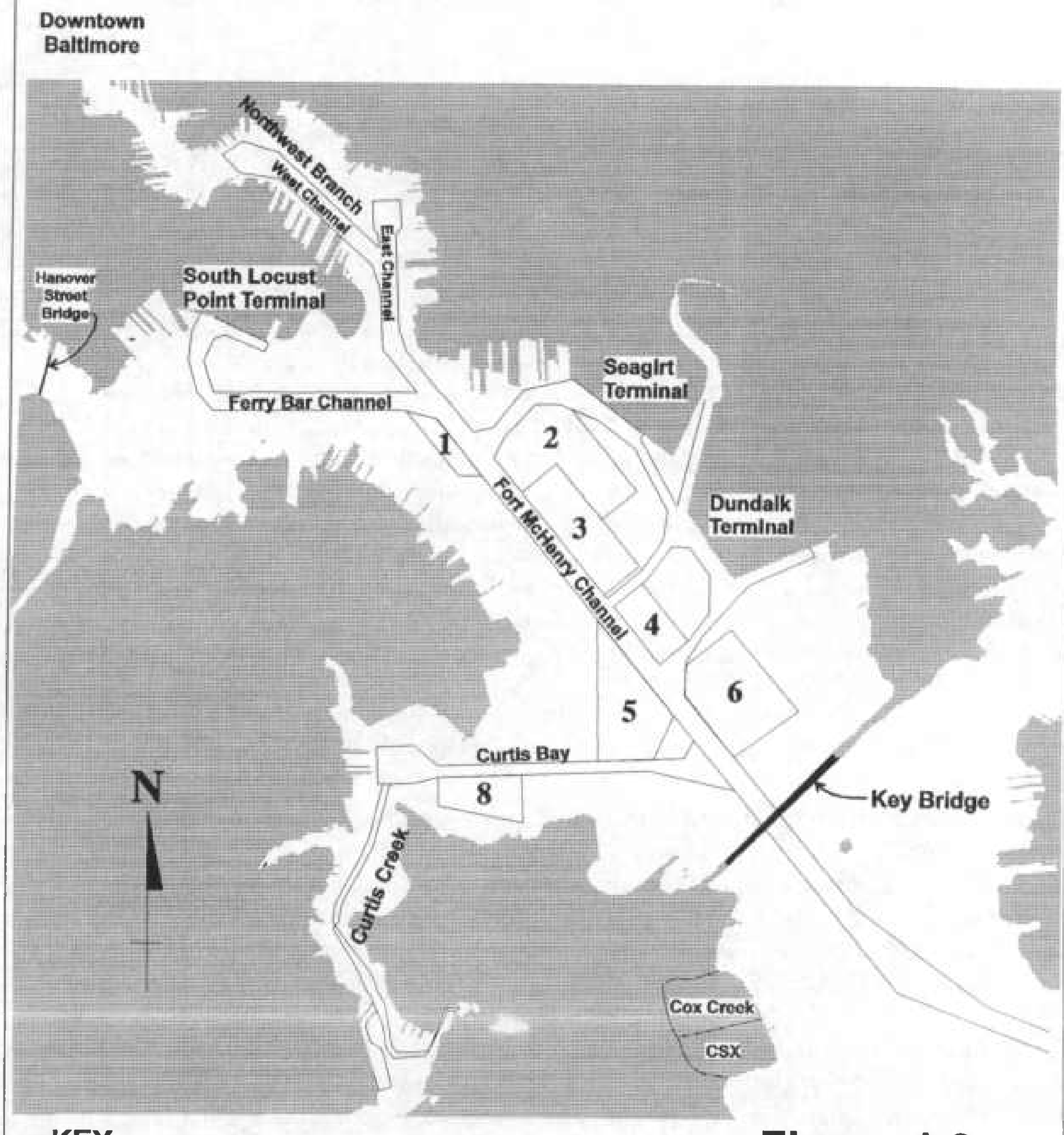


Figure 1.2
Study Area

The material dredged from the harbor during construction of any project resulting from this study will be placed at Hart-Miller Island. The CSX and Cox Creek placement sites are to be improved and used for future maintenance of the anchorages and channels in Baltimore Harbor. These sites will be used for Federal, state, and certain private maintenance projects. Figure 1.3 shows the location of CSX/Cox Creek as well as Hart-Miller Island.

1.4 SCOPE OF STUDY

This submission provides a detailed report on current conditions in the Port of Baltimore Study Area, an analysis of potential navigation improvements within the Port of Baltimore Study Area, and a summary of future conditions with improvements in place. The evaluations are based on site-specific technical information obtained since the completion of the reconnaissance report in 1992. This information includes recent surveys and new mapping; environmental, hydraulic and geotechnical evaluations; economic studies; and computer modeling of traffic movement in the port and main shipping channels. The various investigations and analyses were conducted at a feasibility level of detail. The scope of the feasibility study is relatively detailed in the various plans of analysis: problem identification, analysis of alternatives and inputs, and development of plans. Alternatives considered include channel modifications, anchorage size variations, new construction, and non-structural solutions. Assessments are presented for geotechnical, cultural, environmental, economic, and engineering investigations for various areas of study consideration. These important study elements were fully incorporated into evaluations for this report. The outcome of feasibility-level analysis is a substantive evaluation and presentation of the viability and economic feasibility of implementing plans for improvement of the system.

1.5 PRIOR STUDIES, REPORTS, AND PROJECTS

Other studies and reports on the Port of Baltimore have been conducted by the Corps of Engineers (COE). These studies have generally focused on the Baltimore Harbor and Channels, the Chesapeake and Delaware (C&D) Canal system, port facilities, and the environmental impact of various navigation improvements. Some of these reports have specifically addressed the need for improvements to the anchorages and branch channels within Baltimore Harbor.

The Baltimore Harbor and Channels feasibility study was completed in 1969, and is the most recent study focusing on commercial navigation in Baltimore Harbor to be completed by the Baltimore District COE. The recommendations of the study included deepening and widening the main shipping channel serving the Port of Baltimore. Based on the needs of the commercial shipping industry at that time, potential improvements to the anchorages and non-Federal branch channels were not included in the scope of the study. Construction of improvements to the main shipping channel was completed in October 1990.

2.1.3 Port Facilities

2.1.3.a State-Owned Facilities. Since 1980, over one-half billion dollars have been spent on maritime improvements ensuring that Baltimore remains a thriving world-class port. The MPA currently owns six marine terminal facilities in Baltimore Harbor, which are shown in Figure 2.1 and described below.

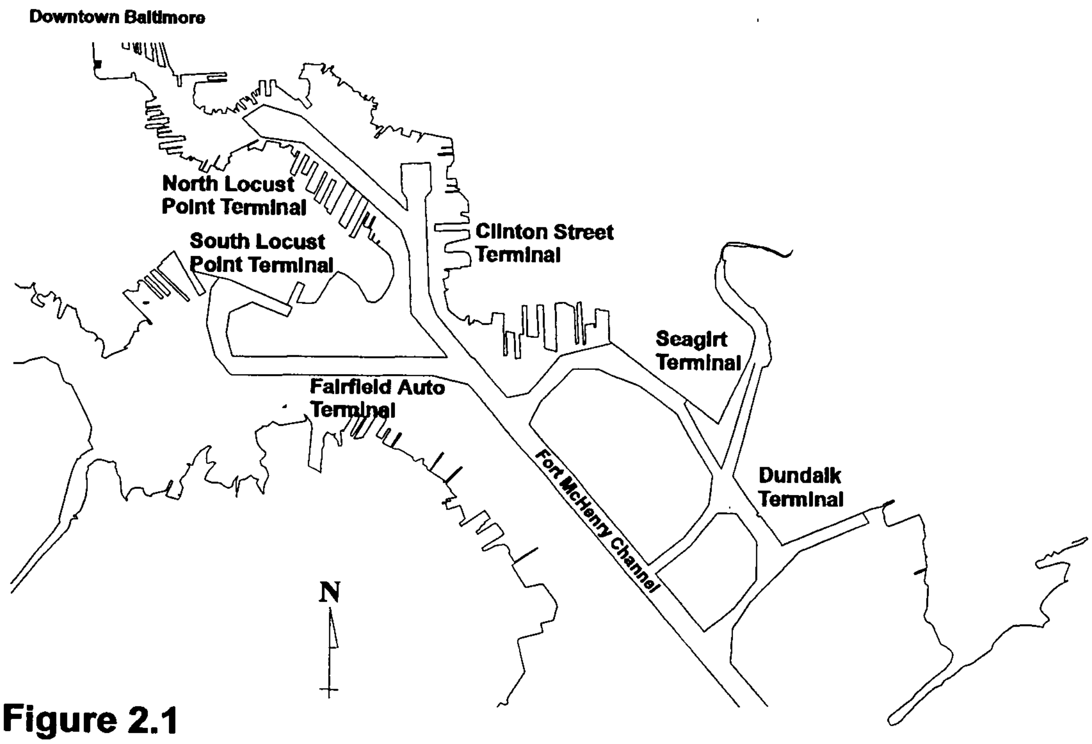


Figure 2.1
MPA Facilities

Not to Scale

The Seagirt Marine Terminal is the newest addition to the Port of Baltimore facilities, having begun operation in September 1990. Seagirt features the latest in cargo-handling equipment and systems with seven 20-story high speed computerized cranes and an Intermodal Container Transfer Facility (ICTF) which allows cargo to move directly from bulkhead to rail head. The $220-million, 265-acre facility is capable of handling more than 150,000 containers annually, increasing the port's container capacity by 50 percent.

Adjacent to Seagirt and the ICTF is the Dundalk Marine Terminal, which began operation in 1959 as a break bulk facility. Today, the Dundalk terminal is capable of handling all types of general cargo. The 570-acre facility is the port's largest and most versatile marine terminal. The facility features 9,942 feet of berth space and 11 cargo cranes. A modernization plan is underway which includes adding a $7.4-million container crane and upgrading three container cranes to Panamax standards at a cost of $9.5 million. Lease agreements have provided several stevedoring companies exclusive use of portions of the Dundalk Marine Terminal.

The South Locust Point Marine Terminal began operation in 1979 as a response to the tremendous volumes of cargo handled by the Dundalk terminal. South Locust Point was designed to accommodate various cargoes and offers heavy-lift, break bulk, roll on/roll off, and container-handling capabilities. The MPA completed a major expansion of South Locust Point in 1988, doubling the size of the terminal to 80 acres, creating four berths, and adding a third container crane.

The North Locust Point Marine Terminal is one of the port's primary multi-purpose facilities. The 89-acre site is ideally suited to handling imported and exported steel products. In addition to the two 75-ton electric gantry cranes, a 45-ton container crane was recently moved to the facility to enhance the steel handling capability. North Locust Point is an ideal facility for handling break bulk cargoes such as wood pulp and lumber, containers, roll on/roll off, and some bulk commodities such as grain and latex.

The Fairfield Auto Terminal was developed to provide better service for over 100 automobile dealers in the Mid-Atlantic region. The 50-acre facility was built for Toyota Motor Sales, U.S.A., which signed a 15-year lease in 1988 to use the facility. The $23 million Fairfield Auto Terminal features an 832-foot pier, ranging in width from 50 to 114 feet.

The Clinton Street Marine Terminal is especially suited for cargos in need of waterfront warehouse space. The terminal features a 1,100-foot by 223-foot finger pier with a two-deck 342,590 square-foot warehouse. The first deck of the warehouse has direct access to rail, while a ramp from the street allows truck access to the second level.

2.1.3.b Other Port Facilities and Equipment. There are numerous other port facilities which are privately owned and serve the users of the Port of Baltimore. The following paragraphs briefly describe the general variety of Port facilities.

There are 16 companies operating at 22 separate facilities engaged in the handling of miscellaneous dry bulk materials, including coal, miscellaneous ores, gypsum rock, fertilizer, cement, sugar, sand, stone, and scrap metal. Twenty-eight waterfront facilities at the Port are equipped to handle crude oil, asphalt, and/or petroleum products; one provides bunkering (fueling) service for vessels. Large oceangoing vessels are usually bunkered at berth by tank barges.

Fifteen separate operators at 16 waterfront facilities handle miscellaneous liquid bulk materials other than crude oil and petroleum but also receive and/or ship a variety of liquid commodities, including fertilizer, latex, molasses, caustic soda, sulfuric acid, and various other chemicals and petrochemicals. The majority of the operators handle specific commodities in connection with their individual manufacturing/processing/terminalling operation; and at time of survey during the feasibility study, there were no public terminals for storage of liquids at the port. One waterfront grain elevator with a total capacity of nearly 6,900 bushels serves the Port of Baltimore. The elevator is used primarily for the movement of export grain, which is generally received by rail from the Midwest. Since 1993, a second grain terminal has not operated due to financial difficulties of its parent corporation.

In the port area, 13 companies operate 19 public storage warehouses, having a total of 48,201,000 square feet of dry storage space and 45,810,000 cubic feet of cooler and freezer space. All but two of the warehouses have rail connections, and all are easily accessible to arterial highways. Diversified handling equipment is maintained by the operators, and special services are provided, including packing and crating, consolidation, forwarding, pool car distribution, weighing, stamping, marketing, and blast freezing. In addition to the long- and short-term covered storage facilities for waterborne cargo, there are 11 waterfront locations providing a total of approximately 455 acres of public open storage area. Other operators along the waterfront have open storage areas to meet their own operational requirements; these areas usually are not available for public use.

Conventional general cargo at the port usually is moved to and from vessels by ships' tackle. Shore-based equipment with lifting capacities ranging up to 100 tons and floating cranes and derricks with lifting capacities ranging up to 150 tons are available at the port. Other cranes, derricks, and special-handling equipment located on other waterfront facilities within the port area are usually for the sole use of operating companies.

Four plants operate waterfront facilities at the port for the construction, repair, and/or conversion of ocean-going vessels, tugs, barges, and other types of vessels. One of the facilities is also used for vessel construction. Two floating drydocks with lifting capacities of 44,000 tons, one 1,200- and one 447-foot-long graving dock, and one 400-ton marine railway are located at the four marine plants. The Port of Baltimore also has a number of plants without waterfront facilities that are engaged in various types of marine repair work. These companies maintain shops and portable equipment for making above-waterline repairs and for installing equipment, gear, and machinery on all types of craft at berth. In addition, there are several marine repair plants with waterfront facilities that are operated solely for the repair and maintenance of company-owned floating equipment and for recreational craft.

Floating equipment based at the Port of Baltimore provides various services including docking, undocking, and towing vessels; it also bunkers fuel and fresh water to vessels at berth and in the harbor. This equipment includes 9 tugs with ratings of up to 3,300 horsepower and tank barges with cargo-carrying capacities ranging up to 6,300 barrels.

2.1.4 Port of Baltimore Commodities

The commodity tonnage profile of the Port of Baltimore is similar to that of other North Atlantic ports in that it includes a strong focus on bulk commodities. Although crude petroleum is the number one bulk commodity in the North Atlantic profile, coal is the primary commodity in Baltimore. In other ways, cargo flows at the Port of Baltimore reflect those of the rest of the globe, except for oilseeds. Table 2.1 below details the tonnages of the top commodities moved in 1993 between the Port of Baltimore and the rest of the world.

Table 2.1

Baltimore Commodities - Total (Inbound + Outbound) Tonnage With Comparative Shares

commodity	1993 mtons	% total	% N. ATL	% USA	% world
Coal & coke	8,615,467	38%	19%	11%	2%
Iron ore	3,279,103	14%	50%	17%	1%
Cement, Lima & Stona	2,004,274	9%	24%	5%	1%
Grain	1,389,019	6%	47%	1%	1%
Oilseeds	966,008	4%	80%	5%	2%
Petroleum Products	727,667	3%	2%	1%	0%
Sugar	617,242	3%	46%	19%	3%
Iron & Steel	606,644	3%	26%	3%	0%
Bauxite & other basa	462,121	2%	42%	2%	1%
Miscellaneous	4,236,774	18%			
Total	22,904,319				

Source: DRI/Mercer World Sea Trade Service, 1993

2.1.5 Vessel Types and Tonnages

The vessels which deliver the commodities and tonnages to and from the Port of Baltimore represent a fairly diverse fleet as reflected in Figure 2.2. In 1993, there were approximately 2,250 outbound deep draft vessel movements leaving the port. Container carriers represented 23 percent of the outbound vessels while dry bulk vessels represented another 21 percent. The dry bulk vessel profile reflects the types of cargoes most prevalent in the port. The port's commodity mix of coal & coke, iron ore, cement, lime & stone, grain and oilseeds typify bulk goods. The "other" category was approximately 27 percent of the outbound fleet profile and represents reefers, combination, and a large assortment of diverse vessel groupings. The remaining vessel fleet to Baltimore in 1993 consisted of general cargo/break bulk vessels at 14.8 percent, vehicle carriers at 8 percent, and tankers at 7 percent.

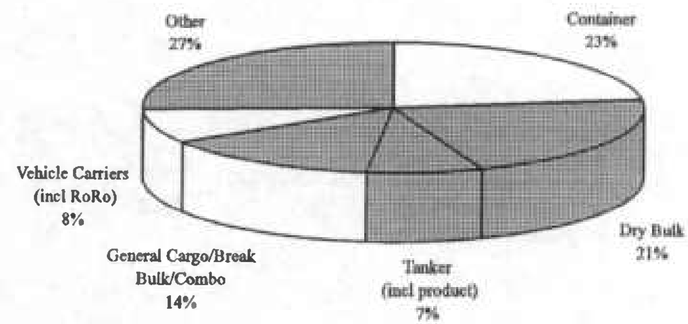
Nearly half of the bulk carriers moving large volume cargoes are in the 40,000 to 80,000 dead weight ton (DWT) range. The rest of the bulk cargo is almost evenly split between 20,000 to 40,000 DWT and 80,000 to 175,000 DWT vessels. Cellular vessels moving containerized cargo between Baltimore and the world move over 15 percent of the total tonnage traded. RORO vessels transport 5 percent. The majority (95 percent) of RORO cargo is carried by vessels that are less than 10,000 DWT. Combination vessels in the 100,000 to 175,000 DWT range carry nearly 75 percent of all tonnage moved by this type of ship. These ships carry just over 2 percent of total traded metric tons. Other ships contributing to total tons moved include product tankers, vehicle carriers, tankers, gas tankers, and reefers (refrigerated containers).

2.1.6 Trade Routes

Figure 2.2

Existing Vessel Profile, 1993

Port of Baltimore



Source: DRI / McGraw Hill from BME data

A large volume of diverse foreign cargoes pass through the Port of Baltimore. Since the late 1980's Baltimore has maintained leading inbound trading partnerships with Canada and Latin America. From 1988-1993, the port imported an annual average of 3.9 million metric tons from Latin America, 3.4 million metric tons of cargo from Canada, 1.1 million metric tons from Northern Europe and 0.7 million metric tons from Japan. One of the Port of Baltimore's largest outbound trading partners is the Northern Europe area. For the period 1988-1993 the annual average trade was 2.6 million metric tons of cargo to Northern Europe, 1.9 million metric tons to Southern Europe, 1.7 million metric tons each to Japan and the Middle East, and 0.8 million metric tons to Eastern Europe. Table 2.2 summarizes the Port of Baltimore's top ten trade routes in terms of commodity tonnages by trade route for the year 1993. These trade routes are further described in terms of percentage break downs for commodity flows and fleet composition.

2.1.6.a Port of Baltimore to Northern Europe. This is the largest trade route for the port in terms of foreign tonnage. Coal and coke constitute 72 percent of all commodities on this route. The remaining 27 percent of tonnage on this route consists of wood products, fruits and vegetables, textile fiber, chemical products and passenger cars. Bulk vessels move over 63 percent of the tonnage on this trade. The remainder of the vessel fleet composition on this route consists of combination carriers, RORO (roll-on roll-off vehicle carriers) operators, general cargo, tanker and vehicle carriers, respectively.

2.1.6.b South America East Coast to Port of Baltimore. The main commodities shipped on this trade route include iron ore at 25 percent, petroleum products at 17 percent, cement, lime and stone at 15 percent. Other commodity cargoes on this trade route consist of pulp and waste paper, sugar, light industrial machinery, auto parts, consumer goods, food products, chemicals and bauxite. Bulk carriers move over 33 percent of the commodities on this trade route, general cargo vessels account for 27 percent, container vessels account for 20 percent, and product tankers move 19 percent of the commodities.

Table 2.2
Top 10 Trade Routes for Baltimore 1993

Route	Metric Tons	Percentage
Baltimore to Northern Europe	3,269,002	21.0%
South America's East Coast to Baltimore	2,146,092	13.8%
Baltimore to Southern Europe	2,006,876	12.9%
Baltimore to Other Mediterranean	1,658,288	10.7%
Baltimore to Japan	1,565,546	10.1%
Baltimore to Eastern Europe	1,103,970	7.1%
Caribbean Basin to Baltimore	1,087,978	6.9%
Australia/New Zealand to Baltimore	944,086	6.1%
Northern Europe to Baltimore	904,319	5.8%
Japan to Baltimore	878,422	5.6%
Total	**15,564,579**	**100%**

Source: DRI/Mercer World Sea Trade Service

2.1.6.c Port of Baltimore to Southern Europe. Coal and coke constitute 60 percent of the commodities shipped on this trade route, with oil seeds at 25 percent, grain at 9 percent, and lumber at 2 percent. The remainder of commodities shipped on this route includes automobiles, plastics, chemical products, iron and steel, chemicals, consumer goods, and heavy transportation equipment. Bulk vessels carry 72 percent of the commodities shipped on this route, general cargo vessels carry 13 percent, combination carriers move 6 percent, and RORO operators move 6 percent with other vessel types accounting for the remaining commodity movements.

2.1.6.d Port of Baltimore to Other Mediterranean. This trade route includes the countries of Morocco, Algeria, Libya, Egypt, Tunisia, Lebanon, Israel, Syria and the former Yugoslavia. Over 98 percent of the tonnage carried to this Mediterranean area consists of coal and coke, grain and oilseeds. More than 90 percent of the commodities transported on this trade route are moved by bulk carriers. General cargo vessels account for 5 percent of the vessels on this route, and container vessels represent 4 percent, with the remainder split between tanker and

RORO operator vessels.

2.1.6.e Port of Baltimore to Japan. Coal and coke constitute 74 percent of the commodities shipped on this trade route, with oilseeds at 18 percent, and grain at 5 percent. The remaining 2 percent is split between passenger cars and lumber. Bulk carriers moved 75 percent of the tonnages on this route, while cellular vessels accounted for 23 percent. General cargo and RORO operators moved the remaining commodities.

2.1.6.f Port of Baltimore to Eastern Europe. Coal and coke accounted for 68 percent of the commodities carried on this trade route with grain accounting for an additional 20 percent of the commodities shipped. Meat, fish, dairy and oilseeds constitute an additional 9 percent with the remaining 3 percent split between a diverse grouping of commodities. Bulk carriers move nearly 75 percent of the tonnage on this trade route with general cargo vessels carrying 18 percent, RORO operators transporting 6 percent and cellular vessels moving 1 percent of the commodities on this route.

2.1.6.g The Caribbean Basin to Port of Baltimore. Cement, lime and stone, petroleum products and other chemicals constitute 99 percent of the tonnages moved on this trade route. Bulk carriers moved 87 percent of the commodities on this route, with tankers at 7 percent, cellular vessels at 3 percent, and product tankers at 2 percent.

2.1.6.h Australia/New Zealand to Port of Baltimore. This trade route consisted almost entirely of bulk commodities with iron ore, bauxite, coal and coke, non-ferrous metals and sugars constituting 99 percent of the commodities shipped. Bulk carriers moved 79 percent of the tonnage on this route, with general cargo at 12 percent, container at 6 percent and RORO operators at 3 percent.

2.1.6.i Northern Europe to Port of Baltimore. Though this is the ninth largest trade route for the port in 1993, it has the greatest mix of bulk and non-bulk commodities. Iron and steel constitute over 20 percent of the tonnage transported on this route, with heavy transportation equipment at 10 percent, other chemicals at 8 percent, passenger cars at 8 percent, cement, lime and stone at 8 percent, food products at 6 percent, paper at 5 percent, petroleum products at 4 percent. The remaining 30 percent of tonnage shipped on this route consists of nonferrous metals and industrial machinery. A variety of vessels work this trade route due to the diverse nature of commodities shipped on this route. Cellular/container vessels account for 29 percent of the tonnage shipped on this route with general cargo vessels at 22 percent, RORO operators at 19 percent, vehicle carriers at 17 percent, bulk carriers at 5 percent and tankers at 3 percent.

2.1.6.j Japan to Baltimore. A diverse group of commodities are shipped on this tenth largest trade route. Approximately 87 percent of the commodities shipped on this trade route consisted of passenger cars, light and heavy industrial machinery, electrical equipment, coke, and iron & steel. Bulk carriers accounted for 65 percent of the carriers working this trade. Vehicle carriers, RORO operators, cellular ships, and general carriers transport 35 percent of the total metric tons moved on this route.

2.2 PHYSIOGRAPHY

The Patapsco River originates near Westminster, in Carroll County, Maryland, and flows southeasterly for 65 miles to enter the Chesapeake Bay 9 miles south of Fort McHenry. The lower 15 miles of the river are tidal. Navigation for deep draft vessels is limited to the area south of the Hanover Street Bridge, where the width of the river increases abruptly to nearly 1 mile. From this point to the mouth, the width gradually increases to about 4 miles. The total drainage area for the Patapsco River is approximately 547 square miles, with a mean discharge of 675 cubic feet per second. A map of Baltimore Harbor is provided in Section 1, Figure 1.2.

The navigable portion of Baltimore Harbor includes the Patapsco River area south of Hanover Street; the Northwest and Middle Branches; and Curtis Bay and its tributary, Curtis Creek. The Northwest Branch varies in width from 1,200 to 3,000 feet, and extends 3 miles to its head. The centrally located area at the head of the Northwest Branch is known locally as Baltimore's Inner Harbor, and offers a variety of landside attractions, including the Maryland Science Center, the National Aquarium, the Columbus Center, and Harborplace. The Middle Branch, also known locally as Spring Garden, extends 1.5 miles northwest of Ferry Bar past Hanover Street, and varies in width from 1,000 to 4,000 feet. Curtis Bay is generally 0.7 miles wide and extends 2 miles west of the Fort McHenry Channel. Curtis Creek empties into the head of Curtis Bay, and extends in a southerly direction.

The main project area is located adjacent to the Seagirt and Dundalk Marine Terminals. This part of the project area is rectangular in shape and includes the Fort McHenry Channel and waters to the northeast between the Fort McHenry Channel and the southern boundary of the Dundalk Marine Terminal. Depths in the area typically range between 25 and 40 feet. A second, smaller project area is adjacent to the South Locust Point Terminal. This part is triangular in shape and includes the Ferry Bar Channel, extending north toward the shoreline west of the Fort McHenry Channel (Figure 1.2). Depths in this area are typically 15 to 25 feet.

2.3 EXISTING NAVIGATION PROJECTS

This study examines the movements of vessels through the Port of Baltimore system which utilize the existing navigation improvements maintained under the authority of the Corps of Engineers (COE), Baltimore District and Philadelphia District.

2.3.1 Baltimore Harbor and Channels

The existing project for the Baltimore Harbor and Channels was adopted by the River and

Harbor Act of 8 August 1917 and modified by the River and Harbor Acts of 21 January 1927, 3 July 1930, 7 October 1940, 2 March 1945, 3 July 1958, and 31 December 1970. The existing navigation project is shown in Figure 2.3 and 2.4.

The existing project includes a main channel, 50 feet deep, between Cape Henry, Virginia, and Fort McHenry at Baltimore. It should be noted that not all of the channels are constructed to their authorized dimensions. The authorized dimensions of the channels are as follows:

1. Cape Henry Channel: 50 feet deep and 1,000 feet wide from the 50-foot depth curve in the Atlantic Ocean to that depth in the Chesapeake Bay, a distance of 3 miles.

2. York Spit Channel: 50 feet deep and 1,000 feet wide connecting the 50-foot depth curves in the Chesapeake Bay opposite the York River near York Spit, a distance of 18.4 miles.

3. Rappahannock Shoal Channel: 50 feet deep and 1,000 feet wide connecting the 50-foot depth curves in the Chesapeake Bay opposite the Rappahannock River, a distance of 10.3 miles.

4. Craighill Approach Channel to Fort McHenry: 50 feet deep and generally 800 feet wide, widened at the entrance and bends, from the 50-foot depth curve in the Chesapeake Bay opposite the mouth of the Magothy River to Fort McHenry on the Patapsco River, a distance of 20.7 miles.

The existing project also authorizes a series of branch channels that provide access to the various public and private terminals serving the Port of Baltimore and that connect the main channel with the C&D Canal. The dimensions of the branch channels are as follows:

1. Connecting Channel to Chesapeake Bay and Delaware Canal Approach Channel: 35 feet deep, 600 feet wide, and 15.6 miles long from the Cutoff Angle in the main channel to the 35-foot depth curves in the natural channel on the east side of the Chesapeake Bay, which is part of the inland waterway from the Delaware River to the Chesapeake Bay. The channel includes the Brewerton Channel Eastern Extension, Swan Point and Tolchester Channels.

2. Curtis Bay Channel: 50 feet deep, 600 feet wide, 2.2 miles long from the main channel to and including a 1,275-foot-wide turning basin at the head of Curtis Bay.

3. Curtis Creek:
   a. A channel 35 feet deep and 200 feet wide from the 50-foot channel in Curtis Bay to 750 feet downstream of the Pennington Avenue Bridge, a distance of 0.9 miles.

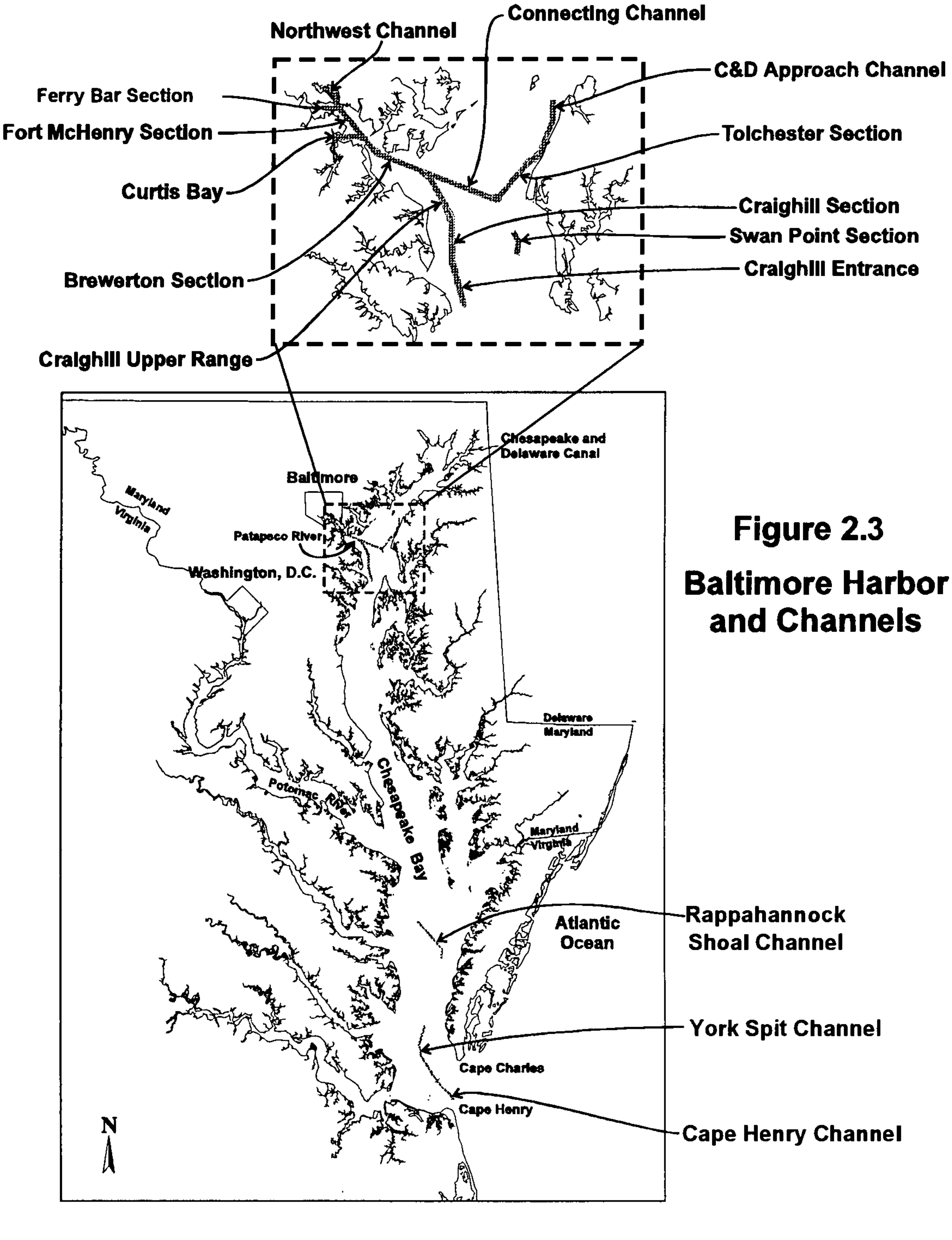


Figure 2.3

Baltimore Harbor and Channels

b. A channel 22 feet deep and 200 feet wide from the 35-foot channel to and along the marginal wharf of the Curtis Bay Ordnance Depot.

c. An irregularly shaped basin 18 feet deep and 320 feet wide, adjacent to the head of the 22-foot channel, a distance of 600 feet.

d. A basin 15 feet deep and 450 feet wide, from the end of the 22-foot channel to the end of the marginal wharf, a distance of 0.2 miles.

e. A channel 22 feet deep and 200 feet wide, from the 22-foot channel of the CSX Rail Transport bridge to the vicinity of Arundel Cove, a distance of 2,800 feet, then 100 feet wide in Arundel Cove for a distance of 2,100 feet, with an anchorage basin 700 feet square adjacent to the channel and southwest of the wharf of the U.S. Coast Guard Depot at Curtis Bay.

4. Middle Branch: Ferry Bar East Section: A channel 42 feet deep and 600 feet wide, from the main channel at Fort McHenry to Ferry Bar, a distance of 1.4 miles.

NOTE: The West Ferry Bar and Spring Garden Sections of the existing project were deauthorized by Section 1001 of the Water Resources Development Act of 1986, PL 99-662.

5. Northwest Branch:

a. East Channel: 600 feet wide and 49 feet deep for 1.3 miles, with a 950-foot-wide turning basin at the head of the channel.

b. West Channel: 600 feet wide and 40 feet deep for 1.3 miles, with a 1,050-foot-wide turning basin at the head of the channel.

2.3.2 Chesapeake and Delaware Canal

The existing project for the C&D Canal is maintained under the jurisdiction of the COE, Philadelphia District. The project was adopted as House Document 63-196 in 1919 and modified by Section 3 of the Rivers and Harbors Committee Document 71-41 and Senate Document 71-151 in 1930; by House Document 72-201, House Document 73-18, and House Document 73-24 in 1935; and by Senate Document 83-123 in 1954.

The Inland Waterway Project (Delaware River to the C&D Canal and Chesapeake Bay) was initiated with the purchase of the canal by the United States in 1919. The existing project provides a channel 35 feet deep and 450 feet wide from the Delaware River through Elk River and the Chesapeake Bay to the 35-foot depth contour in the Chesapeake Bay. A feasibility study has been completed by the Philadelphia District COE that investigated deepening the channel through the Canal and its approaches. Construction is expected in 1999 and 2000.

The project also provides for modifications to bridge crossings, including a railroad crossing with 138 feet of vertical clearance at full lift and a horizontal clearance of 600 feet; high level highway bridges with 135 feet of vertical clearance and 500 feet of horizontal clearance at Reedy Point (2 lanes), St. Georges (4 lanes), Summit (4 lanes), and Chesapeake City (2 lanes); and a bascule drawbridge across the Delaware City Branch Channel.

Other improvements authorized under the existing project include extension of the entrance jetties at Reedy Point; an anchorage in Elk River, 35 feet deep, 1,200 feet wide, and an average length of 3,700 feet; enlargement of the anchorage and mooring basin in Back Creek to 12 feet deep, 400 feet wide, and 100 feet long; a branch channel 8 feet deep and 50 feet wide at Delaware City and deepening of the existing basin to 8 feet; revetment along banks of Delaware City Branch Channel east of the Fifth Street Bridge; and construction of bulkheads.

2.3.3 Anchorages

The four anchorages authorized under the existing Baltimore Harbor and Channels project are shown in Figure 2.4. These anchorages are maintained by the Federal government and are regulated by the U.S. Coast Guard. The Quarantine Anchorage was authorized by the COE, but is not shown on any maps since the construction of the Francis Scott Key Bridge. Regulation of the Quarantine Anchorage was cancelled by the U.S. Coast Guard effective 15 January 1970.

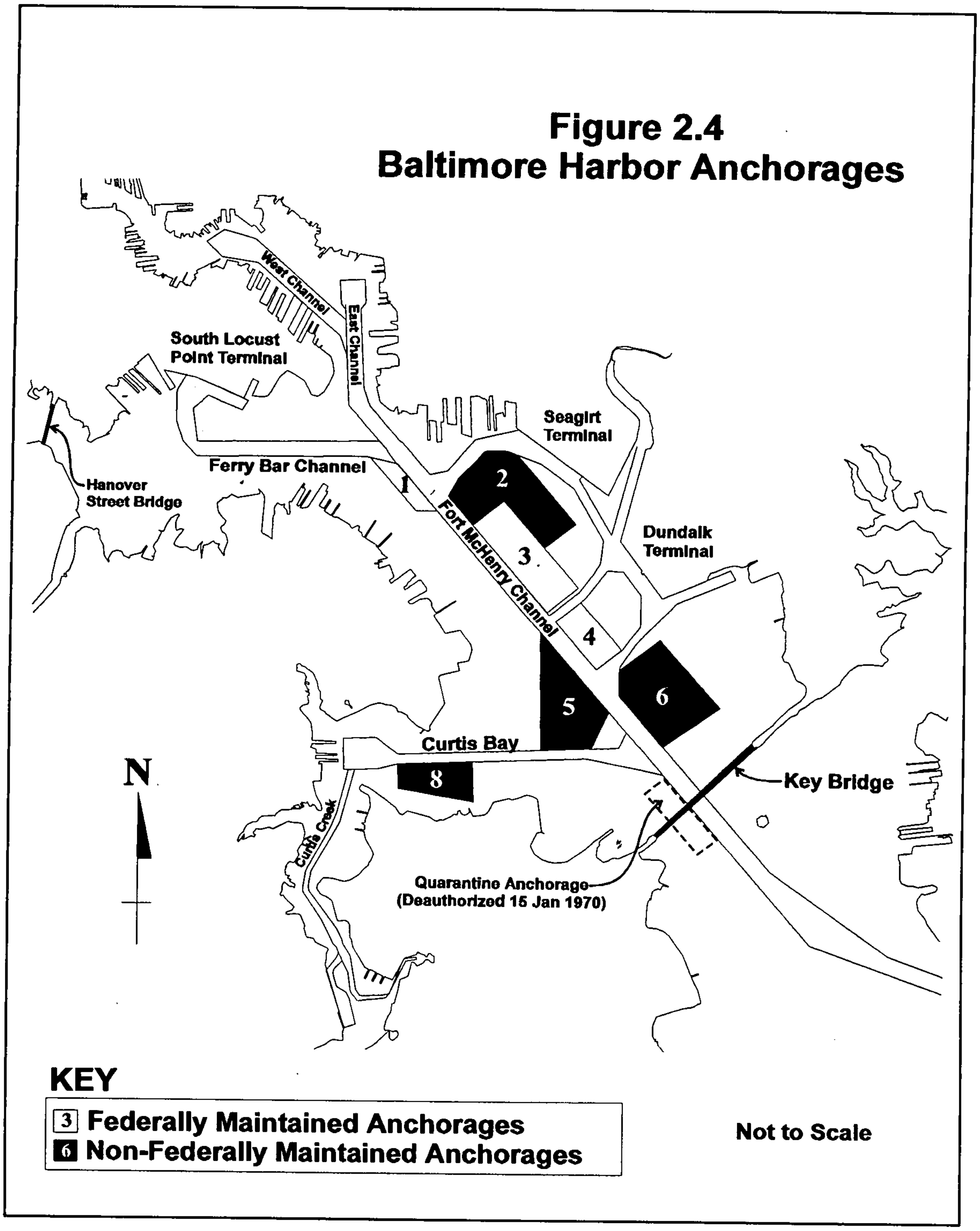
- Anchorage # 1 (Fort McHenry Anchorage): In the Patapsco River near the intersection of the Fort McHenry Channel and the Ferry Bar Channel; 35 feet deep, 3,500 feet long, and 400 feet wide.

- Anchorage # 3 (Riverview Anchorage # 1): In the Patapsco River, on the northeast side of the Fort McHenry Channel, adjacent to Seagirt Marine Terminal; 35 feet deep, 4,500 feet long, and 1,500 feet wide.

- Anchorage # 4 (Riverview Anchorage # 2): In the Patapsco River, 3,000 feet southwest of the Dundalk Marine Terminal; 30 feet deep, 2,400 feet long, 1,200 feet wide.

- Quarantine Anchorage: In the Patapsco River near Hawkins Point, southeast of the angle between Fort McHenry Channel and Curtis Bay Channel; 35 feet deep, 3,500 feet long, and 600 feet wide (deauthorized in 1970).

There are four more Federally regulated, but not maintained, anchorages established at Baltimore which are also shown in Figure 2.4. These anchorages are not authorized under the existing Baltimore Harbor and Channels project and are not maintained by the Federal government. The anchorages are regulated by the U.S. Coast Guard and can accommodate vessels with drafts ranging in depth from 19 to 24 feet. Note that Anchorage #7 was



previously designated the Quarantine Anchorage and is currently reserved by the U.S. Coast Guard for any potential new anchorages that may be established in the future. In addition to the anchorages in Baltimore Harbor, there is an anchorage area at the Annapolis Anchorage

Grounds (Figure 2.5) which is regulated by the U.S. Coast Guard and can accommodate any sized vessel transiting the main shipping channel. The area just south of the established Naval Anchorage is used by commercial vessels for anchoring.

- Anchorage # 2 (General Anchorage): In the Patapsco River, adjacent to Seagirt Marine Terminal and Anchorage # 3; depths range from 19 to 35 feet.

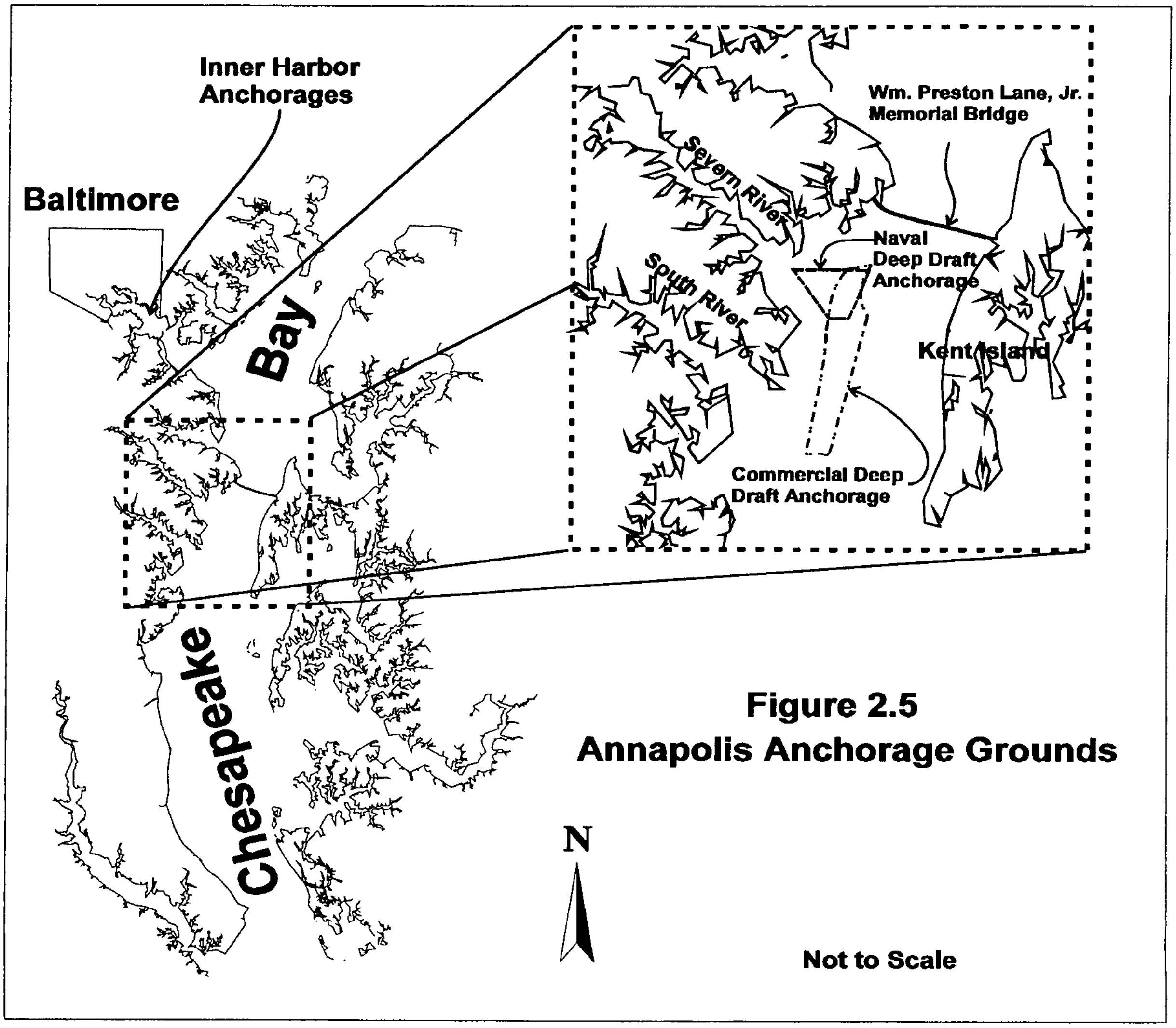


Figure 2.5
Annapolis Anchorage Grounds

- Anchorage # 5 (General Anchorage): In the Patapsco River in the angle between Fort McHenry Channel and Curtis Bay Channel; depths range from 18 to 23 feet over the 305-acre area.

- Anchorage # 6 (General Anchorage): In the Patapsco River approximately 6,000 feet west of Sollers Point; depths range from 17 to 24 feet over the 260-acre area.

- Anchorage # 7 (Previously the Quarantine Anchorage): Reserved for future designation by the U.S. Coast Guard.

- Anchorage # 8 (Dead Ship Anchorage): In Curtis Bay just south of the Curtis Bay Channel, between Sledds Point and Leading Point; depths range from 15 to 22 feet over the 165-acre area.

- Annapolis Anchorage Grounds, Naval Anchorage for Deep Draft Vessels: In the Chesapeake Bay, east of Annapolis and just south of the William Preston Lane, Jr. Memorial Bridge (Chesapeake Bay Bridge). This area is located in naturally deep water and is reserved for deep draft Naval vessels. The Annapolis Anchorage is also used by deep draft commercial ships, although it is not designated on nautical maps as an anchorage.

Use of the designated anchorage areas in Baltimore Harbor is regulated by the U.S. Coast Guard, Marine Safety Office. Vessels calling on the Port of Baltimore are required to notify the Coast Guard 24 hours prior to arrival. At this time, the captain of the vessel requests the use of anchorage and/or berth space, which is entered into the Marine Safety Information System database. The selection of a safe anchorage area for a vessel is the responsibility of the U.S. Coast Guard in accordance with the Code of Federal Regulations and is based on several factors, including information provided by the Association of Maryland Pilots (AMP), berth availability, anchorage availability, docking time, and the length, beam, and draft of the vessel.

Federal regulations limit anchorage use within Baltimore Harbor to periods of 12 to 72 hours, depending on the anchorage used. Vessels requiring longer periods of use must obtain a written permit from the Captain of the Port. With the exception of Anchorages #1 and #8, standard use is limited to 72 hours. Anchorage #1, Fort McHenry Anchorage, is limited to 12-hour use. Most vessels held in this anchorage require tug assistance to avoid projecting into the main shipping channel. Anchorage #8, Dead Ship Anchorage, requires a written permit for any period of use. Vessels anchored in Baltimore Harbor and the Patapsco River outside of the designated anchorage areas are not to exceed a 24-hour period. This is limited to small vessels since the water depths are generally less than 20 feet and the regulations require that no vessel be positioned so as to obstruct the passage of any other vessel or to extend into established channel limits. Baltimore Harbor anchorages are primarily used by smaller bulk cargo vessels waiting for a berth to clear, for cargo to arrive, or for a letter of credit. Container and grain vessels rarely anchor due to scheduling constraints and readily available berth space. One exception is during poor weather conditions. A designated anchorage area located in naturally deep water just east of Annapolis is used for both longer-term anchoring and deep draft vessels. If adequate anchorage area or berth space is not available at Baltimore, vessels will use the Annapolis Anchorage or vary their transit speed en route in order to arrive at berth at a specified time.

Positioning or repositioning of foreign vessels or American vessels engaged in foreign trade within a designated anchorage area is the responsibility of the AMP. The exception is when vessels are maneuvering in a designated anchorage area during berthing or deberthing operations or shifting within the confines of the Baltimore Harbor. If a licensed pilot is not aboard, tug assistance with a docking master aboard the vessel is required.

2.3.4 Curtis Creek

The Curtis Creek Channel, in part, is authorized under the existing Baltimore Harbor and Channels project to a depth of 35 feet. The 200-foot-wide section of the channel provides access to multiple facilities which are used for a variety of purposes, including the shipping and receiving of fuel oil, petroleum products, liquid fertilizer, asphalt, sulfuric acid, potash, bulk cement, sodium hydroxide, and sodium silicate; the mooring of vessels requiring repairs; and the mooring of marine construction vessels and equipment.

Vessel traffic in Curtis Creek is limited to a maximum safe draft of 33 feet. The vessels calling on the facilities are generally barges. The largest vessels calling on Curtis Creek are fuel tankers, which require lightering prior to entering the channel. These vessels lighter to barges in the Annapolis Anchorage or at another berth in order to safely navigate the Curtis Creek Channel.

2.4 NON-FEDERAL BRANCH CHANNELS

There are several non-Federal branch channels which serve to connect the main shipping channels with various public facilities throughout the Port of Baltimore. The branch channels are generally 36, 38, and 42 feet deep and vary in width from 300 to 500 feet. The branch channels are shown in Figure 2.6 and include West Seagirt Branch Channel, Seagirt/Dundalk Connecting Channel, West Dundalk Branch Channel, East Dundalk Branch Channel, and South Locust Point Branch Channel and turning basin. Maintenance of these branch channels and the berthing areas is currently the responsibility of the MPA.

2.5 CLIMATE

The project area has a continental-type climate with four distinct seasons, although extreme winter and summer temperatures are moderated somewhat by the Chesapeake Bay. The average annual temperature is 62 degrees F, with the highest temperatures occurring in late July (the average maximum is 89 degrees F) and the lowest temperatures occurring in January and February (the average minimum is 21 degrees F).

Annual precipitation ranges from 40 to 44 inches, distributed fairly evenly throughout the year. The lowest average monthly precipitation (2.57 inches) occurs in January and the highest (4.26 inches), in August. Winter low pressure systems moving up the Atlantic coast cause most of the precipitation during the cold months, while summer showers and thunderstorms provide warm weather precipitation. Average snowfall in the project area is 20 to 25 inches, mainly occurring in December, January, and February.

The prevailing winds are southerly from May through September and west-northwesterly to northwesterly during the rest of the year. Hurricanes, blizzards, tornadoes, and other destructive storms are uncommon.

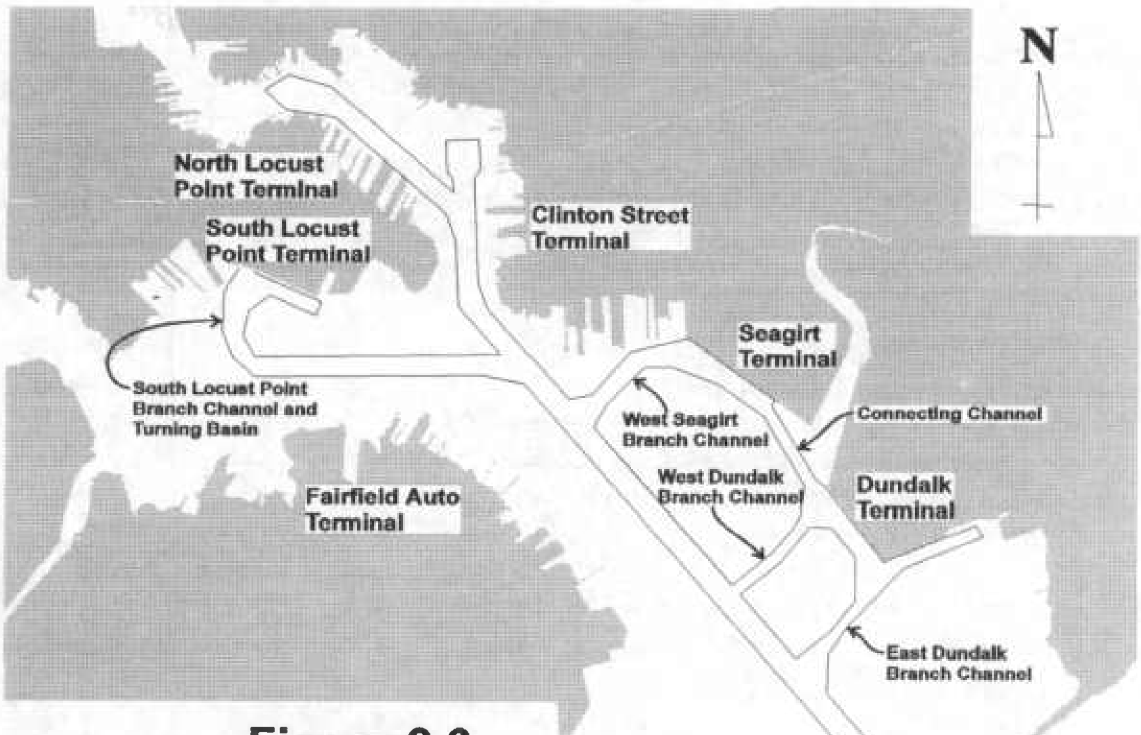


Figure 2.6
Non-Federal Branch Channels

Not to Scale

2.6 AIR QUALITY

Sections 109 and 301(a) of the Clean Air Act as amended in 1990 [42 U. S. C. 7409(a)], and Environmental Protection Agency (EPA) implementing regulations (40 CFR Part 50) define national, primary, and secondary ambient air quality standards as judged necessary to protect public health and welfare for "criteria" pollutants. EPA regulations establish National Ambient Air Quality Standards (NAAQS). The agency publishes a list of all geographic areas relative to their compliance with NAAQS. Areas where NAAQS are being achieved are designated as "attainment" areas and are subject to Prevention of Significant

Deterioration (PSD) regulations. Areas not in compliance are designated as "nonattainment" areas. The proposed project is in a nonattainment area for ozone, and, therefore, is not subject to PSD regulations for ozone. There are several major point sources of air pollution near the project area which are part of MDE's point source baseline , and MDE is evaluating these sources in an effort to reduce emissions. Air quality in the project area is also impacted by Baltimore City with its transportation, infrastructure, industry and power plants.

2.7 TIDAL DATA, CURRENTS, AND SALINITY

The tide range is approximately 1 foot in the project area. In the larger Chesapeake Bay area, the mean range of tide is 2.8 feet at the Cape Henry Channel, 2.3 feet at the York Spit Channel, 1.4 feet at the Rappahannock Shoal Channel, 0.8 feet at the Craighill Entrance, 0.9 feet in the Craighill Upper Range, 1.1 feet at Fort McHenry, and 1.2 feet at Pooles Island in the upper Chesapeake Bay. Prolonged high winds from the north tend to blow water out of the bay, resulting in unusually low tides, and prolonged high winds from the south tend to force water into the Bay, resulting in unusually high tides.

The velocity of the flood current varies in strength from about 1.0 knot at the entrance to the Chesapeake Bay to about 0.6 knot at the Craighill Entrance Channel. A vessel entering the Chesapeake Bay through the Virginia Capes at a speed of 12 knots can pass Cape Henry 2 or 3 hours prior to high tide and carry a favorable current all the way to Baltimore. A vessel leaving Baltimore at the same speed at high tide can carry a favorable current about two-thirds of the way to Cape Henry.

Circulation patterns in the harbor are not well understood. The patterns are affected by wind conditions and by factors related to denser, tidal waters moving into the harbor and converging with less dense freshwater from rivers and other sources.

The salinity of the Chesapeake Bay ranges from highest at the mouth of Chesapeake Bay, where seawater enters the estuary through the Virginia Capes, to brackish water along the Susquehanna flats in the upper bay. Salinity varies considerably throughout the Bay along longitudinal and depth gradients, as well as seasonally. The salinity of the Bay is significantly affected by periods of drought and heavy rains, and by unseasonably warmer temperatures. At Baltimore, the salinity varies from an average of 5 parts per thousand (ppt) in the spring to 10 ppt in the fall. The salinity at the mouth of the Potomac River varies from 11 to 18 ppt, while at Cape Henry it varies from 23 to 29 ppt. The brackish nature of the water at Baltimore can effect the buoyancy of large bulk carriers, sometimes resulting in a 1.0 foot increase in the draft of vessels at Baltimore over that at Cape Henry.

2.8 WATER QUALITY

Water quality conditions in the Chesapeake Bay Area vary due to many factors including proximity to urban areas, type and extent of industrial activity, stream flow characteristics, amount and type of upstream land and water usage. Water quality in the project area is poor. The project area lies within the turbidity maximum of the Upper Bay, and suspended sediment levels may reach 150 mg/liter.

The water quality in the harbor is impacted by the heavy volume of urban runoff in combination with industrial and commercial discharges. Nutrient levels are relatively high and algae blooms are frequent. Waters below the pycnocline frequently become hypoxic (dissolved oxygen less than 2 mg/1) during the summer months.

2.9 SEDIMENTS

The Chesapeake Bay is located in the Atlantic Coastal Plain physiographic province and is underlain by sequences of clay, silt, sand, and gravel. These geologically unconsolidated sediments date from the Cretaceous, Tertiary, and Quaternary Periods.

The general geologic setting of the Baltimore Harbor is comprised of a series of wedge-shaped sediment layers dipping and thickening bayward. The older and generally harder Cretaceous sediments are encountered farthest to the north and west within Baltimore Harbor, while the younger and less compact Tertiary and Quaternary sediments are typically encountered elsewhere.

A detailed sediment sampling and testing plan was developed as part of the geotechnical and environmental analysis. In efforts to control study costs, the scope of this analysis assumed that the most probable structural solutions to the navigation problems would not change significantly from the recommendations of the reconnaissance study. Although the extent of the potential plans may have changed, this analysis assumed the general locations proposed for dredging would not change drastically.

2.9.1 Sediment Composition

The bottom sediments in the Chesapeake Bay and the approach channels to the Baltimore Harbor are predominantly clayey silt, with some locations of sand-silt-clay. The upper Chesapeake Bay is a zone of sediment deposition in the harbor. The principal sources of sediment are the Chesapeake Bay and the P^tapsco. The Patapsco River does not contribute a significant sediment load. The bottom sediments in the project area are generally characterized as soft, highly plastic, organic silty clay. The upper layer of sediment in the project area, varying from 0.5 to 3 feet thick, exists primarily in a semi-liquid state.

Sediment samples were obtained for dredging areas proposed by the COE in April 1994 as part of the feasibility phase technical investigations. The samples were collected and evaluated for two purposes: to determine dredged material placement requirements by identifying the chemical content of the sediments (environmental borings); and to characterize the dredging conditions by analyzing the geophysical properties of the sediments (geotechnical borings). A summary of the sediment composition analyses follows for the potential project areas as identified in the reconnaissance report. Figures 2.7, 2.8, and 2.9 show the locations of the borings conducted (see Appendix D - Work Plan for Environmental and Geotechnical Investigations for additional information).

2.9.1.a South Locust Point. Sediments in the South Locust Point area are primarily composed of very soft, highly plastic, silty clay with traces of sand. Mica and shell fragments are frequently observed in these sediments. Cobbles and wood pieces are observed occasionally in these sediments.

However, within 1,000 feet of the South Locust Point Marine Terminal, the nature of the sediments changes significantly. In this area, sediments consist of alternating layers of medium-stiff to stiff, silty clay and sandy silt with traces of gravel; and loose- to medium-dense, silty and clayey sand. These harder sediments are encountered at depths of 32 to 50 feet below Mean Lower Low Water (MLLW).

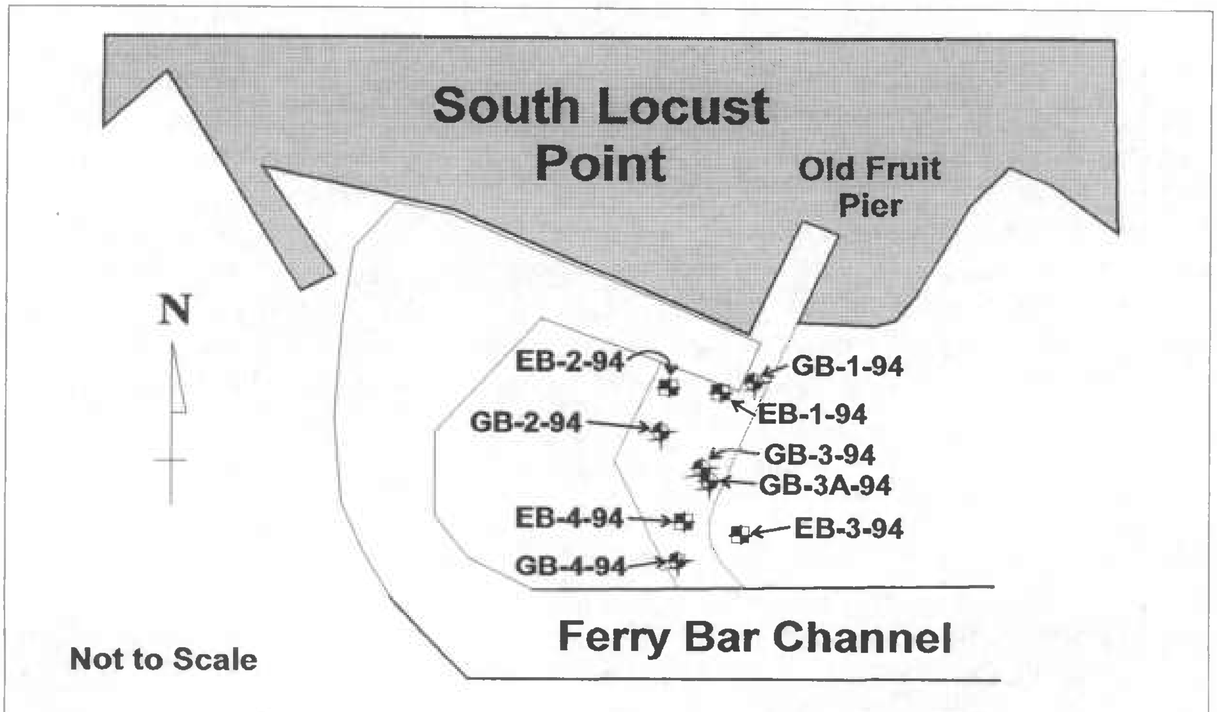


Figure 2.7
Site Investigation Map
South Locust Point

2.9.1.b Anchorage Areas #2 & #3. Sediments in anchorage areas #2 & #3, bordered by the

West Seagirt Branch Channel and the West Dundalk Branch Channel (Figure 2.8), are entirely composed of very soft, highly plastic, silty clay with traces of sand and gravel. Shell fragments, slag pieces, and cobbles are observed occasionally in these sediments.

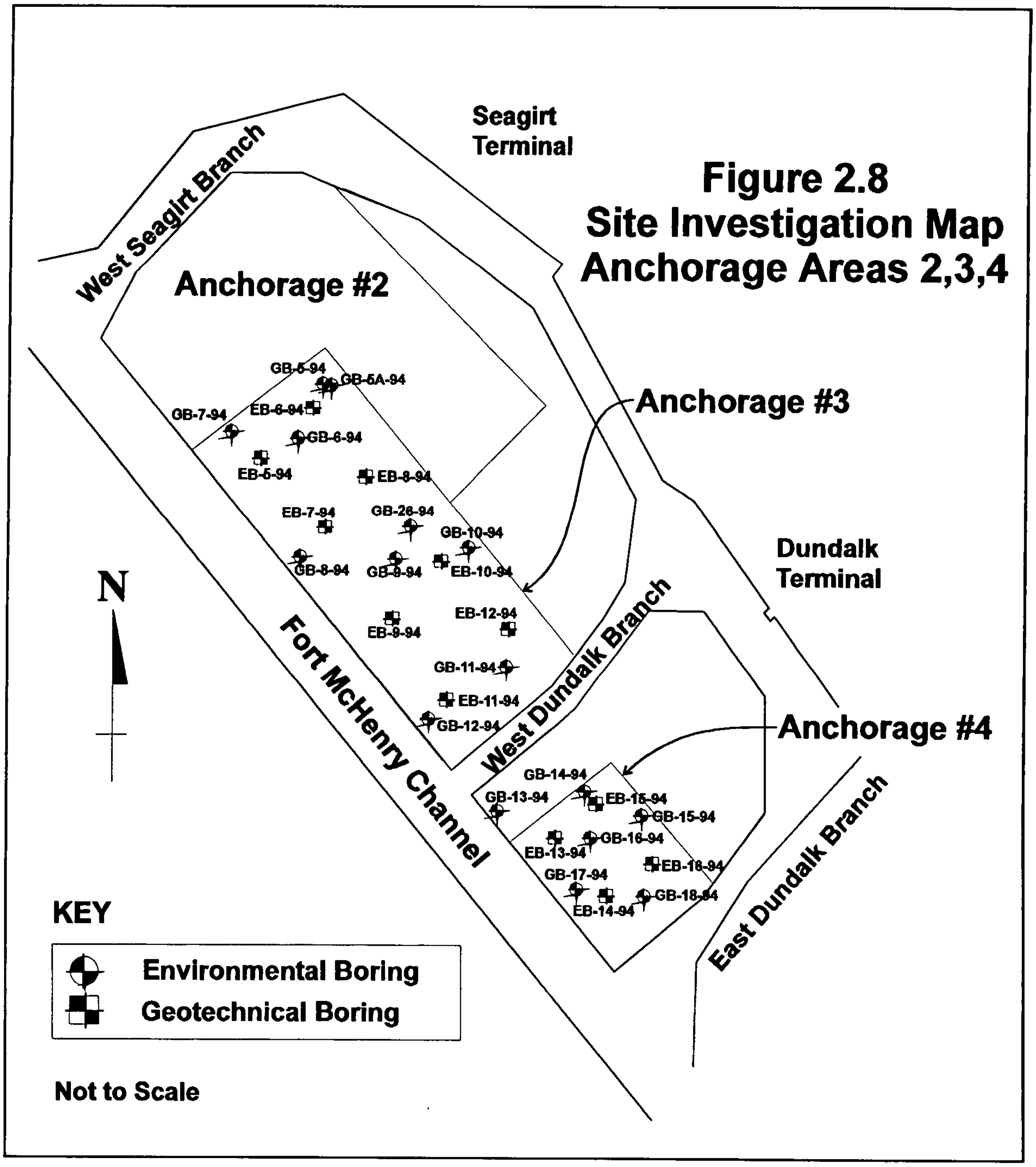


Figure 2.8
Site Investigation Map
Anchorage Areas 2,3,4

2.9.1.c Anchorage Area #4. Sediments in Anchorage Area #4, bordered by the West and East Dundalk Branch Channels (Figure 2.8), are entirely composed of very soft, highly plastic, silty clay with traces of sand. Shell fragments, wood pieces, and gravel are observed occasionally in these sediments.

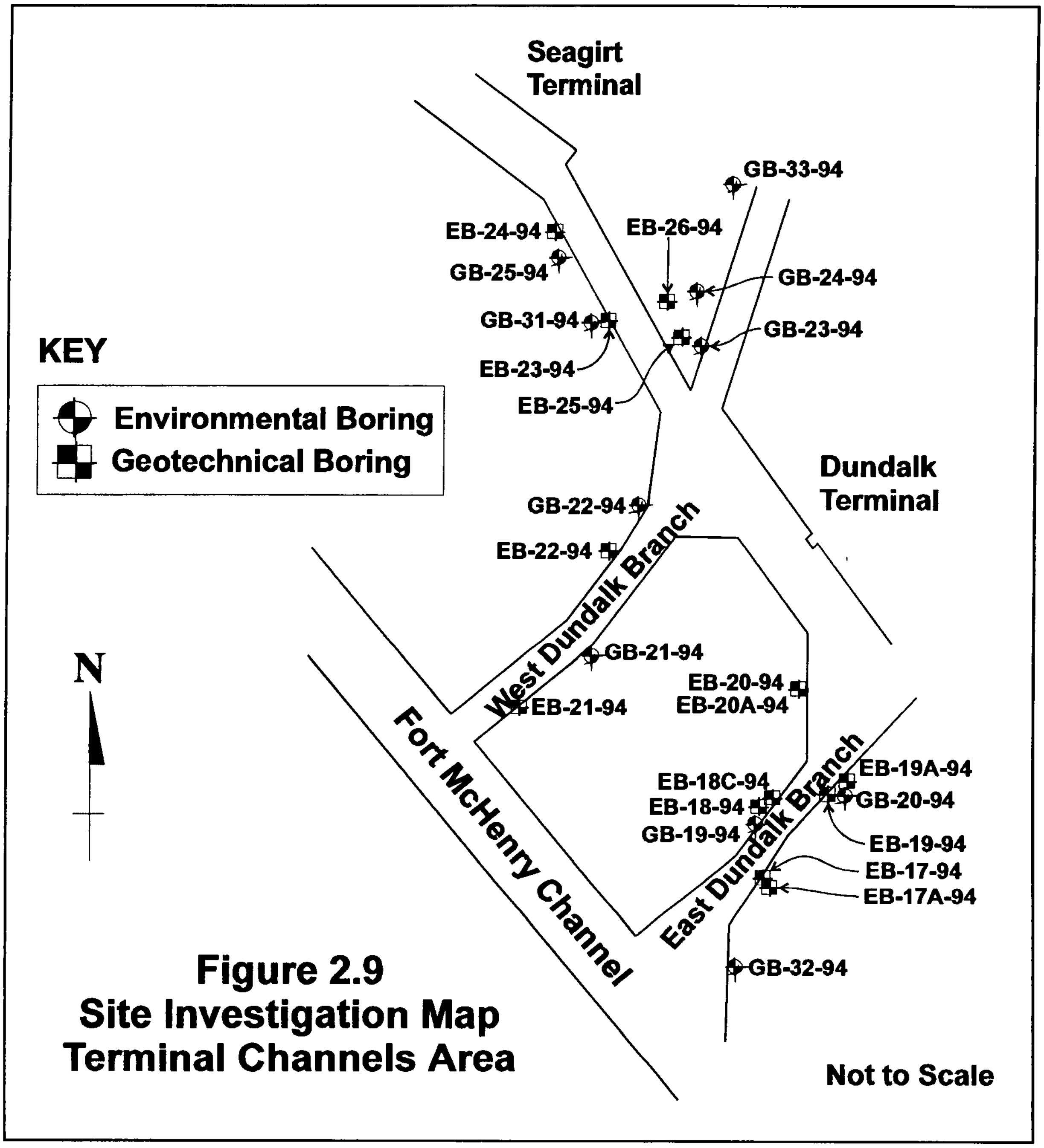


Figure 2.9
Site Investigation Map
Terminal Channels Area

2.9.1.d Branch Channel Areas. Sediments in the channel areas, Figure 2.9, are primarily composed of very soft, highly plastic, silty clay with traces of sand. Shell fragments are frequently observed in these sediments. Mica, cobbles, and wood pieces are observed occasionally in these sediments. In the northern half of the West Dundalk Branch Channel and in the proposed cutoff angle area between the Seagirt and Dundalk Marine Terminals, the nature of the sediments changes significantly. Sediments in these areas consist of stiff to very stiff, silty and sandy clay and sandy silt, and loose to dense, clayey and silty sand. These harder sediments are encountered at depths of 22 to 50 feet below MLLW.

2.9.2 Sediment Quality

Sediments proposed for dredging contain a diverse suite of contaminants typical of urbanized/industrialized harbors in North America. An extracted summary of results if chemical analysis is presented in Appendix F.

Some priority pollutants, including several heavy metals, are present in the proposed dredged material in concentrations that are known to cause either or both acute and chronic toxicological effects in some sensitive marine organisms. In addition, the combination of multiple priority pollutants probably causes some synergistic toxicological effects. A clear indicator of this likely toxicity is the depauperate benthic community in many areas of the Harbor near the proposed dredging.

Sediments in the project area contain a variety of organic contaminants; however, only limited survey data on these contaminants is available. A limited data set compiled in 1994 revealed that many organic compounds, including PAHs and DDT, occur at concentrations at which occasional biological effects are expected. A health advisory by the Maryland Department of Environment has been issued recommending limited consumption of Baltimore Harbor channel catfish (Ictalurus punctatus) and American eel (Anguilla rostrata) because of high concentrations of chlordane in edible tissue.

Trace metals in Baltimore Harbor sediments have received the most study of project area contaminants. Tests indicate that concentrations of metals (chromium, cobalt, iron, nickel, zinc) are consistent in the first meter at various locations in the harbor and the project area. However, below one meter, the level of sediment contamination varies with the depth below the bottom's surface. The concentrations of several metals (chromium, mercury, nickel, zinc) in the project area sediments are high enough for one to expect occasional to frequent incidence of biological effects on organisms. Biological effects may range from reduced fertility and growth to mortality.

Recent tests indicate a decrease in metal concentrations below sediment depths of approximately 5 feet. At depths of approximately 10 feet, the concentrations of chromium and zinc (two metals which are common pollutants in the harbor) were found in concentrations which were 66 percent and 75 percent lower, respectively. Testing in some parts of the harbor indicate that sediments deposited within the last 20 years may be less contaminated than deeper material. A 1991 test of sediments in certain harbor locations found that concentrations of most trace metals in the upper 2 centimeters of sediment averaged approximately 50 percent less than comparable measurements made in 1973. It is unclear whether the same deposition pattern exists in areas of the harbor where sediments are subjected to greater physical disturbance and mixing than in the areas tested.

It has been calculated that the contaminated sediment layer may be 3 meters or more in thickness in the Inner Harbor near Fort McHenry. The thickness of the contaminated layer becomes progressively less toward the mouth of the Patapsco River; where it is believed to be less than 0.5 meter.

The proposed placement of the dredged material within the Hart-Miller Island Containment Facility and/or within the CSX/Cox Creek Dredged Material Containment Facility has been determined to be the best management practice to control and reduce the aforesaid contaminant related effects.

2.9.2.a South Locust Point. Results of the sediment quality tests at South Locust Point indicate that this area contains considerably lower levels of contamination (metals, semivolatiles, oil and grease, total phosphorus, total nitrogen, and total organic carbon) than other harbor areas. These results are similar to the EPA study (Villa and Johnson, 1974) in which Middle Branch sediments showed lower metals levels than other harbor areas.

2.9.2.b Anchorage Areas #2 and #3. Results of the sediment quality tests in Anchorage Areas #2 and #3 indicate that these areas contain the highest levels of barium detected in the harbor sampling areas. The levels of the heavy metals (mercury, chromium, and zinc) were elevated in these sampling areas. The total nitrogen and total organic carbon were also higher in these areas than in other areas of the harbor.

2.9.2.c Anchorage Area #4. Results of the sediment quality tests in Anchorage Area #4 indicate that this area contains the highest levels of arsenic, copper, and lead detected in the harbor sampling areas. The levels of fluoranthene, naphthalene, benzo{a}pyrene and pyrene were highest in this sampling area. These contaminants are typically associated with the production and use of coal.

The proposed dredging and placement of the dredged material within the Hart-Miller Island Containment Facility and, or within the CSX/Cox Creek Dredged Material Containment Facility has been determined to be the best management practice to control and reduce the aforesaid potential contaminant related effects

2.9.2.d East and West Dundalk and Connecting Channels. Results of the sediment quality tests in the East and West Dundalk and Connecting channels indicate that these areas are higher in nickel and iron levels than the other areas sampled. The only semivolatiles detected in these areas were phthalate compounds which are plasticizers in plastics principally found in industrial wastewater during production and use.

2.9.3 Shoaling Rates

Baltimore Harbor is a shallow embayment on the western shore of the Chesapeake Bay at the mouth of the Patapsco River. The Patapsco drains a small, highly urbanized watershed and carries a correspondingly small sediment and particulate load. The Federally-maintained anchorages are adjacent to the Fort McHenry Channel in the vicinity of the Seagirt and Dundalk Marine Terminals. While maintenance of the Fort McHenry Channel has required dredging sediment quantities indicative of a shoaling rate of about 100,000 cubic yards per annum over the length of the channel, no maintenance dredging of the anchorages has been conducted since FY 1985. The shoaling rate for the Federally-maintained anchorages is less than 35,000 cubic yards per year. The anchorages are normally maintained on a 10-year dredging cycle. The shoaling rate in the existing branch channels and anchorages averages approximately 0.25 feet per year. The branch channels are normally maintained by the MPA every 6 to 8 years. The annual maintenance dredging requirement for these channels is approximately 34,000 cubic yards of dredged material. A more detailed discussion of maintenance dredging requirements for both "with-project" and "without-project" conditions is provided in Section 6.2, Operation and Maintenance Dredging Requirements.

2.10 DREDGED MATERIAL PLACEMENT SITES

2.10.1 Placement Site Development Efforts

The management of dredged material is an ongoing concern for the Port of Baltimore as the need for larger and deeper channels creates a greater demand for identification and development of confined placement sites and especially for material from Baltimore Harbor. Title 8, Section 8-1602, Subsection (a), of the Annotated Maryland Code prohibits the placement of any dredged material from Baltimore Harbor into any portion of the water or bottomland of the Chesapeake Bay, or the tidewater portions of any of its tributaries outside of Baltimore Harbor. For this reason, significant resources have been allocated by the State of Maryland to identify new ways to manage dredged material. The MPA is committed to finding new placement areas. This commitment has already been demonstrated by the MPA's efforts for the Baltimore Harbor and Channels 50-foot project, which required an investment of over $60 million to develop and manage the Hart-Miller Island dredged material placement area. Currently, the MPA has $7 million available to fund efforts related to the identification and planning of new dredged material placement sites for the continued maintenance of the Baltimore Harbor navigation system.

Currently alternatives for dredged material placement include: development of sites proposed by the MPA or selection of new sites. In response to this need, the MPA and the Corps of Engineers are currently planning for alternate solutions and are involved in developing other alternative dredged material placement areas to accommodate both current and future dredging projects.

2.10.1.a Governor's Task Force - 1990. In July 1990, Maryland Governor William Donald Schaefer convened a task force to review dredged material management options. The membership of the task force was broadly based, representing State, Federal, and local governments, members of the academic community, groups concerned with protection of the environment, parties involved in maritime commerce, and parties whose livelihood is dependent upon the quality of Bay waters. In the February 1991 report of its recommendations to the Governor, the task force noted:

> *The Chesapeake Bay, one of the country's most valuable natural treasures, remains a highly productive resource even after centuries of intensive use. It contributes significantly to Maryland's economy. Its waters supply millions of pounds of seafood and play an important role in Atlantic Coast fisheries. It provides extensive habitat for wildlife. It is a nesting area for endangered species such as the bald eagle. The Bay also offers a wide variety of opportunities for recreation and tourism. In short, the Chesapeake Bay greatly enhances Maryland life....New strategies addressing the dredging issue are required to both protect and promote the recovery of the Bay and safeguard the vitality of the Port of Baltimore.*

The task force's primary recommendation was:

> *A new, comprehensive, and integrated approach linking dredged material management, environmental issues, and community development is recommended. The foundation for this unique approach is supported by four principles:*

- *Minimization: The amount of material to be dredged, and the amount of material requiring containment should be minimized.*

- *Comprehensive Monitoring: Ongoing State and Federal water quality and sediment transport monitoring programs should be integrated with pre-, during, and post- event monitoring of dredging and placement activities. This will provide a more comprehensive assessment of environmental aspects of dredging projects.*

- *Emphasis on Beneficial Use of Dredged Materials: Material dredged from shipping channels need not be seen as spoil to be disposed—instead, it can and should be utilized as a resource. Decisions regarding placement of dredged materials should emphasize productive uses—those benefiting the environment and communities. Opportunities to use dredged materials as a marketable product should be fully explored.*

- *Use of existing placement sites and creation or designation of new sites: Conventional means of placement (containment sites, open water placement, and upland placement sites) will be required to accommodate both short- and* *long-term demand for placement of dredged materials.*

2.10.1.b Dredging Needs - Placement Options Program (DNPOP). The MPA and the Baltimore District are jointly involved in developing other alternative dredged material placement areas to accommodate both current and future dredging projects. For example, the MPA is currently pursuing various options for the management of dredged material through their Dredging Needs and Placement Options Program (DNPOP). The goal of this program is to identify sites for the placement of dredged material from construction and maintenance of projects under the jurisdiction of the MPA. The program identifies short-term capacity shortfalls as well as long-range alternatives for dredged material placement. The DNPOP is not intended to be a one time study effort to develop a fixed plan, but is a program that is constantly changing to meet the dynamic needs of the Port of Baltimore. The MPA has also developed a Master Plan to identify dredged material placement alternatives for sediments removed from Baltimore Harbor. The plan identifies dredged material placement options that were selected based on the results of a two-phase screening process. These sites were chosen to meet the harbor's placement needs in a cost effective and an environmentally acceptable manner. A summary of the potential sites identified for placement of dredged material is listed in Table 2.3.

Subsequent to the task force report and MPA Master Plan, the MPA developed the Dredging Needs and Placement Options Program (DNPOP). The program, like the task force, is a multigovernmental program charged with developing a comprehensive dredged material management plan. The objective of the program is to identify and develop near-term to long-term dredged material placement options for the Port of Baltimore and its approach channels. These include the Baltimore Harbor channels (those channels that lie inside the North Point to Rock Point line); the Bay Channels, which include the Brewerton Extension, Tolchester, and Swan Point channels and the southern approach from the Craighill Entrance to the Cutoff angle; the C&D Approaches, which include those channels from Pooles Island north to Courthouse Point; and the C&D Canal, which includes those channels from Courthouse Point to Reedy Point.

The MPA and the COE are working closely to develop a multi-phased study called the Dredged Material Management Plan (DMMP). The objective of this study is to identify placement capacity for the next 20 to 50 years. Plan formulation was initiated in Fiscal Year 1995 and will include consideration of all dredging maintenance and construction of Federal projects, as well as state and private projects. The study will stress long-term solutions and beneficial uses of dredged material. Recommendations from this study are expected within 2 to 3 years.

2.10.1.c April 1996 Governor's Action Plan for Dredged Material Management. The April 1996 Governors Action Plan for Dredged Material Management is the most recent plan to provide dredge material placement capacity for the State of Maryland. The plan includes the options listed below:

I. Expand use of placement sites by Pooles Island
II. Raise north cell dike system at Hart-Miller Island
III. Restore poplar Island (Phase I: 640 acres)
IV. Reactivate CSX/Cox Creek Containment Cells
V. Establish open-water sites for near-term placement of dredged material
VI. Construct new upper bay containment with beneficial use component

Implementation of the above initiates involves the completion of environmental documentation, public review and MPA obtaining applicable permits from the Corps of Engineers and state agencies.

2.10.2 Overview of Placement Options

For the purposes of providing dredged material placement for this project all potential sites were considered. Table 2.3 shows a summary of the more seriously considered sites. A more detailed discussion of each follows.

2.10.2.a Open Water Placement. Open water placement of dredged material has been and continues to be an important component of the effort to maintain the navigation channels serving the Port of Baltimore and open water placement of dredged material has been accepted, albeit sometimes reluctantly, by natural resource management agencies in the past. Open water placement of dredged material does carry some short term and localized impact to benthic habitats, but this alternative has also been shown to result a substantial long term increase in primary productivity in otherwise depauperate benthic areas. The Wolf Trap and Wolf Trap Alternate placement sites in the Virginia reach of the Chesapeake Bay are good examples of increased productivity resulting from open water placement of dredged material. Agencies are now expressing concerns regarding unconfined open water placement of dredged material at Bay sites that are dispersive in nature while they have not expressed specific concerns regarding well-managed placement of dredged material at nondispersive sites. While each placement site needs to be evaluated independently there is ample information to indicate that sites known as sinks are not likely to cause long-term impacts so long as dredged material composition is similar to that of the existing sediments. Sites such as the Deep Trough which extends approximately 20 miles beginning offshore of Kent Island and extending south to the Little Choptank River, Kent Island Deep (Site 104) which is off of Kent Island and north of the Bay Bridge, and the currently used Pooles Island sites were not considered for this project since they are outside of the North Point - Rock Point Line and, by law, can not accept inner harbor materials.

2.10.2.b Poplar Island. Since Poplar Island, like many islands in the Chesapeake Bay, is currently eroding, it was determined that island restoration/creation could be an ideal solution to the dredged material management problem that the MPA is facing. Offshore islands are a unique ecosystem component in the Chesapeake Bay watershed. Although similar vegetative communities may occur on the mainland, isolation, lack of human disturbance, and fewer predators make islands more desirable as nesting sites for colonial waterbirds and some endangered species.

Table 2.3
Summary of Potential Placement Sites

Sites:	**Sollers Point**	**Masonville**	**Thoms Cove**	**Dead Ship Anchorage**
Type:	Land Creation	Modify, expand	Modify, expand	Land creation
Acres:	90	200	380	125
Adjacent Activities:	Wetland, Highway	Harbor, Highway	Industrial	Industrial
Distance from Shoreline:	0	0	0	0
Dredge Capacity (Est.):	4 million cy (Mcy)	3 Mcy	5 Mcy	7 Mcy
Distance from Anch. Basin:	3 miles	2 miles	2.5 miles	2.5 miles
Current Status:	Small capacity. Must remove muck before use.	Active and nearly full.	Tidal and non-tidal wetlands involved in filling in cove.	High cost due to dike constr. Will destroy wetlands.
Sites:	**CSX Property**	**Cox Creek Property**	**Patapsco River Mouth**	**Hart-Miller Island**
Type:	Modify, expand	Modify, expand	Land Creation	Constructed Island
Acres:	72	61	1,000-2,210	840 (N. Cell)
Adjacent Activities:	Wetland, industrial	Wetland, industrial	Open water, residential on nearby shore.	Open water, residential on shore.
Distance from Shoreline:	0	0	N/A	
Dredge Capacity (est.):	3.2 Mcy	2.8 Mcy	50-100 Mcy	30 Mcy
Distance from Anch. Basin:	4 miles	4 miles	10 miles	
Current Status:	Purchased by MPA. Ready by 1997.	MPA negotiating purchase.	Close to residential area. Will affect small boat area.	Operational

The group of islands known as Poplar Island is located in the upper middle Chesapeake Bay approximately 34 nautical miles southeast of the Port of Baltimore and 1 mile northwest of Tilghman, Talbot County, Maryland. A project to reconstruct Poplar Island to its approximate size in 1847 using uncontaminated dredged material from Baltimore Harbor and Channels Federal navigation project has been developed though cooperative efforts of many state and Federal agencies, as well as private organizations. The recommended plan would create a 1,100 acre dredged material placement area within a 35,000-ft perimeter. This area would then be filled with uncontaminated dredged material obtained from periodic maintenance dredging of Federal navigation channels that serve the Port of Baltimore, and developed into low and high marsh wetlands and upland habitat. The projected site capacity associated with the recommended plan is 38 million cubic yards, which is expected to be placed over a period of 24 years. The site would consist of 50 percent tidal wetlands, of which 80 percent would be low marsh and 20 percent would be high marsh, and 50 percent uplands with an elevation up to +20 feet MLLW. Poplar Island is not feasible since it can not accept Inner Harbor material which, by law, must be considered contaminated. Its annual capacity has been appropriated for dredged material from open Bay channels that is considered clean.

2.10.2.c Patapsco River Mouth. Between 1975 and 1983, almost 6 million cubic yards of dredged material from maintenance of approach channels to Baltimore Harbor was placed at a shallow-water site in the mouth of the Patapsco River. State law (Subsection 8-1602.1 of Maryland Code) enacted in the mid-seventies prohibited placement of dredged material from channels upstream of the "Rock Point - North Point Line" into waters of the Chesapeake Bay; consequently, no dredged material from the Harbor was placed at this site, nor can it be considered for this project.

2.10.2.d Masonville. The Masonville site, which is also operated by MPA, is located along the southern shore of the Middle Branch of the Patapsco River off the Ferry Bar Channel. The site consists of approximately 152 acres of fast land and 175 acres of submerged land. A detailed development plan and environmental impact analysis were prepared by the MPA in 1982. The site has been an important part of the harbor maintenance dredging program for the disposal of dredged material from small private jobs. Currently there are five containment cells which are essentially full.

2.10.2.e Sollers Point. This site is 90 acres in the inner harbor. The area is considered environmentally degraded. It has a small capacity compared to most other sites. Disadvantages of using the site include the need to move large quantities of muck, loss of wetlands and bottom material unfavorable for dike construction.

2.10.2.f Worton Point. This area has a very large capacity and is close to the shipping channels. The shoreline is highly eroded and in need of stabilization. The site is not now considered viable because of its high environmental value and requirements of the landowner.

2.10.2.g Thoms Cove. This site in the Inner Harbor has a small capacity and is one of the last natural areas in the Inner Harbor.

2.10.2.h CSX and Cox Creek Placement Site. These sites are adjacent to each other and where appropriate general conditions are described in this overview section. Where more specificity is need details are provided under the CSX and the Cox Creek headings

The CSX and Cox Creek placement sites are located approximately one mile south of the

Francis Scott Key Bridge, on the west bank of the Patapsco River, near Foreman's Corner,

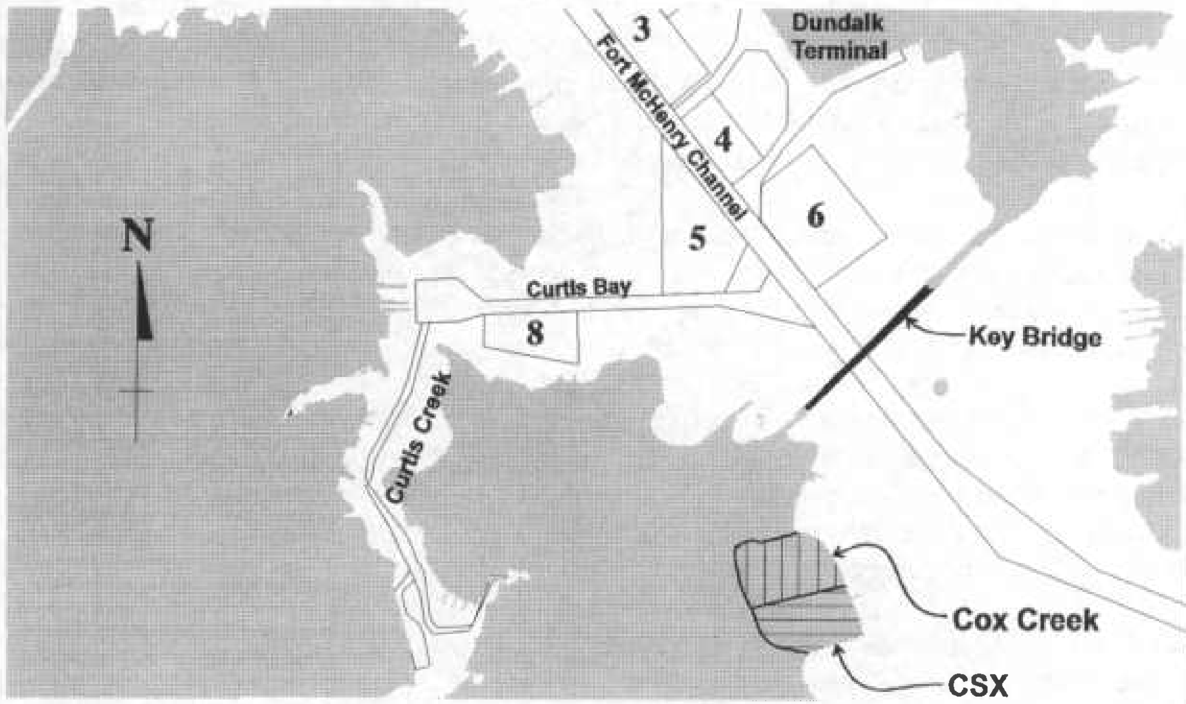


Figure 2.10
CSX and Cox Creek Placement Sites

in Anne Arundel County, Maryland (Figure 2.10). The CSX site was purchased by the State of Maryland in July 1993. The total area of the site is 206 acres; the dredged material placement cell is 72 acres. The MPA is currently pursuing efforts to prepare the newly acquired CSX site for future operation and is also involved in negotiations to purchase the 61 acre Cox Creek site.

Both of these sites are former dredged material placement sites that were constructed by the Corps of Engineers for deepening the main channels from 39 to 42 feet during the 1960s (see Section 1, Figure 1.2). The CSX placement cell was constructed in the mid-1960s and has been used periodically by non-Federal interests for dredged material placement. The 72-acre CSX site was previously permitted for placement of dredged material from dredging operations in the Patapsco River and Baltimore Harbor areas. The dikes have been raised periodically as the cell has reached capacity. The last reported use of the site for the placement of dredged material was in 1984. The most recent work on the placement site was completed in 1991 and included repairing the existing dikes and raising them an additional 4.5 feet, to an elevation of 20 feet Mean Lower Water (MLLW). It is estimated that the cell currently has capacity for 800,000 cubic yards of dredged material.

The Cox Creek Lagoon Property was developed as a containment site by placing dredged material excavated from the 42-foot-deep navigation channel of the Baltimore Harbor and Channels project. The site has not been actively used for dredged material placement since its construction in the mid-1960s. An existing 15-acre pond located within the diked area serves as a catch basin for a permitted outfall (storm sewer) from the Cox Creek Refining Company. The dikes are now 15 feet MLW and it is estimated that the cell currently has capacity for 200,000 cubic yards of dredged material.

MPA's current plans for re-development of the dredged material containment sites include raising the existing CSX and Cox Creek dikes to provide approximately 6 million cubic yards of capacity. MPA has completed a study which indicates that it is feasible to raise the dikes to elevation +28 MLLW to provide approximately 3.7 million cubic yards of capacity. Raising the dikes to elevation +39 to provide the desired capacity of 6 million cubic yards has not been evaluated by the Corps of Engineers. To accomplish the remaining efforts, the MPA has developed a three step plan, which includes acquisition of Cox Creek, modification/repair of the existing dikes and re-routing of the storm sewer, installation of discharge spillways, and raising of the dikes. MPA's schedule is to have the CSX/ Cox Creek sites available for placement of dredged material in 1997.

The MPA has coordinated use of the sites for material placement with the Maryland Waste Coalition and local community groups. The 134 acres of the CSX site that will not be used for dredged material placement include 69 acres of wetlands plus additional wildlife habitat. These existing wetlands are not expected to be impacted by the proposed project and will be protected for conservation purposes. Some portion of the remaining land at the CSX site (up to 72 acres) may be used as a staging area for operating equipment and personnel during material placement. Preliminary coordination with state natural resource management agencies was initiated by MPA to discuss development of the non-placement portions of the site as a public recreation area following project implementation.

These sites are specifically designated for "contaminated" material. The MPA has indicated that the CSX and Cox Creek placement areas are currently designated for projects resulting from the Baltimore Harbor Anchorages and Channels study and other sites within Baltimore Harbor. A preliminary determination of the Cox Creek site by the COE's Regulatory Branch indicates that the local sponsor may be required to obtain permits from the COE and the Maryland Department of the Environment. Additional chemical analysis may be necessary to meet Federal Water Quality Standards and other non-Federal standards.

These sites do not allow for adequate annual placement capacity to accept initial construction dredged matrial from the Baltimore Harbor Anchorages and Channels project. These sites will be used for the ongoing maintenance of Inner Harbor anchorages, channels, and non-Federal projects. Further analysis of these sites is presented in this report since these sites will likely be used for maintenance of the improvements recommended herein.

2.10.3 Regional Geology and Hydrogeology of CSX and Cox Creek Placement Areas

2.10.3.a CSX and Cox Creek Regional Geology. The unconsolidated sedimentary deposits underlying the CSX and Cox Creek Sites are part of the Atlantic Coastal Plain physiographic province, a southeastward thickening wedge of sediments that extends from the eastern edge of the Piedmont to the Atlantic Ocean. The Potomac Group constitutes the basal unit of sediments of the Atlantic Coastal Plain in Maryland. In the CSX and Cox Creek Site areas, the Potomac Group sediments include, in ascending order, the Patuxent Formation, the Arundel Clay, and the Patapsco Formation. Large and abrupt variation of lithology are typical of the Potomac Group. Clay-silt beds in the Patuxent and Patapsco Formations are generally developed as lenticular bodies and exhibit little lateral continuity; they are interbedded with sand and gravel.

The Patuxent Formation in the general area of the site includes medium to coarse sand and gravel interbedded with relatively thin, pale-gray clay. The total thickness of the Patuxent Formation is approximately 300 feet lying at a initial depth of 400 feet below sea level. Overlying the Patuxent Formation is the Arundel Clay, which is a tough massive clay containing lignite and siderite, usually a dark-gray to maroon, and 100-foot-thick. The Patapsco Formation outcrops in the northern areas of Arundel County where it overlies the Arundel Clay. The 250 to 300-foot-thick Patapsco Formation includes yellowish sand, fine to medium grained, interstratified with massive to laminated, variegated (gray, brown, and red) silty clay. In the flood plains of the streams as well as in the tidal marsh along the Chesapeake Bay estuaries, the Patapsco Formation is partially overlain by alluvial sediments of Holocene and Pleistocene age. A groundwater investigation conducted in the Glen Burnie area (approximately 5 miles from the placement sites) by the Maryland Geological Survey (MGS) identified the Patapsco aquifer system as consisting of an upper and lower aquifer separated by a confining unit of variable thickness. In the CSX and Cox Creek Site areas, the uppermost confining unit of the Patapsco aquifer is missing and the aquifer is therefore under unconfined (water table) conditions.

2.10.3.b CSX and Cox Creek Regional Hydrology. Information gathered in the Maryland Geological Survey (MGS) groundwater investigation near this area indicates water levels in the lower confined aquifer are higher than the water table aquifer, and groundwater in the lower Patapsco aquifer flows upward into the water table aquifer and subsequently discharges into the Patapsco River. Both the CSX and Cox Creek sites are adjacent to the Chesapeake Bay in an area where water typically discharges from the subsurface to a local water body. The direction and magnitude of the local groundwater flow is principally controlled by local topography, with the water table being a subdued expression of the land surface. It is expected that local groundwater moves from areas of higher elevation to areas of lower elevation and ultimately discharges in the Patapsco River. The water associated with the dredged materials will follow this pattern and is expected to move from the slightly elevated placement site to adjacent points of discharge in the Patapsco River.

The Arundel clay is a massive and laterally extensive unit which consists of low permeability clay and silt materials. These sediments act as a significant barrier of water flow and effectively confine the Patuxent aquifer from the overlying Patapsco aquifer. Due to its isolation, the Patuxent aquifer will remain unaffected by current surficial activities, such as dredged material placement at the CSX and Cox Creek sites.

The Patuxent and Patapsco aquifers are heavily used for industrial and public water supplies. The lower Patapsco aquifer is the primary source for large municipal water supplies in northern Anne Arundel County, with seven active pumping well fields (representing a total of 18 wells) located in this area. Concerns regarding substantial groundwater pumping and water withdrawal, combined with increasing water supply demands, have induced groundwater studies by the MGS, the Maryland Department of Environment (MDE), and the Anne Arundel Department of Public Works (DPW). The future potential for reversing the groundwater gradients, enhancing saltwater or brackish-water intrusion, contamination from harbor sediments, and diminishing baseflows in the surface tributaries were identified as hazards with continued groundwater pumping trends. In the event of a groundwater gradient reversal influenced by industrial and public water use, leachate associated with the dredged materials placed in the CSX and Cox Creek sites may follow this new pattern and potentially could be expected to contribute to diminishment of water quality of the Patapsco aquifer. For this reason, the Corps of Engineers has conducted a groundwater simulation model for the area, which is discussed below.

2.10.3.c Summary of Preliminary CSX and Cox Creek Groundwater Analyses. A groundwater investigation was conducted in 1996 by the Baltimore District at the two adjoining dredged material placement sites known as CSX/Cox Creek. Currently the CSX/Cox Creek placement sites have dikes at respective elevations of roughly 20 and 15 feet MLLW. This site has been identified for reactivation as a repository for dredge material from dredging activities in Baltimore Harbor. The site will likely be used for placement of material from maintenance dredging of the Baltimore Harbor Anchorages and Channels Project. Experience in the Baltimore harbor indicates that dredged material from maintenance operations is primarily composed of clay.

The purpose of the investigation was to determine 1) the site-specific geologic and hydrogeologic conditions, 2) the current groundwater flow directions on and around the site, 3) the current and potential groundwater use in the area, including human receptors, and 4) the affect of a dredge material placement area on the quality or quantity of groundwater, including any future conditions such as drought which could alter current groundwater flow conditions. Existing wells were identified and located, eleven new wells were installed, groundwater levels were monitored, a pump test was performed, and a groundwater model was constructed. Results of the investigation are as follows:

1) Published geologic literature describes a surface aquifer, a regional confining layer, and a deeper aquifer, all contained within the Cretaceous Patapsco Formation. Below these aquifers lies a thick, dense unit known as the Arundel Clay which forms an effective lower boundary to the shallow flow system. Well bores performed for this

investigation support this basic conceptual model; however, the surface aquifer does not appear to exist over most of the CSX/Cox Creek site. Instead, there is a thick clay (with a few sand and silt layers) which extends from the surface to a depth of about 150 ft. The aquifer sands of the Lower Patapsco are located below this clay.

2) Based on several rounds of synoptic water level measurements, groundwater at the site is flowing east, toward Sparrows Point. Well clusters located directly on the dike next to the Patapsco River indicate that there is a downward vertical gradient. Water levels in the Lower Patapsco Aquifer are actually below sea level. This surprising observation violates the standard coastal groundwater model where the major waterway represents the effluent point for groundwater flowing through the aquifer. This indicates that there is a significant pumping center located to the east of the site. Analysis of regional water levels suggests that the industrial pumping by Bethlehem Steel at Sparrows Point may be the cause of the downward vertical gradients. Bethlehem Steel claims to be pumping from the Patuxent Aquifer located below the Arundel Clay; however, the USGS observation well located on their property shows the lowest Patapsco water level in the region (1.7 ft below msl). Bethlehem Steel reportedly pumps over 6 billion gallons per month (about 200 mgd) from the Patuxent Aquifer. Their pumping center is located about 3 miles east of the CSX/Cox Creek placement site.

3) There is no current or potential groundwater use in the area of the placement site. Anne Arundel County's municipal wells are located in various sites around the city of Glen Burnie, about six miles southwest of CSX/Cox Creek. Based on the 1990 appropriation, Anne Arundel County is allowed to pump 11.8 mgd from the Patapsco Aquifer, though actual pumpage probably does not exceed 9 mgd. Though more water-level data are needed to accurately define the radius of influence for this well field, existing data indicate that its closest point lies three to four miles southwest of the CSX/Cox Creek placement site. Existing wellhead protection investigations and modeling support this conclusion. Based on the master plan of Anne Arundel County, there are no plans to drill any other Lower Patapsco wells in this part of the county.

Interviews with residents indicate that there are only two households still utilizing groundwater in the area. These houses are located roughly at the intersection of Ft. Smallwood and Kembo roads and are located more than a mile up gradient from the CSX/Cox Creek placement site. According to the groundwater model, the small amount of pumpage from these wells is not able to create a measurable reversal in the regional flow direction.

4) Based on groundwater modeling, expansion of the CSX/Cox Creek dredged material placement site, dredged material will not affect flow direction or quality of groundwater. Several different placement site scenarios were modeled: current conditions, placement site elevations of +28 and +39 feet MLLW, impoundments filled with both water and dredge material (clay), and drought. In all cases, the

placement site had no substantial effect. Groundwater flow in the Lower Patapsco Aquifer was never affected. Model results indicate that there will be groundwater flow in the surface clay from the placement site to the adjacent wetlands southwest of the site. The extremely low conductivity of the clay, however, makes any contribution from the placement site *de minimis* in quantity. Particle tracking was performed to estimate groundwater travel times out of a filled, 39-foot impoundment. The worst case scenario, with no retardation, indicated that over a 100-year simulation, horizontal travel distance totaled slightly more than a foot; vertical travel distance totaled slightly less than a foot.

2.10.4 CSX/Cox Creek Terrestrial Resources

The terrestrial community at the placement sites is limited by the almost monotypic community of common reed (Phragmites australis) and a small number of cattails (Typha sp.) around the perched intermittent ponds.

The following animals have been observed at or may be expected to inhabit or utilize one or both of the proposed placement sites:

Mammals: muskrat (*Ondatra zibethieus*), raccoon (*Procyon lotor*), Eastern cottontail (*Sylvilagus floridanus*), gray squirrel (*Sciurus carolinensis*), deer mouse (*Peromyscus maniculatus*), red fox (*Vulpos vulpos*), meadow vole (*Microtus pennsylvanicus*), and white-tail deer (*Odocoileus virginianus*).

Amphibians and Reptiles: green frog (*Ranu clamitan*), Southern pickerel frog (*Rana palustris*), black rat snake (*Elaphe obsoleta*), American toad (*Bufo americanus*), and Fowlers toad (*Bufo woodhousei*).

Avian resources: herring gull (Laurus argentatus), song sparrow (Melospiza melodia), red-wing blackbird (Agelaius phoeniceus), great blue heron (Ardea herodias), green heron (Butorides striatus), Carolina wren (Thryothorus ludovicianus), American crow (Corvos brachrhynchos), starling (Sturnus vulgaris), common grackle (Quiscalus quiscula), house sparrow (Passer domesticus), slate colored junco (Junco hyemalis), and white throated sparrow (Zonotridia albicollis).

2.10.5 CSX/Cox Creek Aquatic Ecosystems.

The proposed placement sites are located in an area referred to as the outer harbor. The following aquatic resources could be expected to be found in juvenile or adult stage at the outer harbor: Tidewater silverside (*Membras martinica*), northern pipefish (*Syngnathus fuscus*), white perch (*Morone americana*), striped bass (*Morone saxatilis*), yellow perch (*Perca flavescens*), bluefish (*Pomatomus saltatrix*), silver perch (*Bairdiella chrysura*), spot (*Leiostomus xanthurus*), Atlantic croaker (*Micropogon undulatus*), naked goby (*Gobiosoma bosci*), summer flounder (*Paralichthys dentatus*), winter flounder (*Pseudopleuronectes *americanus*), hogchoker (*Trinectes maculatus*), American eel (*Anguilla rostrata*), blueback herring (*Alosa sapidissima*), American shad (*Alosa sapidissima*), Atlantic menhadden (*Brevoortia tyrannus*), gizzard shad (*Dorosoma cepedianum*), bay anchovy (*Anchoa mitchilli*), banded killifish (*Fundulus diaphanus*), mummichog (*Fundulus heteroclitus*).

2.10.6 CSX/Cox CreekThreatened and Endangered Species

The USFWS has indicated that no Federal or stae listed Rare, Threatened, or Endangered species are known to inhabit the project area except for occaisional transient individuals.

2.10.7 CSX/COX Creek Recreation

The sites are not now significantly used for recreation. Illegal deer hunting and the illegal dumping of trash and large household appliances are common recreational activities in the project area.

2.10.8 CSX Placement Site

2.10.8.a Location and Physiography. The CSX site is located adjacent to Foremans Corner in Anne Arundel County, Maryland (Figure 2.11). It is bounded by the Patapsco River to the east, by Cox Creek Refining Company which includes a small portion of Kembo Road and Brandon Shores Drive to the north, by Baltimore Gas Electric to the southeast, and by CSX Railroad property and tracks to the west.

The proposed CSX placement site is an irregularly shaped parcel of land comprised of 206 acres. The site is part of a larger parcel known as the Foremans Corner Site, containing approximately 530 acres. The larger site is bounded by Fort Smallwood Road on the west; Kembo Road and Cox Creek Refining Company on the north; the Patapsco River on the east; and the Baltimore Gas and Electric Company's Brandon Shores Power Plant on the south. This larger parcel is bisected by the B&O Railroad tracks which run in roughly a north/south direction and form the western boundary of what is known as the CSX Site. Brandon Shores Road also bisects the Foremans Corner Site and provides access to the CSX Site from Fort Smallwood Road.

Elevations of the Foremans Corner Site range from over 60 feet in the southwest corner to near mean sea level along the Patapsco River. The area of higher elevation to the west contains wooded sections. A series of small ponds and connected wetland formed by Swan Creek flow west to east through the central portion of the site. A portion of the Foremans Corner Site known as the B&O Landfill was located on the southeast side of Kembo Road, directly adjacent to the B&O Railroad tracks, and just across the tracks from the CSX Site. Limited use was made of the approximately 107 acres of the area as a closed solid-waste landfill. The landfill was used over a period of about 7 months in 1972 to 1973 for disposal of excavated soil and debris accumulated during maintenance of railroad tracks and property. The landfill was granted closure by the Maryland Division of Solid Waste in December 1976.

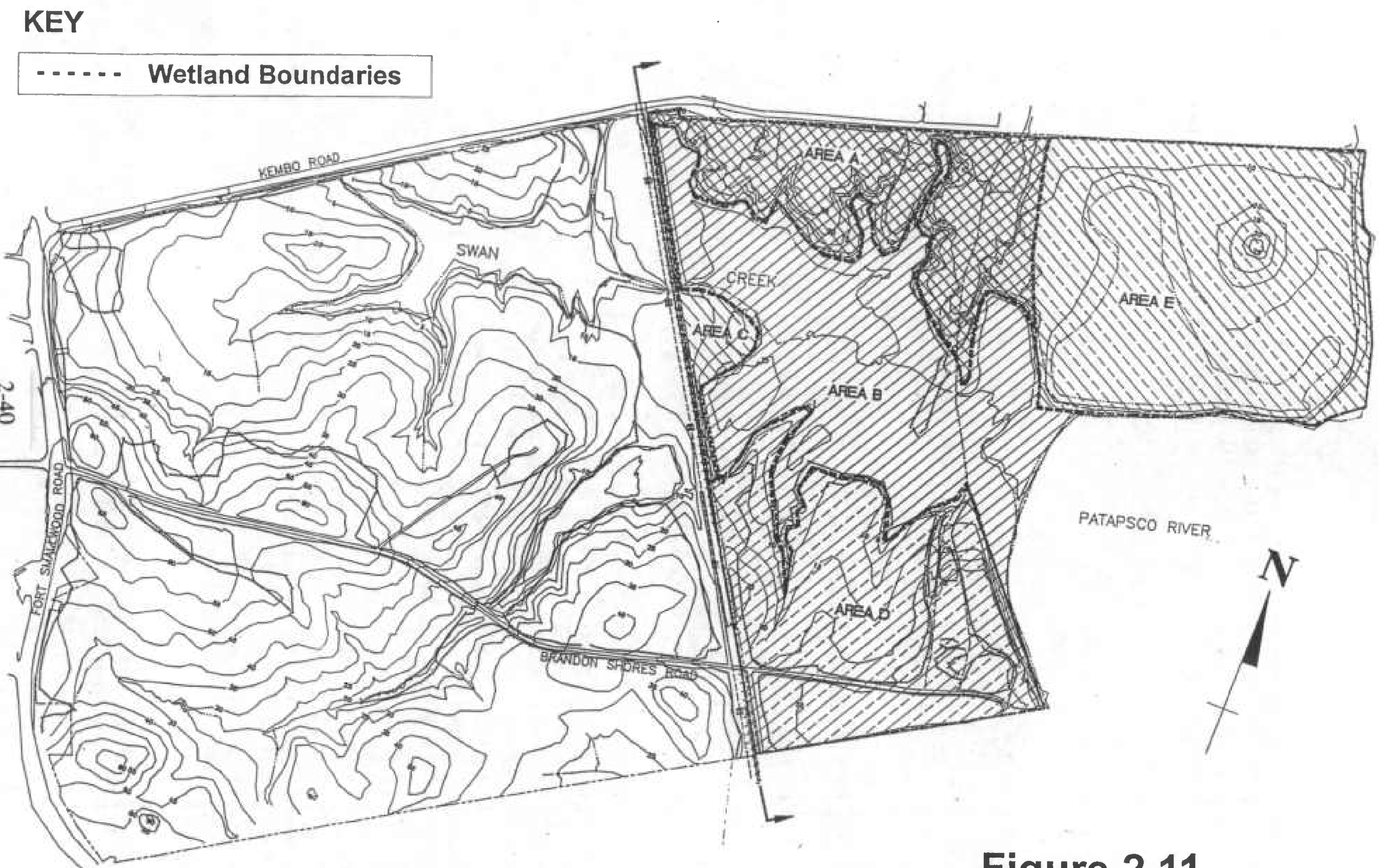


Figure 2.11
CSX Placement Site

The 206-acre CSX site, located to the east of the railroad tracks, forms the eastern half of the Foremans Corner Site, as shown in Figure 2.11. The remainder of the CSX site is further subdivided into approximately 69 acres of wetlands and wildlife habitat, and approximately 77 acres, some of which may be used as a staging area for operations during dredged material placement. The existing dredged material placement area is diked on three sides and is directly adjacent to the Patapsco River. The dikes were constructed to a height of 20 feet MLW. The west side of the placement area is contained by the natural earth bluff that previously fronted the Patapsco River.

The topography of the CSX site is moderate, with elevations ranging from approximately 25 feet MLW in the southwest corner to near sea level along the Patapsco shoreline. Relatively steep slopes exist along Swan Creek. The creek and its tributaries form several surface ponds and wetland areas before it outlets into the Patapsco River.

2.10.8.b Geology and Soils. A review of soils data indicates that the material placement area was formerly designated a tidal marsh and open water area. Old maps identify the area as a tidal flat. In the non-placement portion of the site, several scattered areas were designated as cut and fill, gravel pits or borrow areas, mixed alluvium, and areas of loamy and clayey land that were not classified by soil series. The non-classified areas are generally located along Swan Creek and its tributaries, which extends across the northcentral portion of the site from west to east, and also includes the dredge disposal area located in the northeast corner of the site. Within the diked placement area, natural wetland soils beneath the 20-foot-high pile of dredged material show evidence of significant settlement, apparently resulting from the higher loads associated with the dredged material.

2.10.8.c Surface Water and Wetlands. There are two extensive wetland areas at the CSX site. These areas are located along Swan Creek and within the dredged material placement area (Areas B and E). These wetlands comprise approximately 60 acres and 32 acres, respectively. In addition, another small wetland area which is only 0.1 acre in extent, is located to the north of Swan Creek in the western portion of Area A. The majority of Area E (the diked containment area) is not a jurisdictional wetland and will not require a permit. However, some of the lower-lying wetlands in Area E are considered jurisdictional wetlands and will require issuance of a permit prior to being filled.

2.10.8.d Floodplain. Much of the CSX site is located within the area identified by Flood Insurance Rate Maps (FIRM) as a 100-year floodplain. All of the diked material placement areas, with the exception of the dike itself, is located within the limits identified as Zone A or within areas subject to a 100-year flood, with flood hazard factors not determined. In addition, Swan Creek, its tributaries, ponds, and wetlands are also within the 100-year floodplain (Zone A). Higher areas to the north and south of Swan Creek, as well as the dike and the gravel road along the top of the dike, are considered areas of minimal flooding (Zone C). Several small areas bordering the wetlands are considered subject to minimal (depths less than 1 foot) flooding during a 100-year flood (Zone B).

2.10.8.e Environmental Testing. Tests were conducted in 1992 by Woodward-Clyde Consultants and used to evaluate environmental conditions at the site. Information gathered and tests conducted included a review of site history, geologic and hydrogeologic information; a site reconnaissance; soil sampling and chemical analysis; groundwater monitoring, well installation, sampling, and chemical analysis; geotechnical soils analysis for the dredged material disposal area; and a preliminary wetlands assessment. Analytical results of the soil samples collected include Priority Pollutant metals as well as cyanide, barium, manganese, and vanadium. The Priority Pollutants include antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc. The data from the CSX soil samples were compared to the proposed RCRA action levels at that time. Twelve out of the 27 soil samples indicated beryllium concentrations ranging from 0.57 to 2.3 mg/kg compared to the proposed RCRA action level of 0.2 mg/kg. It is important to note that the proposed 0.2 mg/kg RCRA action level has not been finalized. Reported beryllium concentrations in USA soils ranges from <1.0 to 7.0 mg/kg; beryllium concentrations in Maryland soils are somewhat lower - <mdl to 3.0 mg/kg. While almost half of the samples did exceed the proposed action level, all samples were within the range of beryllium concentrations that occurs naturally in Maryland soils. Beryllium was not a target analyte in the COE's 1994 field investigation of potential sediments to be dredged. The levels of arsenic, barium, cadmium, chromium, lead, nickel, selinium, silver, and zinc for the proposed dredged material were less than, or equal to the range of metals identified in the 1992 soil tests. Bis(2-ethylhexyl)phthalate (350 μg/kg) was the only target semivolatile organic compound found in the 1992 study of the soil at the CSX site and was below the proposed RCRA action level of 50 mg/kg. It was also identified in the soil tests for proposed dredged material (1.39 mg/kg), but was determined to be below the action level. Results from the tests performed do not indicate the presence of contaminants in amounts or under circumstances that would require removal or remediation under current regulations.

2.10.8.f CSX Site Vegetation. The majority of the 218-acre CSX site is vegetated with a diverse and locally dense community of trees, shrubs and ground cover. Areas of ponded water and marsh are found primarily across the center of the site along Swan Creek. A brief description of the vegetation at the site is given. Area E is the area proposed as the placement site. For the areas described, see Figure 2.11.

Area A is located to the south of Kembo Road and north of the open water and tidal marsh area along Swan Creek. The area consists primarily of a deciduous upland forest that contains evidence of prior disturbance in the eastern third. Dominant species observed in the tree, sapling and shrub layers include sweetgum (*Liquidamber styracidua*), red oak (*Quercus rubra*), white oak (*Quercus alba*), chestnut oak (*Quercus prinus*), and black oak (*Quercus velutina*). Other species identified within the sapling and shrub layers include red maple (*Acer rubrum*) and black cherry (*Prunus serotina*). Within the disturbed portion of Area A, black locust (*Robinia pseudo-acacia*), witch hazel (*Hamamelis virginianca*), Hercules club (*Aralia spinosa*), Japanese honeysuckle (*Lonicera Japanica*), and common greenbrier (*Smilax *rotundifolia*) can be found.

Area B is comprised of the open water and tidal marsh areas located along Swan Creek. The dominant vegetation includes common reed grass (*Phragmites australis*), water willow (*Decodon verticullatus*), and cattail. A greater diversity of emergent wetland species occurs along the southern edge of the area. Some sweetgum, black cherry, and silver maple trees (*Acer pennsylvanicum*) and saplings were observed near the edges of this area, and black gum was found growing in standing water at one location. American holly saplings and shrubs, and common greenbrier were also found near the edges of Area B.

Area C is located along the east side of the railroad tracks and west of Area B. Vegetation dominating the fill materials included common reed grass, honeysuckle, staghorn sumac (*Rhus glabra*), and unidentified grasses. The forested area is dominated by red maple and sweet gum in the tree and sapling layers, American holly and Hercules club in the shrub layer, and greenbrier in the herb layer. A dense stand of Virginia pine (*Pinus Virginiana*) is found near the center of the forested area.

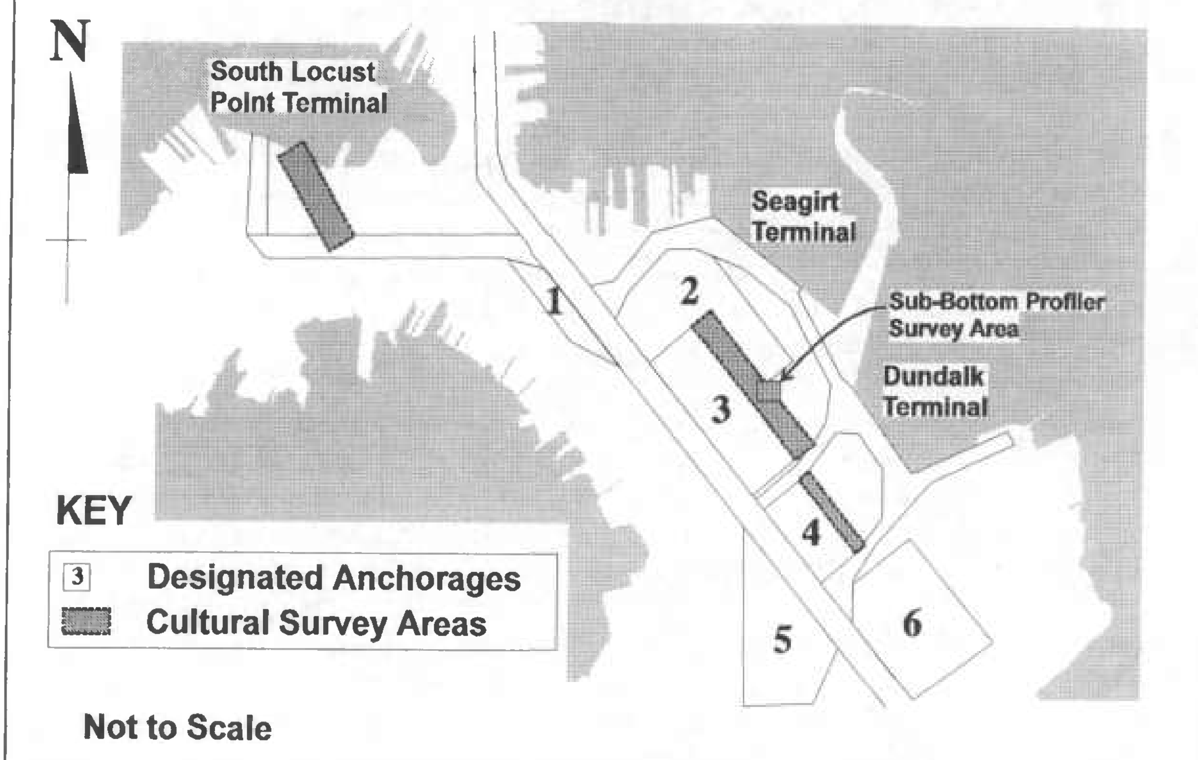
Area D is located to the south of the open water and tidal marsh along Swan Creek and north of the southern property boundary. This area consists primarily of a deciduous upland forest with evidence of prior disturbance in the eastern third and to the south of Brandon Shores Road. The disturbed area extends eastward to the remnants of beach homes that were located on a bluff overlooking the Patapsco River.

Dominant vegetation throughout Area D includes chestnut oak, southern red oak, black oak, willow oak (*Quercus phellos*), and sweetgum in the tree and sapling layers. Some black cherry and red maple also occur in the sapling and shrub layers. Previous cutting and clearing in the disturbed area is evidenced by numerous stumps and a predominance of sapling and shrub size vegetation. Within the disturbed area Virginia pine, sweetgum, and red maple are dominant in the tree layer, and black cherry, southern red oak, red maple and sweetgum dominate the sapling layer. American holly, greenbriar, and honeysuckle are also found throughout Area D in the shrub and herb layers, though they were more prevalent in the disturbed area.

Area E includes the dredged material placement area located in the northeast corner of the site. Vegetation in Area E is almost exclusively common reed grass with some cattails in the ponded areas.

2.10.8.g Cultural Resources at the CSX site. The 72-acre CSX diked placement area is located on an area identified in pre-1970 maps as a tidal flat. The area was filled with material dredged from harbor navigation channels. For that reason, it is expected that no cultural resources are located within the diked placement area.

Figure 2.12
Cultural Survey Sites



An archaeological investigation which included the 66 wetland acres on the CSX site was completed in 1981. The focus of the investigation survey was for a proposed 31-acre upland placement site located near Fort Smallwood Road and between Kembo and Brandon Shores Roads. The proposed placement site was located at the headwaters of Swan Creek, east of the creek and its wetlands. The area investigated extended beyond the proposed 31-acre placement site to include the entire Swan Creek area: the creek, its tributaries, and connected ponds and wetlands.

As part of this Feasibility Study, the Baltimore District conducted an initial information needs assessment for compliance with Section 106 of the NHPA. This information assessment consisted of the review of existing site location documentation for the dredged material placement sites on file with the MSHPO.

The Swan Creek project area has a high potential for prehistoric and historic cultural resources. The Patapsco River watershed was intensely occupied by Native American population groups, especially during the Woodland phases. The riverfront environments particularly suited their lifeways, a combination of agriculture and harvesting for shellfish. Prehistoric occupation of the project area is expected, due to the ecosystem of the Patapsco River, Swan Creek, and adjacent wetlands.

Historically, the Patapsco River waterfront experienced development as early as the late 17th century. The earliest settler of the land just south of Swan Creek was a John Hawkins, who established the "Boleal Monack" Plantation there in 1667 or 1668. The occupation of this area as one or more estates continued through the 19th century. One farmhouse, the Louisa Hancock farm, is illustrated in the 1878 atlas of the county. By the early 20th century, soon after the construction of the Marley Neck Branch of the Baltimore and Ohio Railroad, a summer community was constructed along the Marley Neck shoreline. This community consisted of small summer cottages, outbuildings, piers, and other structures. The entire community was razed about 1980 after the Marley Neck property was purchased by the B&O holding company.

Previous cultural resources investigations were conducted within this property, at which time small lithic scatters, foundations to a historic still, and an unrecorded shell midden were discovered. Of the known sites within the project area, the Maryland SHPO determined that several sites (sites identified as 18An507, 509, and 510) are not eligible for listing to the National Register (Little 1981). However, prehistoric site 18An508 represents a potentially eligible site.

Site 18An508 is located within the boundaries of the CSX property acquired for this project; however, the site is located outside of the diked dredged material placement area and outside of the Swan Creek wetland complex. The site is located on a peninsula of higher ground that juts into the wetlands on the south side of Swan Creek.

This area is included in the approximately 77 acres that may be used for operations and personnel during placement activities; therefore, if further design indicates that this site may be impacted, it is recommended that cultural resources investigations are conducted to determine the nature and potential eligibility of prehistoric site 18An508. Coordination with the Maryland Historic Trust should be conducted prior to and after any cultural resources investigations have been conducted.

2.10.9 Cox Creek Placement Site

2.10.9.a Location and Physiography. The Cox Creek site is also located adjacent to Foremans Corner in Anne Arundel County, Maryland, and is approximately 1 mile south of the Key Bridge. The site is adjacent to and immediately north of the CSX Site. Kembo Road forms the boundary between the CSX and Cox Creek sites.

The Cox Creek Lagoon Property, as it is formally known, is a 61-acre parcel and roughly triangular in shape. In addition to Kembo Road on the south, the site is bordered on the west by the Cox Creek Plant Property and on the east by the Patapsco River. The site is surrounded by dikes that were constructed to a height of 15 feet MLLW. The site was originally developed in the mid-1960's; however, it has not been actively used as a placement site since that time. It is estimated that the site currently has the capacity to contain 200,000 cubic yards of dredged material.

2.10.9.b Geology and Soils. Soils at the site are sediments which were placed during the original construction of the site and dikes and are typically saturated. Soils in the western portion of the site include a layer of black organic silty clay, that is approximately 15 feet thick. The layer of silty clay is presumed to be dredged material. Below the silty clay is a layer of tan-white or red-white clays, which are about 3 to 6 feet thick. Soils in the eastern portion of the site consist of a layer of medium to fine sand, approximately 15 feet thick and also presumed to be dredged material, which is underlain by a clay and silt matrix.

2.10.9.c Surface Water and Wetlands. Roughly 15 acres of the property is occupied by an existing lagoon or pond. The lagoon receives water in the form of precipitation and storm water run off from the Cox Creek Refining Company, which is adjacent to the Lagoon Property on the west side. The lagoon is not open to tidal interaction. The lagoon is served by a permitted spillway for release of storm water runoff into the Patapsco River. A preliminary determination by the COE's Regulatory Branch indicates that the local sponsor may be required to obtain permits from the COE and the Maryland Department of the Environment. Additional chemical analysis may be necessary to meet Federal Water Quality Standards and other non-Federal standards. A more thorough delineation of wetlands will also need to be performed by the local sponsor prior to permitting. Clean Water Act 404 (a) will be required for the local sponsor; however to aid in overall analysis,the COE's NEPA document will address discharge of dredged material in the CWA 404(b)(1) analysis. Although the Cox Creek and CSX sites were previoulsy used for the placement of material, these areas were considered waters of the United States prior to placement and discharge was authorized under either the Federal Water Pollution Control Act or the Clean Water Act. As long as these sites were being used Clean Water Act Section 404 permits were not needed. Once the sites were abandoned and no longer used for the placement of dredged material the sites reverted back to waters of the United States and are not now exempt due to lack of use of CWA Section 404 exemptions. The Cox Creek site contains Submerged Aquatic Vegetation (SAV) which makes the 404 evaluation more stringent.

Low lying vegetated areas not connected with the pond or greater than the maximum high water of treatment system are probably waters of the United States and may require a permit. Placement of dredged material in the ponded lagoon area will be covered under section 404(b)(1) of the Clean Water Act. Re-routing the existing permitted spillway to an outfall into the Patapsco will be covered under Section 402 of the Clean Water Act, a permit from MDE may be required prior to that action.

2.10.9.d Floodplain. Most of the Cox Creek Site is located within the 100-year floodplain, identified as Zone A in the FIRM. Higher areas, including the dikes surrounding much of the placement area, are considered areas of minimal flooding (Zone C). A small area between the placement site and the constructed dike is considered Zone B and is expected to have less than 1 foot of flooding during the 100-year event.

2.10.9.e Environmental Testing. Tests similar to those conducted at the CSX site were done in 1994 by EA Engineering, Science, and Technology to evaluate environmental conditions at the Cox Creek site. Analytical results of the soil samples collected at the site included Priority Pollutant metals as well as cyanide, barium, manganese and vanadium. Priority Pollutants include antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc. The data from the Cox Creek soil samples were compared to Risk-Based Concentrations (RBCs) that had been developed by the EPA Region III office. The RBCs represent the concentration of a particular chemical in soil, using a standardized exposure scenario, that corresponds with an unacceptable human health risk under the most likely future land use. Anticipated future land use for the facility was identified as industrial/ commercial, which includes soil ingestion and inhalation of soil particulates. Beryllium concentrations in two samples exceeded the RBC in two samples. However, the exceedences appear to be minimal and the samples were collected from 8 feet and below grade, indicating that exposure to these soils would likely be minimal. While the RBC is higher than the proposed RCRA action level of 0.2 mg/kg (ppm), it is still lower than the mean concentration of beryllium insoils of the eastern USA (0.85 mg/kg) and the mean concentration of beryllium in soils of the conterminous USA (0.92 mg/kg). Beryllium concentrations measured in the Cox Creek site are consistent with naturally occurring concentrations of beryllium in Maryland soils.

No other metal concentration were detected in the CCRC lagoon property samples that exceed RBC values Semi-Volatile Organic Compound (SVOC) analytical results of five samples indicate the concentration of benzo(a)yrene in the duplicate sample exceeded the RCC value. The sample was collected at 6 - 8 feet. The depth of this soil indicates that potential exposure to this soil is not likely. Lead concentrations ranged from 3.3 - 144 mg/kg. None of the concentrations which do not exceed the EPA OSWER directive for lead in soil. Zinc concentration ranged from 6.7 - 370 mg/kg. The concentrations do not appear to present a significant environmental concern at this time. Cyanide and Volatile Organic Compounds (VOCs) were not detected in any of the soil samples were taken at the site. As there are currently no U.S. EPA or state sediment quality criteria, the measured sediment concentration were compared against several sets of guidelines that have been developed by various government agencies and researchers. Based upon this very small data set, sediments appear moderately contaminated by metals. No VOC, SVOCs or cyanide concentrations were detected in the two sediment samples.

Test results show that VOCs, SVOCs, and cyanide concentrations were detected in the surface water samples on the property. The concentration of dissolved copper and nickel in the lagoon were found to exceed applicable surface water levels permitted by environmental regulations. In addition, the reporting limit for dissolved mercury is above the salt water chronic value. The test results of the Corps 1994 study indicate that levels of existing contaminants on the Cox Creek property are greater than the levels of contaminants in the proposed dredged material.

2.10.9.f Cox Creek Site Vegetation. A variety of cattails, phragmites, and other wetland plants vegetate the edges of the existing 15-acre lagoon on the Cox Creek property. The remaining 45 acres exhibit marsh-like wetland conditions and are vegetated predominantly with phragmites. The predominance of phragmites results in the site being considered a low-quality wetland.

2.10.9.g Cox CreekCultural Resources. The 61-acre Cox Creek diked placement area is located on an area identified in early maps as a tidal flat. For that reason, no cultural resources are expected in the material placement area.

2.10.10 Hart-Miller Island (HMI) Dredged Material Placement Site

Since 1984, Hart-Miller Island has been used for placement of dredged material removed from Baltimore Harbor. The site was expected to reach its capacity, be capped with clean material, and stop accepting any additional material by the year 2000. Construction is currently underway, however, to raise the dikes on the North Cell of the island to 44 feet MLLW. This would provide 30 MCY at an approximate placement rate of 2.5 MCY per year. This additional capacity will allow for containment of all the initial construcion material from the Baltimore Harbor Anchroages project. After the north cell reaches capacity it will be capped with clean material and developed to provided recreational opportunities and habitat. The permit issued by the Baltimore District of the Corps of Engineers for the original construction of HMI stipulates that: "Provision shall be made for a park combining intensive recreational facilities, low intensity use areas, open green space areas, and fish and wildlife recreational areas. Consideration shall be given to possible cultural activities on the site. As part of the open space concept, productive marshes shall be included within the project area."

2.10.10.a Location and Physiography. Hart-Miller Island is located in the Upper Chesapeake Bay, north of the mouth of the Patapsco river. The site is approximately 13 miles due east of Baltimore City, near the mouth of Back River in Baltimore County. HMI has approximately 6 miles of stone dike and is an oval approximately 2 miles long and 1 mile wide (see map xY). Construction of the placement site began in 1981 and the dikes were raised to +18 ft high at MLW by 1984. The original 18 foot high dikes were raised an additional 10 feet to a height of 28 feet above MLW during the fall of 1988 to provide additional capacity for the expedited completion of the 50' Deepening Project. The 1140 acre oval placement site has stone dikes 28 feet high and holds approximately 62 million cubic yards of dredged material. As operations began in May 1984, cost-sharing legislation for the 50' project, the primary reason the site was constructed, was tied up in Congress. As a result approximately 16 mcy of clean material were placed in the facility from other navigation projects crucial to keeping the Port of Baltimore viable, before the 50' Project could be initiated. The site has been divided into two cells. The south cell crust management and grading program has been underway since October, 1990 to prepare a foundation for recreational development. To facilitate restoration of the approximate 300 acre south cell, a 10 ft. surface layer of clean sandy material has been placed at the surface of the cell.

Structures include a sand dike at +18' elevation above MLW, 164' wide at MLW, with 3-1 outer slopes, and 5-1 inner slopes. The dike has a 20' roadbed on top, with bay side slopes protected by revetment consisting of filter cloth on the sand dike, covered by a layer of gravel, which is covered by a layer of riprap weighing up to 8,500 lbs. per stone. The +28' raised portion of the dike has 2-1 outer slopes, 3-1 inner slopes, with a 10' roadbed on top.

There is a primary and secondary unloading area on the bay side, with mooring dolphins and barge unloader slot. The primary area has an operations building complex with laboratory, equipment storage and repair facilities and a crane pier. Unloading operations may also be carried out at other locations along the bay side perimeter of the facility, provided an operations plan is approved by Maryland Environmental Service (MES) and MPA.

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2.10.10.b <u>HMI Geology & Soils</u>. The Maryland Geological survey has completed an extensive review of the geological history of Hart and Miller Islands. The following are excerpts from their memoranda on the subject as quoted in the 1976 FEIS:

> *"A generalized theory for the origin of the islands is that the islands are erosional remnants of a Patapsco river neck extension. It is safe to assume that the islands were a peninsula extending out into the mouth of Back River with time, the daily activity of waves and currents eroded the peninsulas at different rates, maximum erosion at weak points and minimum erosion at strong points. The sub-surface geology of the islands indicates a clay lens approximately 60 feet thick with surrounding and underlying sands and gravels".*

2.10.10.c <u>HMI Hydrogeology</u>. Water depths adjacent to Hart-Miller Island average 15 feet. Water is brackish with salinity ranging from 8-15 ppt.

2.10.10.d <u>Surface Water and Wetlands</u>.

2.10.10.e <u>Floodplain</u>. The HMI site is within the 100 year floodplain.

2.10.10.f <u>Environmental Testing</u>. Environmental monitoring at the facility has been on-going since before construction began in 1981. There are several different environmental permits which control the operations. Information on permits is given below. The number of state and Federal agencies administering permits require that the owners and operators of HMI expend every effort to ensure that operation of the facility be conducted in an environmentally sound manner.

A State Discharge Permit, issued by the Maryland Department of the Environment, controls and regulates the quality of effluent discharged from the facility and sets monitoring requirements. This permit has been modified to permit raising of the dikes to 44 ft.

Each of the five outfalls at HMI is permitted as a point source discharge, with monitoring requirements and discharge limitations of pH, Total Suspended Solids and five metals. In the first seven years of operation, there were a total of 10 violations of discharge permit limits. None of these violations have been for toxic parameters. No violations have occurred since 1991.

There are additional monitoring requirements for one specific outfall which requires the analysis of over 120 other potential contaminants on a quarterly basis. This quarterly monitoring is also repeated in adjacent bay waters. Aquatic toxicity testing of the effluent is performed every six months.

A Wetlands License issued by the Board of Public Works sets guidelines for development into a recreational area and requires monitoring of the effects of operations on the environment and resources outside of the facility. This permit has been modified to permit raising of the dikes to 44 ft. This monitoring is performed by principal investigators from the University of Maryland and the Maryland Geological survey under contract to the MPA. The monitoring efforts are supervised by DNR.

The Wetlands License also requires that the operator monitor wells in the dike of the facility. This is done on a monthly basis and is reported to the HMI Technical Review Committee.

An Army Corps of Engineers Construction Permit contains requirements and oversight provisions for construction and development activities on the site. Corps personnel also perform inspection duties during Federal projects to ensure operational requirements such as freeboard limitation (maintaining two feet separation between the slurry elevation and top of the dike) are enforced. This permit has been modified to permit raising of the dikes to 44 ft.

A Water Quality Certification, issued by the Department of Natural Resources on 1975 (now regulated under the Maryland Department of the Environment), ensures that construction and operations are performed in accordance with the Corps of Engineers approved plans and Maryland Water quality standards. This includes providing adequate sediment erosion control, prevention of fuel spills into the waterway, and development of crust management techniques and a water quality monitoring system.

A Water Appropriations Permit, issued by the Department of Natural Resources, allows withdrawal of water from the Chesapeake Bay. In the case of Hart-Miller Island, water is used by hydraulic unloaders during inflow of dredged material and at dredging sites where hydraulic dredges are utilized. Semi-annual reports are submitted on water used during the previous 6 months.

2.10.10.g HMI Vegetation. Pines, sycamore, and maple have been planted around the dikes as has coastal panic grass, Blackwell switch grass, and weeping love grass. The dredged material at HMI has not been fully dewatered. Common Reed (Phragmites australis) which colonizes disturbed soils is established at HMI. Phragmites is not considered good habitat because of its thick underground and aboveground growth. It provides cover but little food resources. Phragmites control measures have been undertaken by MPA.

2.10.10.h HMI Cultural Resources. Cultural investigations for Hart-Miller Island were conducted for the preparation of the Main Report and Environmental Statement for the Baltimore Harbor and Channels, Maryland and Virginia completed in August 1981 by the USACE Baltimore District. In a letter dated June 26, 1996, the Maryland Historical Trust has indicated that no further aquatic cultural investigations are necessary for Hart-Miller Island. Cultural investigations have indicated that use of the site would produce no significant adverse impacts to cultural resources.

2.10.10.i HMI Terrestrial Resources. Mammals have not been encouraged by the deliberate creation of mammal habitat. Mammals at Hart-Miller include: Red Fox, Muskrat (Hart Island), Raccoon, occasional white-tail deer, and field mice. Reptiles reported at the site include: Water snakes (Natrix (sp.), black rat snake (Elaphe obsoleta), and snapping turtle (Chelydra serpentina).

2.10.10.j HMI Avian Resources. In the northern portion of the Chesapeake Bay, one of the most limited avian habitats is shallow water habitat for wintering waterfowl and shallow water and mudflat habitat for migrant shorebirds. Over the years the Hart-Miller complex has proven to be a significant provider of this type of habitat. At times during operation of this facility, as many as 20,000 waterfowl have been observed using the facility. There has been significant nesting and nursery type activities, which, with some operational variation and difficulty, were protected from operational impact. The mudflats and ponds at the site are a valuable resource for shorebirds. HMI has attracted over 235 observed species, including great blue heron, Canada geese, northern pintail, blue-wing teal, northern shoveler, canvasback, scaup, mallard, ruddy duck, and others (Ringler 1992). The Maryland Ornithological Society has stated that the facility at times has supported the largest single concentration of waterfowl in the mid- Atlantic Region. Birds identified from 1977-1991 are in Appendix B. A colony of approximately two dozen Great Blue Herons is reported at Hart Miller state park. Occasionally a Bald eagle is sighted, but no eagles are known to nest at Hart Miller. Barn owls, Ospreys, and Whet owls have been identified.

Common avian resources at HMI include: herring gull (*Laurus argentatus*), song sparrow (*Melospiza melodia*), red-wing blackbird (*Agelaius phoeniceus*), great blue heron (*Ardea* *herodias*), green heron (*Butorides striatus*), Carolina wren (*Thryothorus ludovicianus*), American crow (*Corvos brachrhynchos*), starling (*Sturnus vulgaris*), common grackle (*Quiscalus quiscula*), house sparrow (*Passer domesticus*), slate colored junco (*Junco hyemalis*), and white throated sparrow (*Zonotridia albicollis*).

2.10.10.k HMI Aquatic Ecosystems. HMI provides habitat by providing about 19,000 feet of reef-typed habitat for the attachment of algae, seaweed, and crustaceans. The site is not a recognized spawning or breeding ground for commercially important or unique fish or shellfish although the outfalls are popular fishing areas. Fish inhabiting the project area are shown in Table 2.4.

Benthos - The HMI Exterior Monitoring Technical Review Committee (TRC) reported to MPA in January 1996 based on annual monitoring performed for 14 years at Hart Miller Island that there has been no significant observed impact to the benthic community and benthic populations. Stations in the area that are considered zinc enriched areas did not appear to differ from populations observed in the original nearfield and reference stations. MDE also states that elevated levels of zinc are reported baywide. The HMI TRC also reported that a fluid mud layer was created as a result of the initial construction of the HMI perimeter dike. The mud layer was observed to extend from 525 to 1090 yards from the perimeter of the facility. Changes in the benthic biota accompanied the occurrence of this mud layer. However, recovery of the benthic population was observed in subsequent years.

Table 2.4
Hart-Miller Island Fish Species List

Beach Seine

Bay Anchovy	Northern pipefish
Menhaden	Grass shrimp
Atlantic silverside	Blue crab
Tidewater silverside	Pumpkinseed
Banded killifish	Gizzard shad
Striped killifish	Yellow perch
Spot	Striped bass
White perch	Needlefish
Brown bullhead	

Offshore

White perch
Bay anchovy
Blue crab
Spot
Harvestfish
Striped bass

2.10.10.1 HMI Recreation. The 1976 EIS states that the Hart-Miller Island project will be used for recreation. The Hart-Miller State Park is a well recognized and appreciated State recreational facility, as evidenced by the presence of approximately 1,000 boats from which visitors enjoy the beach on any given summer weekend. On the Back River side of the facility, a 3,000 foot beach connecting the Hart and Miller islands is maintained as a public park by the Maryland Park Service. Additionally, fishing is permitted around the bay side perimeter of the dike, with the exception of dredged material unloading areas. Recreational projects completed include beach nourishment, first-aid and comfort stations, and a boardwalk on Hart island. The state has initiated a feasibility study for long term recreational development of the approximately 300 acre south cell. The Corps of Engineers Waterways Experiment Station (WES) and the Baltimore District have developed a conceptual plan for the development of the south cell.

2.11 Project Area BIOLOGICAL RESOURCES

The biological resources in the Baltimore Harbor area have been reduced over the years. The wide variety of pollutants released into the harbor by extensive industrial development in the area and port-related activities have had a severe impact on the biota in the harbor. Few mollusks and crustaceans can be found in the area, and no oyster bars are known to exist in the harbor today.

2.11.1 Project Area Benthic Resources

Currently, the benthic macroinvertebrate community in Baltimore Harbor is substantially poorer in biomass and species diversity compared to historical conditions and to other areas in the Chesapeake Bay. The layer of fluid mud which exists in most of the project area constitutes a poor substrate for many benthic species. In addition, the material, as well as the organisms which might be expected to live in it, is easily disturbed by the harbor traffic and related activities. The benthic communities that survive in the project area are not well developed and are comprised of mainly pollution-tolerant species.

A 1975 study found that tubiflex worm, an indicator of pollution, was fairly common in the harbor, but that crustaceans and mollusks were scarce. The low biomass and diversity of benthic organisms indicate that conditions in the area can be characterized as semi-polluted to polluted.

A 1983 study of the benthic community found that diversity declined from the mouth of the harbor to the head. The benthos consisted mainly of ephemeral, surface-dwelling opportunistic species in the region of the anchorages, while longer-lived, deep-dwelling species were absent. Annelids, marine worms that live in sediments closest to the surface, comprised over 90 percent of the benthic community. The study found that larvae of the common Baltic clam (Macoma balthica) settled in the project area in large numbers; however, they did not survive to achieve significant growth.

The condition of the benthic habitat in the harbor varies greatly. These variations are reflected in the condition of benthic communities which are degraded but improving.

2.11.2 Project Area Wetlands

The tidal wetlands that once occupied 3 square miles of the harbor area have been virtually eliminated by industrial and commercial development, reducing the quality of environmental resources in the area. Polluted discharge and runoff from land activities has degraded the overall water quality as well as the bottom habitat. The remaining wetlands in Baltimore Harbor consist primarily of patches of phragmites reed, which are less valuable to fish and wildlife than historic marshes.

2.11.3 Project Area Aquatic Resources

A number of resident and migratory fishes inhabit Baltimore Harbor. White perch is the most abundant species, with large numbers of both adults and juveniles present. Current abundance of all species in Baltimore Harbor is dramatically reduced. There are very few bottom-dwelling species present, and there is a high occurrence of diseased fish.

It is expected that the low numbers and diversity of finfish in the project area is partly a result of the water quality problems and degraded benthic habitat. Anadromous species, particularly alewife (Alosa pseudoharengus) and blueback herring (A. aestivalis) migrate through the Patapsco estuary en route to and from spawning areas in the upper non-tidal section of the river. Other anadromous and resident fishes found in Baltimore Harbor include white perch, anchovy, hogchoker, and silversides; the blue crab (Callintectes sapidus) is a common shellfish.

In an effort to increase the amount of spawning habitat in the Patapsco River and potentially increase the number of fish utilizing the river, an anadromous fish passage restoration plan is being implemented. As part of this plan, the Patapsco has been stocked with alewife and blueback herring to help reinvigorate the spawning run.

Surveys performed by the EPA have indicated that there is no submerged aquatic vegetation in the project area except for the small amount of SAV at the Cox Creek lagoon.

2.11.4 Project Area Avian Resources

The United States Fish and Wildlife Service (USF&WS) reports the existence of two waterbird nesting colonies near the harbor. An established colony of black-crowned night herons (Nycticorax nycticorax), consisting of approximately 350 breeding pairs, nest at Sollers Point near the northern end of the Francis Scott Key Bridge. This is approximately 6,000 feet from the nearest proposed dredging site and 9,500 feet from the CSX and Cox Creek placement sites. Approximately 500 pairs of herring gulls nest at a site on Sparrows Point. Additionally, a variety of waterfowl species winter in the harbor area. These include mallards, scaup, bufflehead, goldeneye, ruddy duck, canvasback, Canadian geese, and black duck.

2.11.5 Project Area Rare, Threatened, and Endangered Species

The USFWS identified two Federally listed endangered species in the Baltimore Harbor area. Peregrine falcons have been consistently observed nesting in downtown Baltimore at the Inner Harbor. A pair of falcons nests less successfully on the Key Bridge. Their diet generally consists of pigeons, but they occasionally will prey on various waterbirds. A bald eagle nest site is located in the vicinity of Black Marsh near the mouth of Back River. Black Marsh is approximately 7 miles from the project area. Bald eagles feed primarily on fish, however, neither species is expected to be affected by the proposed project.

2.12 Project Area HAZARDOUS, TOXIC, AND RADIOACTIVE SUBSTANCES - HTRS

Port-related activities which handle or store hazardous materials, including oil, chemical, coal, steel, and ore companies, have the potential to release HTRSs into the harbor during transfer operations or material handling, such as off-loading of fuel oils from tankers, lightering of cargo, and bunkering.

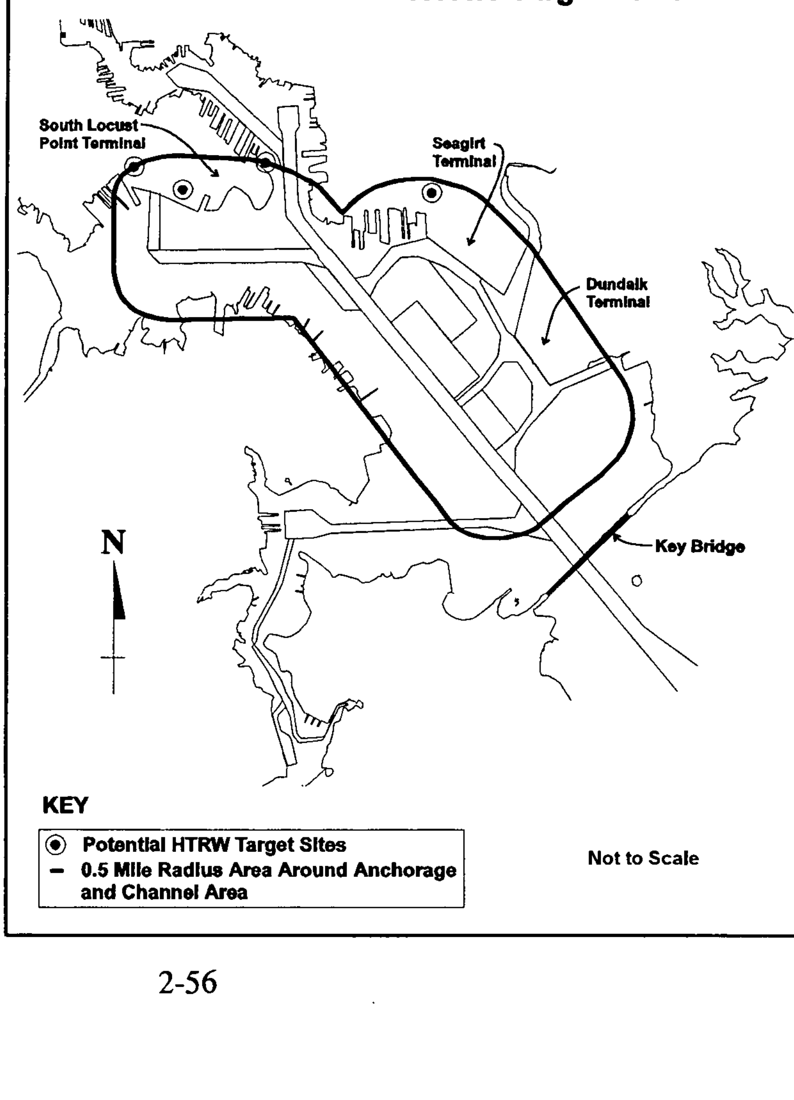
Corps regulations require documentation of the existence of Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) and National Priority List (NPL) sites within the boundaries of a proposed project which could impact, or be impacted by, the presence of HTRS contamination. COE regulation ER 1165-2-132 provides that dredged material and sediments beneath navigable waters proposed for dredging qualify as HTRS only if they are within the boundaries of a site designated by the EPA or a state for a response action, such as removal or remediation under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA).

Information about chemical contamination in Baltimore Harbor sediments was collected from several sources. These include a search of Federal and state environmental databases, and a field investigation. Data supplied by the MDE identified 71 CERCLIS sites in Baltimore and Anne Arundel Counties, none of which was within 0.5 mile from the project area. A second database search, conforming with the American Society of Testing Materials (ASTM) standards and including access to 13 databases, confirmed that no CERCLIS or NPL sites were reported within the project area or within a 0.5 mile radius around the project area. The second analysis covered records for environmental permits, underground storage tank registrations, hazardous material spill incidences, PCBs, violations under the Resource Conservation and Recovery Act (RCRA), toxic release inventories, and sites that generate, transport, store, treat, and/or dispose of hazardous waste. Over 600 entries were identified within a 3-mile radius of the center point of the project area.

Four potential environmental target sites were identified to be within or touching the 0.5-mile boundary around the study area. Two of the four potential environmental target sites are within 0.5 mile of the study area boundary and are identified as having multiple facilities at one location (Figure 2.13). One site is located within the study boundary just north of the Seagirt to Dundalk study area; the second is within the study boundary and located just north of the Ferry Bar Channel. In addition to the two sites located within 0.5 mile of the study area, another two sites are located just outside, but touching the 0.5-mile boundary area. Each of these two sites represents two separate potential environmental target sites and both sites are located north of the Ferry Bar Channel study area. Based on the information provided in the database search, it does not appear that any of these four sites represents environmental hazards.

In addition to the database search, a field investigation was performed in April 1994 by the COE. The purpose of the investigation was to measure levels of contaminants in the project area. See Figures 2.7 - 2.9 for sampling locations.

Figure 2.113
HTRW Target Sites



All samples were collected in accordance with EPA and COE regulation ER 1110-1-263 - Chemical Data Quality Management for Hazardous Waste Remedial Activities. Samples were analyzed in accordance with EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846. Quality assurance samples were analyzed by the Corps of Engineers, New England Division Environmental Laboratory. See Appendix D for a copy of the Workplan for Environmental and Geotechnical Investigations. The results of chemical testing indicate that all samples did not exceed Federal and State hazardous waste (Toxicity Characteristic Leachate Procedure - TCLP) limits. See Appendix F - Chemical Data Results for a copy of the chemical test results.

2.12.1 HMI HTRS

A 1996 search of Federal and state environmental databases for CERCLA and RECRA sites was performed by the Baltimore District for the HMI area. The results of the search indicate that there are no RECRA or CERLA sites in the HMI area.

2.12.2 CSX/Cox Creek HTRS

The containment areas at the placement sites were created from dredged material excavated from Baltimore Harbor and navigation channels. The material currently contained in the dredged material placement site is not considered HTRS. The results of the sample tests and borings of surface water, ground water, and soils outside the diked containment area are contained in reports on the environmental conditions at each site. The report for the CSX site was prepared in 1992 by Woodward - Clyde; the Cox Creek report was prepared in 1994 by EA Engineering, Science and Technology. Both reports were prepared for the UIPA and are available for reference at:

U. S. Army Corps of Engineers
Baltimore District
10 S. Howard Street
Baltimore, Maryland 21201

2.13 PROJECT AREA NOISE AND ODORS

Noise in the harbor is generally that of a port and is caused by equipment on land and aboard ships. Noise is also produced by ships. In general the noise level in the harbor is not disturbing to animal or human users of the area

Activity at the CSX and Cox Creek dredged material placement sites is minimal and the sites are generally quiet; however, some noise has been generated by earth moving equipment during prior construction and dredged material placement activities. Noise generated at the sites is not considered a problem because of the somewhat isolated location of the sites, the industrial nature of the area, and the buffering distance to residential areas.

Noise at Hart-Miller Island originates from equipment on site and from boats using the site. Citizen concern regarding noise is based on noise from boats carrying project crews to and from the site. Tests indicate that the noise is within recognized safety levels.

Local citizens were apprehensive that the Hart-Miller Island project would create offensive odors that would be noticeable at their homes and residences. This has not been the case and MPA has indicated that it receives no complaints related to odors generated at the site.

2.14 PROJECT AREA CULTURAL RESOURCES

A literature review of the existing maritime history was performed for the Baltimore Harbor Anchorages and Channels Study project area. The search included a review of the Maryland Historical Trust files, COE Wreck Removal documentation, and Coastal and Geodetic and National Oceanic and Atmospheric Administration navigation charts. Approximately 80 individual wrecks and 10 ship graveyard areas have been recorded within the 45-mile Patapsco River estuary waterfront that encompasses approximately 13 square miles of water.

The study area has been assessed to determine its potential for significant submerged maritime resources and subsequently divided into areas of high, moderate, and low potential. A high potential area constitutes those areas of the Patapsco estuary where shipwrecks have been recorded, including the undisturbed shorelines and tributaries. A moderate potential includes the offshore portions of the estuary that have not been disturbed by previous construction; these areas also have a recorded history of shipwrecks. A low potential area constitutes those areas of the Patapsco estuary that have been disturbed by recent maritime related construction, including navigation channels, marine wharfs and terminals, ship yards, tunnels and military construction.

During the Reconnaissance Phase for this study, the Maryland State Historic Preservation Officer (SHPO) and the Corps determined that channel-deepening actions would not require cultural investigations, but that any widening actions would have to be subject to Phase I cultural investigations prior to construction.

The Baltimore District conducted Phase I cultural resource investigations of the portions of the study area identified in the reconnaissance report as areas of potential widening. This work was conducted to comply with Section 106 of the National Historic Preservation Act (NHPA).

The cultural investigations were conducted in a two-stage process. The first stage was intended to identify any magnetic anomalies that could constitute potential cultural resources. This Phase I survey was conducted in June 1994. In accordance with accepted techniques, this investigation consisted of: (1) the review of state site files to identify known cultural resources; (2) the review of historic and maritime records to identify the potential for shipwrecks and other cultural resources to be located within the project area; (3) the review of geotechnical data to evaluate the geological nature of the project area; and (4) the investigation of the project area through the use of a magnetometer and sub-bottom profiler. The survey sites are shown in Figure 2.12.

During the field investigation, magnetic anomalies with the potential to be a cultural resource were identified near the Dundalk Marine Terminal. However, the survey equipment was not able to provide a definitive identification of the nature of the anomalies. Due to the need to identify them, the Baltimore District continued Phase I investigations during August 1994, utilizing a highly-sophisticated CHIRPS sonar as indicated in Figure 2.12. This machine is a new type of sub-bottom profiler which is able to penetrate the dense sediments (liquid mud) in Baltimore Harbor. The CHIRPS sonar was able to definitively identify that the magnetic anomalies were not cultural resources, but deposited materials of recent origin. Due to the concern that the anomalies could represent closed barrels of hazardous materials, divers from Fort Eustis were summoned to identify the objects. In June 1995, the divers identified the anomalies as metallic debris and removed them. There was no sign of hazardous materials.

The project area has been highly disturbed by several centuries of harbor activities and development; no archeological resources have been found in the study area. Therefore, the Baltimore District determined that the proposed Baltimore Harbor Anchorages and Channels project will have no effect on cultural resources. Finalization of Section 106 work will be conducted prior to construction of the project, and will consist of the transmittal of the draft and final reports of the investigations to the Maryland SHPO.

2.15 PROJECT AREA AESTHETIC RESOURCES

The visual experience in the project area is typical of commercial/industrial ports. Many container vessels, tankers, bulk carriers, general cargo vessels, and other large commercial vessels use the anchorages and other port areas that will be dredged as part of the project. There is general and constant activity as large vessels arrive and depart and many smaller commercial vessels move around the harbor and anchorage areas. The existing visual impact is one of a working harbor area.

The CSX and Cox Creek placement sites are not considered a significant aesthetic resource. They are in an industrial area and parts of the sites have been used for dumping trash and household appliances illegally. The actual appearance of the placement sites will be disrupted during construction and future maintenance operations. The long term impacts are likely to be positive once the placement activities are terminated and vegetation is reestablished.

Prior to construction of the Hart-Miller facility, citizens were concerned about the potential impact the project could have on aesthetic resources in the project area. Concerns were expressed regarding the blocking of views and in the impact of the project on aesthetics resources in the area. This issue is still a concern to citizens and citizens groups. To make the site more attractive, the MPA is committed to planting and landscaping.

2.16 PROJECT AREA RECREATION RESOURCES

The recreational setting in the Port of Baltimore is generally limited to boating-related activities. Located only 12 miles northwest of the Chesapeake Bay, the Baltimore Harbor is attractive to recreational boating enthusiasts, both private boat owners and commercial recreation craft, and to commercial shipping agents. Recreational fishing activity occurs primarily in the outer regions of the harbor and in the Chesapeake Bay. Sport fish frequently sought within the Patapsco River area include white perch, channel catfish, striped bass, bluefish, and blue crab. Conflicts with commercial navigation are rare.

2.17 PROJECT AREA SOCIAL AND ECONOMIC RESOURCES

Since its founding in 1706, the Port of Baltimore has been a major impetus for growth and economic development. This influence has been, and continues to be, manifested not only at a local and regional level but at the national level as well. The Port of Baltimore's influence extends beyond the boundaries of the State of Maryland to the Midwest, north into the Canadian provinces, and beyond the Atlantic Coast to the port's European and Asian trading partners.

The Port of Baltimore is located in the center of the Boston-Atlanta Corridor on the Atlantic Seaboard. Maryland is the 19th most populous state in the nation and exhibits a per capita income that is the 5th highest in the nation. More than 80 percent of Maryland's 5.0 million residents live in the Baltimore-Washington corridor (1995 estimate).

2.17.1 Land and Water Use

The land surrounding Baltimore Harbor is highly developed. More than 43 percent of the defined area is industrial, and 7.5 percent is classified as commercial. Only 34 percent of the area consists of urban and residential land use. Water use is predominantly related to commercial shipping due to the extensive public and private port facilities and deep draft channel system. Other water uses include recreational boating and commercial fishing.

2.17.2 Population

In 1993, the Office of Management and Budget (OMB) designated the Washington and Baltimore Metropolitan Areas as the country's 4th largest Consolidated Metropolitan Statistical Area (CMSA), ranking behind only the New York-New Jersey CMSA; the Los Angeles-Riverside-Orange County CMSA; and the Chicago-Gary-Kenosha CMSA. Population statistics from the 1990 census indicate that the Washington-Baltimore CMSA had a total population of 6,727,050. The Washington DC Primary Metropolitan Statistical Area (PMSA) registered a 1990 population of 4,223,485 while the Baltimore, Maryland, PMSA registered a 1990 total population of 2,382,172. Based on 1992 estimates, the Washington DC CMSA population has grown to a total of 6,919,572, which represents a 2.9 percent growth from the 1990 totals.

All jurisdictions within the Washington-Baltimore CMSA will be impacted by the proposed modification of branch channels and anchorages in the Port of Baltimore. The several jurisdictions of Baltimore City, Baltimore County, and Anne Arundel County immediately adjacent to the port, however, will likely experience more direct impacts than the suburban Maryland jurisdictions and Washington, D.C. Baltimore City registered a 1990 population of 736,014 while its 1994 estimated population is 703,057. Baltimore County's 1990 recorded population was 692,134 and has increased to a 1994 estimated population of 711,783. Anne Arundel County also recorded population growth over this time period with its 1990 total population of 427,239 increasing to a 1994 estimated population of 456,171.

2.17.3 Employment/Industry

Employment in the study area was 3,581,926, based on the results of the 1990 census. This employment was based on a civilian labor force total of 3,736,265 and does not include individuals employed by the Armed Forces. Given the 1990 unemployment figure of 154,339, the Washington-Baltimore CMSA study exhibits a relatively low unemployment rate of 4.1 percent. Unemployment in the study area has historically been below the national average, due largely to the presence of the Federal government in the region and to the diversity of the region's economy.

Persons 16 years of age or over who are employed in the study area work in a variety of occupations distributed over many industrial sectors. Executive, administrative, and managerial positions; professional specialty occupations; administrative support positions; sales; and service position occupations account for more than 2.5 million of the 3.5 million people employed in 1990. Industry sectors employing major portions of the workforce include construction (7.5 percent), manufacturing (8.4 percent), retail trade (14.3 percent), public administration (13.7 percent), health services (7.6 percent), and educational services (7.7 percent). Major employers in the study area include Bethlehem Steel, General Motors, Lockheed-Martin, Marriott International, McCormick and Company, IBM, Mobil Corporation, and USAIR.

One of the largest employers and revenue producers in the region is the Port of Baltimore. A recent analysis of job creation by the port indicates that nearly 87,000 jobs are directly or indirectly tied to commodity movement and vessel activity in the port. Slightly more than 50 percent of these jobs are held by Maryland residents and more than 18,000 are jobs directly generated by (and wholly dependent upon) activities at the Port of Baltimore. Revenue generated by the movement of cargo and vessels through the port is estimated to have been $1.305 billion in 1992. This estimate is based on revenues accruing to various sectors including; maritime services, surface transportation, State and Federal government, and financial and legal services. Continued efforts on the part of the port community to offer high quality and cost-effective service will ensure its position as a major force in the generation of jobs and revenues in the study area.

2.17.4 Education

More than 80 percent of the adult population in the Washington-Baltimore CMSA are high school graduates. Nearly 32 percent of the adult population hold college degrees, which is the highest percentage in the country and nearly twice the national average. Moreover, five of the ten counties in the United States with the highest educational achievement are located in the CMSA.

Over 1.5 million students attend the region's public and private elementary and secondary schools. These schools offer virtually every kind of educational experience, from the traditional to the innovative. All public school systems in the study area offer major programs for both gifted and handicapped children. Vocational-technical training and specialized educational programs in the arts and sciences are also available. As one of the United States' leading academic centers, the Washington-Baltimore CMSA is home to over 60 colleges and universities and to more than 250 trade and technical schools, each capable of meeting the educational and research needs of employers in the region including growth, service, and technical companies. Some of the many premier institutions in the CMSA are Johns Hopkins University, George Washington University, the University of Maryland, Catholic University, the University of Virginia at Falls Church, George Mason University, and the University of the District of Columbia.

2.17.5 Transportation

The study area is centered in one of the nation's most comprehensive transportation networks along the Eastern seaboard. Three major airports serve the region, offering a variety of commuter, national, and international flights. Major rail service is provided primarily by CSX Transportation, Conrail, and Amtrak. Additionally, commuter service to and from Washington is provided by the State of Maryland through its commuter rail service (MARC). Light rail systems in the study area together with two major and modern subway systems provide efficient and convenient means of commuter transport.

The study area provides a safe, efficient, and extensive network of interstate roads and highways including I-95, I-81, I-83, I-70, I-83, I-270, the Washington Beltway (I-495), and the Baltimore Beltway (I-695). These highway systems are used extensively by approximately 5,000 private truck haulers and independent common and contract haulers within the study area.

The Port of Baltimore has superior container-handling and auto-handling facilities as well as modern facilities for loading/unloading a full range of bulk and general commodities. The port is serviced by a 50-foot main channel which ranks Baltimore as one of the world's deepest ports. Cruise ships increasingly call on the Port of Baltimore, and plans are underway to study the feasibility of expanding cruise ship operations.

Section 3

PROBLEM IDENTIFICATION

The rapid growth of international bulk and container trade during the past few decades and the concurrent expansion of the world fleet have led to considerable enlargement and improvement of the facilities at the Port of Baltimore. Construction of a 50-foot main shipping channel into the Port of Baltimore thus allowing deep draft bulk cargo vessels to call on the port was completed by the COE and the MPA in October 1990. Other improvements that have been made in the Port of Baltimore in recent years include expansion of public and private marine terminals in the harbor and construction of new terminals, such as the Seagirt Marine Terminal, which is designed to efficiently handle containerized cargo. These capital improvements have enhanced the efficiency of the Port of Baltimore, resulting in an increase in maritime-related business. This section identifies problems in the Port of Baltimore that require additional improvements to continue to meet the needs of current users and also to ensure that the Port of Baltimore remains a thriving world-class port well into the 21st Century.

3.1 MEANS BY WHICH PROBLEMS WERE IDENTIFIED

During the course of the reconnaissance study, meetings were held with local interests to identify navigation-related problems affecting the study area. Some of the problems cited by the maritime community included; time delays, idle labor, C&D Canal depth restriction, the need for a turning basin, insufficient anchorages in the Inner Harbor, difficulty in navigating the branch channels, and other problems. As part of the feasibility study, an approach was developed to review the previously identified problems and to identify any new problem areas. This approach, outlined below, was a major contributor to the feasibility study problem definition focusing on the existing anchorages and branch channels and the extent to which these problems affect the Port of Baltimore maritime community.

3.1.1 Notice of Study Initiation and Coordination

A study initiation letter and public notice were issued to approximately 1,000 individuals and groups in September 1993 to announce the initiation of the feasibility study and to identify any problems or concerns early in the study process. In addition, a review of prior reports on the Baltimore Harbor and Channels was completed to identify problems which had previously been addressed and to evaluate the adequacy of the data used in addressing these problems. This included planning and technical documents leading to the 50-foot deepening project, prior reports conducted over the years, and the Baltimore Harbor Anchorages and Channels Reconnaissance Report. The feasibility study effort was also coordinated with the

C&D Canal Feasibility Study, which has been completed by the Philadelphia District, to ensure that no overlap existed with that study.

3.1.2 Meetings With Port Maritime Community

Following initiation of the feasibility study in July 1993, a brainstorming meeting with the Port of Baltimore maritime community was held to advance the study effort. The purposes of the meeting were: (1) to provide an overview of the reconnaissance study; (2) to provide an overview of the feasibility study effort; and (3) to solicit input from the users to assist in economic data collection efforts. The meeting was attended by the following members of the Baltimore maritime community:

- Baltimore Maritime Exchange
- Curtis Bay Company
- Moran Towing
- Baltimore Docking Pilots
- McAllister Towing
- CSX Transportation
- Corps of Engineers
- Country Mark Grain Cooperative
- Consolidation Coal Sales Company
- Rukert Terminals, Inc.
- U.S. Coast Guard
- Northern Chesapeake Docking Pilots Association
- Steamship Trade Association
- Association of Maryland Pilots (AMP)
- Maryland Port Administration

No new problems were identified at the meeting, although the extent of previously identified problems was clarified. It was agreed that future meetings with these members of the maritime community would be scheduled to solicit additional information and to coordinate the study findings.

Throughout both the reconnaissance and feasibility study investigations, numerous meetings were held with the AMP, the Baltimore Docking Pilots (BDP), and the tug companies serving the Port of Baltimore (Moran Towing and McAllister Towing). The AMP is involved, to varying extents, in nearly every aspect of navigation in the Port of Baltimore. This organization has a very good understanding of the commercial shipping channels and is aware of problems which impact the industry. Input from these and other maritime community members was incorporated into the design of anchorage and branch channel improvements recommended in the feasibility report.

As the primary point of contact with Baltimore's maritime community, the MPA was an important partner in clarifying problems affecting the port. This agency was responsible for coordination with all major shipping lines as well as with local facilities and operations in identifying problems which affect navigation. During the reconnaissance study, the MPA provided a list of the major problems including the lack of adequate anchorage in the Inner Harbor and the insufficient dimensions of some branch channels in the port. These problems continue to impact the Port of Baltimore and were the main focus of the feasibility study effort, as discussed in the following sections.

3.2 PROBLEMS, NEEDS, AND OPPORTUNITIES

The following section provides a discussion of the problem areas that were identified during the feasibility study. Table 3.1, toward the end of the section, presents a summary of the structural problems that were identified.

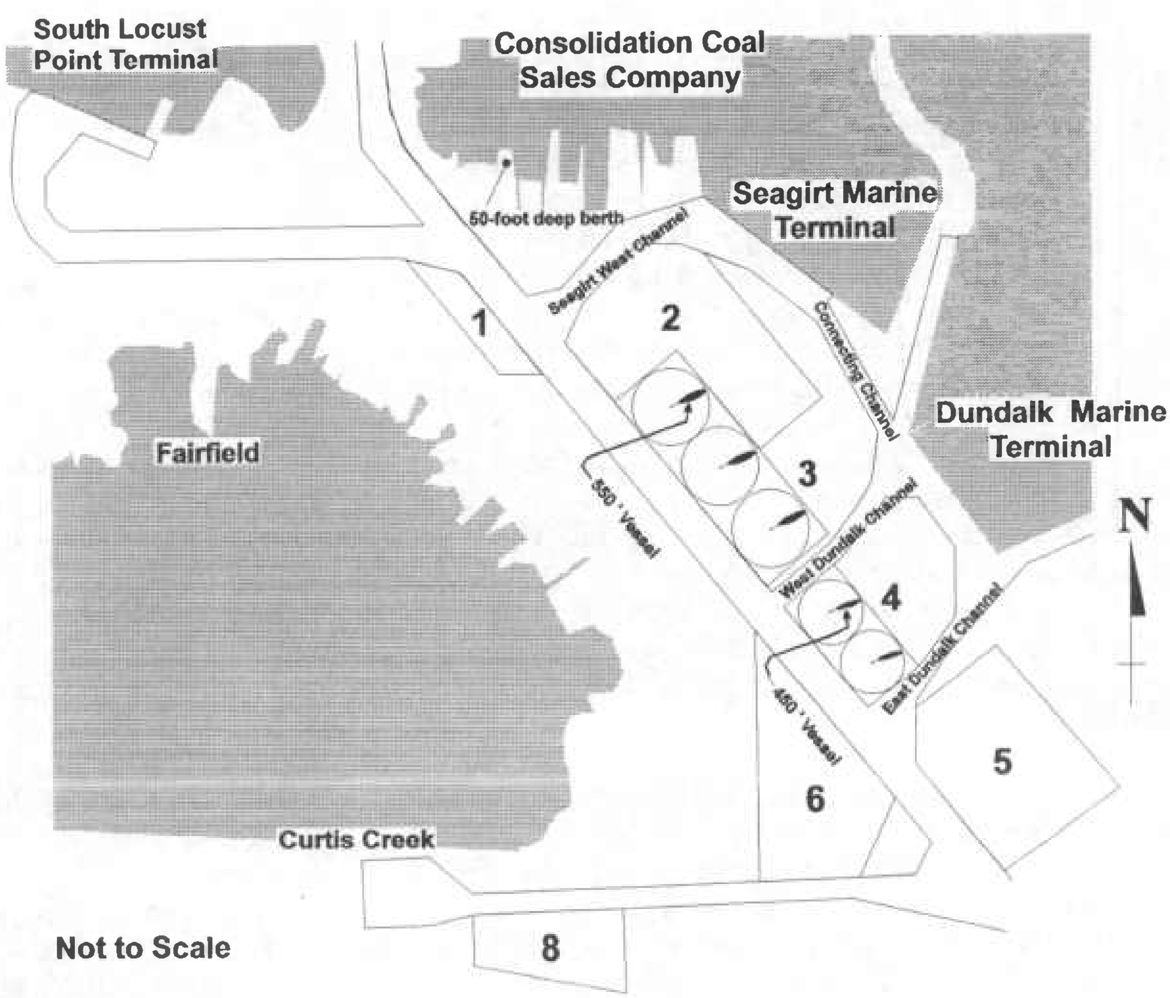
3.2.1 Anchorages

The existing anchorages are not sufficient in width or depth to accommodate the larger-sized vessels calling on the port today (Figure 3.1). The three Federal anchorages that are maintained by the COE as part of the existing Baltimore Harbor and Channels project were initially authorized for construction between 1909 and 1945, at a time when vessels were much smaller than those calling on the port today. The location of Anchorages #3 and #4 is ideal for activity in the Port of Baltimore. These anchorages are located adjacent to the Seagirt and Dundalk branch channels and are close to Curtis Creek, South Locust Point, Fairfield, and other private terminals. Many of the larger vessels currently calling on Baltimore are required to use the Annapolis Anchorage Grounds, which are located about 25 miles south of Baltimore Harbor. The inability of these vessels to use the convenient inner harbor anchorages causes tremendous losses in terms of efficient vessel movement. A vessel anchored in the Annapolis Anchorage Grounds awaiting berth in the harbor must wait not only for the berth to be vacated, but for the vacating vessel to transit out of the harbor and past the Annapolis Anchorage Grounds before the next vessel can proceed toward the harbor. The maneuvering is required since passing in the channels is dangerous and not often practiced, and, therefore, involves a tremendous amount of time. This situation is a direct function of the insufficient size of the inner harbor anchorages. Specific problems with the existing dimensions of the Baltimore Harbor anchorages are outlined below.

3.2.1.a Anchorage Length and Width. The Baltimore Harbor anchorages are not wide enough to allow safe anchorage of all vessels at all times. The vessels for which the anchorages were initially designed were much smaller than those currently calling on the port. The Baltimore anchorages were designed to permit the free-swinging movement of an anchored vessel around a single-point. This design permits a ship to adjust to sudden changes in wind direction and current without having to reanchor, and thus assures that vessels do not swing into a channel, bank, or another vessel. In the United States, the use of free-swinging moorings in major ports of call is the standard.

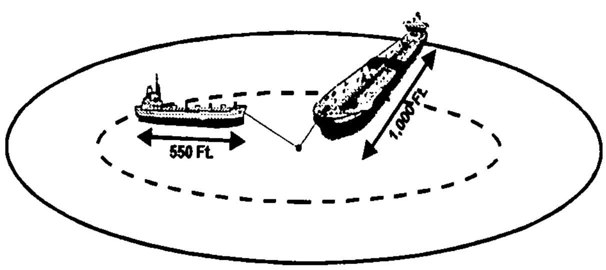
Free-swinging anchorages require a circular area having a radius equal to the length of the ship plus the anchor chain, which is generally five to six times the depth of the water. As shown in Figure 3.2, larger anchorage areas are required for larger vessels. Anchorage #3 was initially designed to safely accommodate three vessels anchored in this manner. Design parameters require the vessels to have drafts under 33 feet and lengths under 550 feet, as shown in Figure 3.1. Similarly, Anchorage #4 can accommodate two vessels with drafts under 28 feet and lengths under 450 feet (Figure 3.1). Together these anchorages provided berths for a maximum of 5 vessels at any time. Anchorage #1 is too narrow to accommodate the free-swinging motion of a vessel since it is only 400 feet wide. It was designed to accommodate smaller vessels with drafts of 33 feet or less; use of this anchorage requires tug assistance to hold the vessel in position. Modern vessels are nearly twice the length of the longest vessels that the anchorages were designed to safely accommodate: more than 80 percent of the vessels calling on the Port of Baltimore in 1993 had lengths greater that 550 feet. Many of these ships must anchor near Annapolis.

Figure 3.1
Baltimore Harbor Anchorages



Large vessels greater than 550 feet in length are sometimes positioned in the anchorages based on the direction of the prevailing winds, since the existing anchorages are not adequate to allow free-swinging movement. If a change in weather causes the wind to shift direction, pilots and tugs may be needed to reposition the vessels to prevent grounding or collisions with other vessels. As a result, shippers may incur additional pilot and tug costs for repositioning the vessels. This is further complicated by the fact that pilots usually require a minimum of 2 hours notice of intent to move within the harbor, and this may not be sufficient time to prevent the occurrence of a hazardous situation.

Figure 3.2
Typical Free-Swinging Anchorage



Anchorage	Vessel Length	Anchor Chain	Anchorage Diameter
- - - Existing	550 ft.	200 ft.	1,500 ft.
——— Required	1,000 ft.	200 ft.	2,400 ft.

3.2.1.b Anchorage Depth. Another problem is the limited depth of the existing anchorages. Many bulk cargo and new container vessels can not be accommodated in any of the existing anchorages in Baltimore Harbor due to their deeper drafts. The deepest anchorages in Baltimore Harbor are Anchorages #1 and #3, which have an authorized depth of 35 feet. Vessels using these anchorages must have a maximum safe draft of 33 feet or less. Anchorage #1 is too narrow to be used for long-term anchoring, although it is sometimes used as a short-term emergency anchorage. In addition, the northern portion of Anchorage #1 is often used as a turning basin by vessels backing out of the 50-foot deep berth at Consolidation Coal Sales Company pier, which may create additional problems for other vessels concurrently held in the nearby anchorages (see Section 3.2.3.c).

Anchorage #4 is authorized to a depth of 30 feet and can accommodate small vessels drafting 28 feet or less. The other anchorages in Baltimore Harbor are much shallower than the Federally maintained anchorages. Anchorage #2 ranges from 20 to 30 feet deep. The lower anchorages (#5 and #6) can only be used by vessels with drafts of 20 feet or less (e.g., general cargo ships). Anchorage #8, Dead Ship Anchorage, ranges in depth from 8 to slightly less than 20 feet.

Large bulk and container vessels draft approximately 36 to 38 feet or more, and, therefore, can not anchor in the harbor regardless of their length. In emergency situations, such as engine failure or the onset of a sudden storm event during berthing or deberthing, these larger vessels must be temporarily held in the channel by tugs until the problem can be corrected. This creates a dangerous situation where both the main channel may be blocked and the vessel itself may be damaged. Groundings, including even minor scrapes against the channel wall, can result in costly damage to a vessel's propellers, rudders, shafts, and hull. It commonly costs up to $100,000 just to drydock a vessel with actual repairs costing far more. Due to the cost of actual repairs coupled with the cost of vessel downtime, the liability concern, and the disruption to the port, the maritime community is extremely sensitive to vessel damage and even to situations with the potential for damage. Documentation on these occurrences is normally forwarded to the shipping agent/owner by the captain of the vessel promptly following the incident, and such occurrences can directly influence future business for the Port of Baltimore. Shipping lines tend to avoid ports where unsafe conditions may exist.

3.2.2 Curtis Creek Channel

Problems affecting navigation in the Curtis Creek Channel were first identified during the development of the reconnaissance report, which was completed in April 1992. Following certification of the reconnaissance report, COE Headquarters concluded that pursuing feasibility-level study of deepening the existing channel at Curtis Creek would not be consistent with current COE policy on single-owner situations. Baltimore District was directed to exclude further study of the Curtis Creek Channel from the scope of the feasibility study. However, during the course of the feasibility technical investigations, the increasing need for improvements at Curtis Creek was repeatedly brought to the attention of MPA officials at various meetings with the Port of Baltimore maritime community. This action resulted in additional efforts to identify a second user that would have a reasonable prospect of benefiting from improvements at Curtis Creek, either now or in the near future. Again, no additional or prospective users, other than Amerada Hess, were identified. At this time, there is no Federal action to pursue improvements at Curtis Creek. Any efforts in the future will likely be conducted separate from this study. These problems, however, continue to affect commercial navigation in Curtis Creek. For this reason, a discussion of these problems based on the results of the reconnaissance study is provided below.

The existing Baltimore Harbor and Channels project includes a channel 35 feet deep and 200 feet wide in Curtis Creek, which extends from the terminus of the 50-foot-deep channel in Curtis Bay at the mouth of Curtis Creek, to 750 feet downstream of the Pennington Avenue Bridge, as shown in Figure 3.3. Shallower channels continue further upstream on Curtis Creek. The limit of the existing 50-foot project, at the confluence of Curtis Creek and Curtis Bay, does not benefit public and private

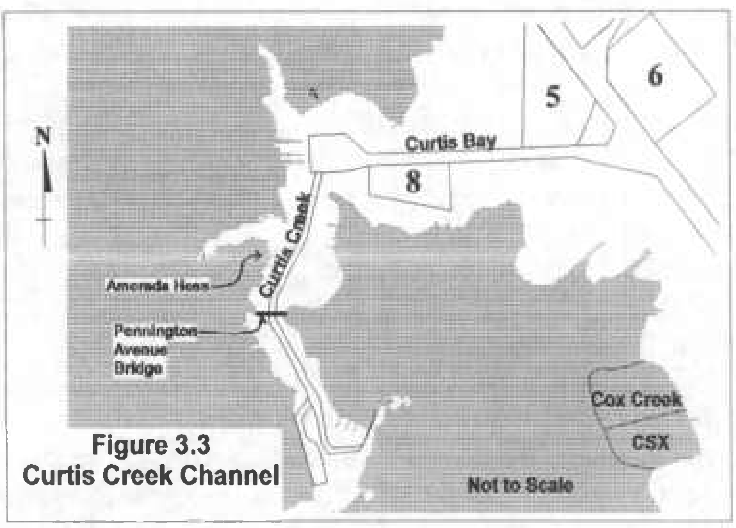


Figure 3.3
Curtis Creek Channel

facilities located in the Curtis Creek area. The maximum vessel draft that can be safely accommodated in the Curtis Creek Channel is 33 feet. Vessels drafting greater than 33 feet are required to lighter (transfer some cargo to another vessel or barge) to a shallower draft in order to safely navigate the channel. The following paragraphs discuss the specific problems which continue to affect various aspects of the petroleum industry in Curtis Creek.

Amerada Hess Corporation operates a terminal at Curtis Creek, approximately 3,800 feet upstream from the limit of the 50-foot project in Curtis Bay (see Figure 3.3). The commodities received at the terminal include gasoline, No. 2 fuel oil, No. 6 fuel oil, and kerosene. Amerada Hess owns and operates six Cat-Tug vessels and a variety of shallow draft barges and smaller vessels, which regularly call on the Curtis Creek facility. The Cat-Tug vessels draft 41 feet when fully loaded. Due to the limited depth of the Curtis Creek Channel, the current operation for Amerada Hess requires lightering of the Cat-Tugs to a maximum draft of 33 feet prior to entering the Curtis Creek Channel. This time-consuming and costly procedure is often performed in the designated anchorage area near Annapolis, or at Hampton Roads, Virginia. In 1991, 31 vessels (82 percent) of the total vessels calling on the Amerada Hess terminal at Baltimore required lightering prior to entering the Curtis Creek Channel.

The Chesapeake Bay is vulnerable to a potential fuel-oil spill each time a tanker lighters to a shallower draft. Lightering requires the attachment of flexible hoses between the vessel and a barge, through which the fuel-oil is pumped until the desired draft is obtained. The vessel and barge are subject to pitching and rolling caused by the action of wind and waves in the Chesapeake Bay, which could potentially result in accidental detachment of these lines. Such an accident may result in the release of hundreds to thousands of gallons of fuel oil into the waters of the Chesapeake Bay. Any of the lightering operations performed in 1991, as well as in the years since that time, presented the potential for an oil spill.

Deepening of the Curtis Creek Channel would provide the benefits of a deeper shipping channel resulting in decreased operating costs to businesses located in Curtis Creek, such as Amerada Hess Corporation. In addition, there are specific environmental advantages associated with improving the Curtis Creek Channel. These benefits include reducing the potential for accidental fuel-oil spills as a result of local lightering operations, and improving the environmental quality of the channel by removing significant volumes of contaminated material during the channel deepening process. Based on the results of the reconnaissance study, costs associated with lightering 31 vessels destined for the Curtis Creek Channel totaled approximately $615,000 in 1991. These costs were considered average annual costs at that time due to the insufficient depth of the Curtis Creek Channel and the continuation of lightering operations. The reconnaissance report also showed a benefit-to-cost ratio much greater than 1.0 for the deepening of the Curtis Creek channel. Benefits were derived from the current need for time consuming lightering and the use of barges within the channel.

3.2.3 Non-Federal Branch Channels

Some of the non-Federal branch channels in Baltimore Harbor have dimensions and designs which render them inadequate for efficient navigation. Much time is required to safely navigate these channels, which results in costs to the shipper and the vessel agent/owner. The following paragraphs describe the specific problems with the existing dimensions of the Baltimore Harbor branch channels that are the cause of these movement costs.

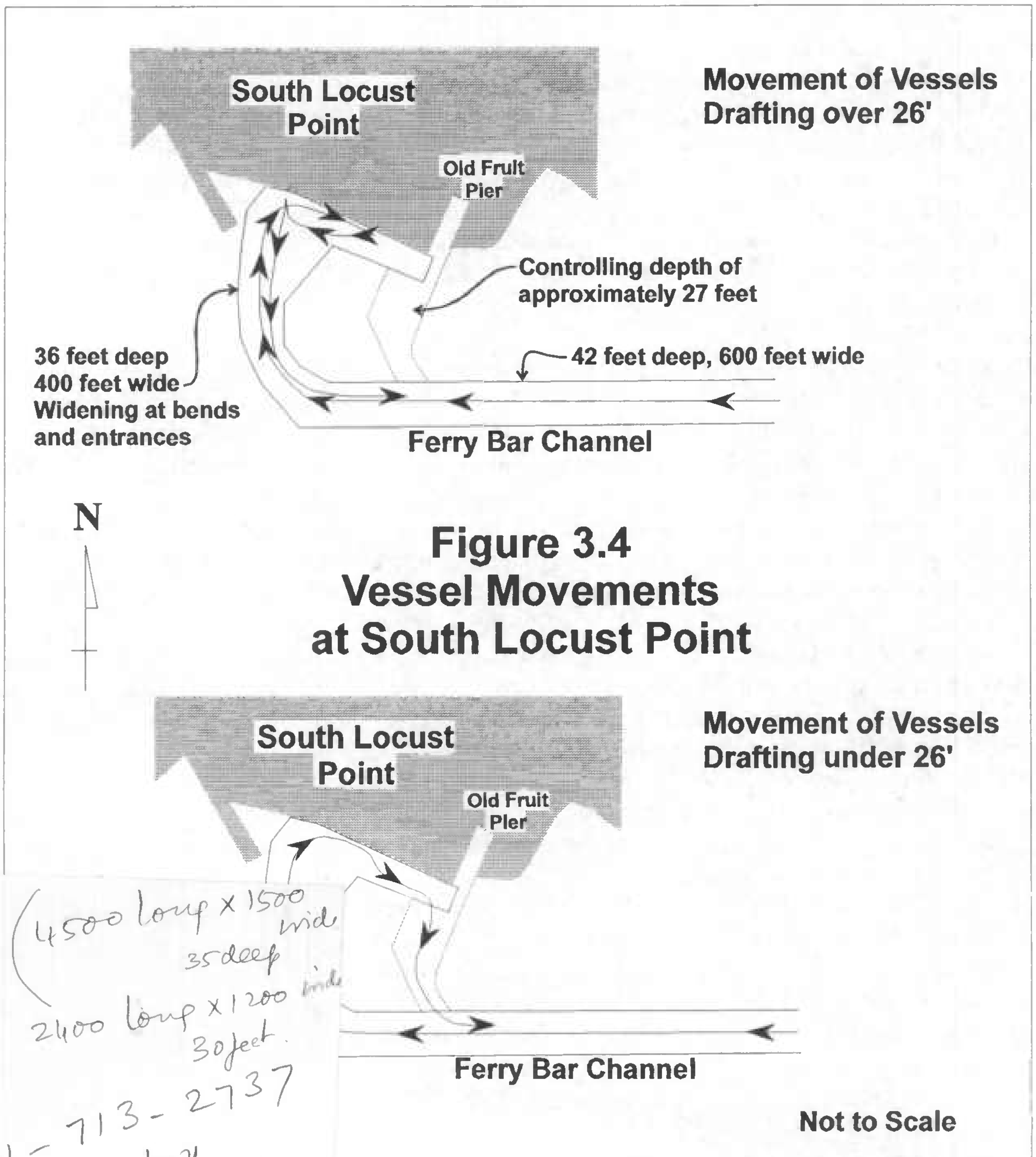


Figure 3.4
Vessel Movements at South Locust Point

#3 (4500 long x 1500 wide 35 deep
#4 2400 long x 1200 wide 30 feet.

301-713-2737
Curt Loy
Howard Danley
301-713-2732
x 105

3.2.3 Non-Federal Branch Channels

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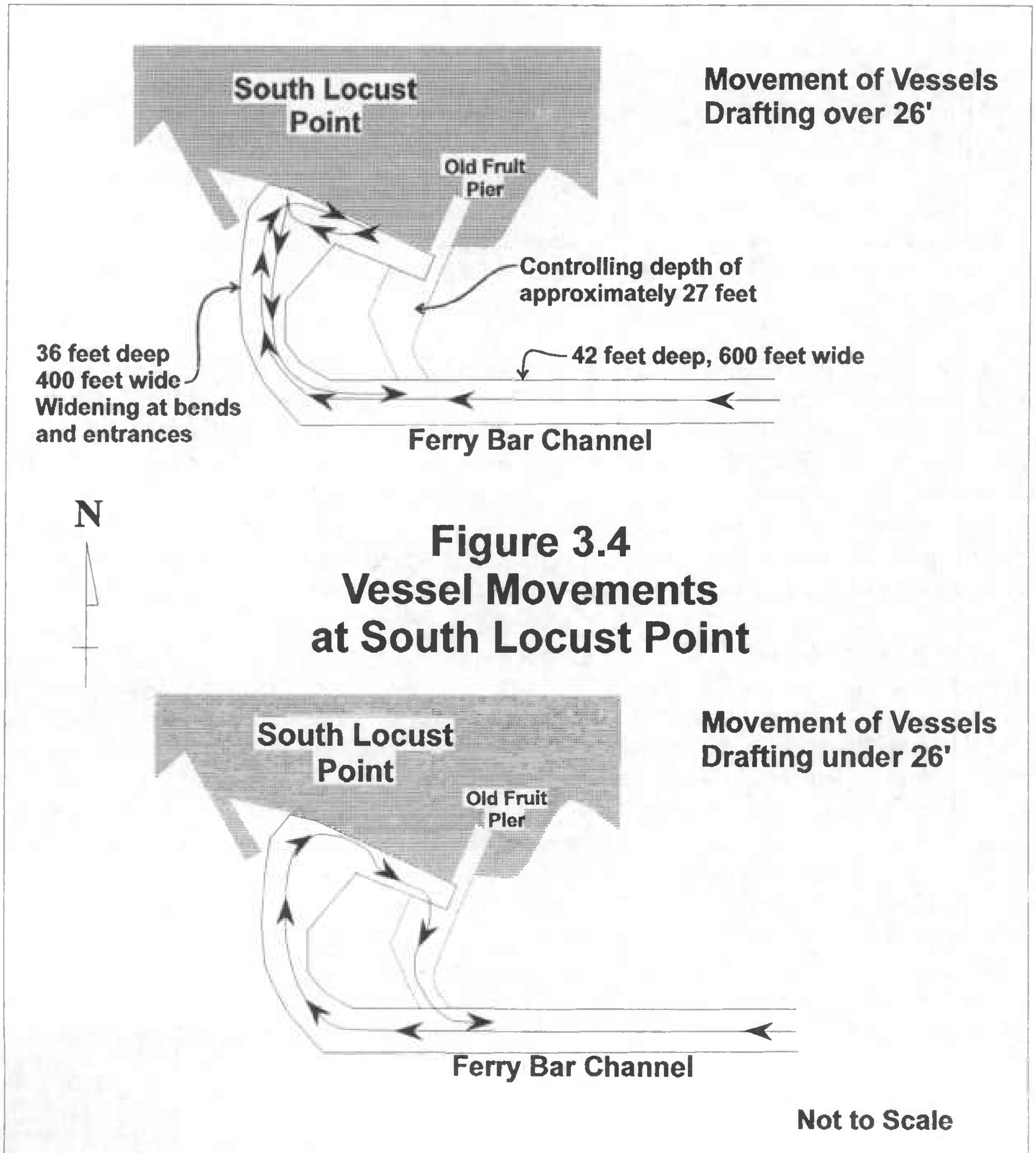


Figure 3.4 Vessel Movements at South Locust Point

3.2.3.a South Locust Point Marine Terminal. The configuration of the branch channels at South Locust Point is inadequate for larger vessels calling on the terminal. Vessels currently access this terminal using the 36-foot-deep channel, which is maintained by the MPA, as shown in Figure 3.4. Upon exiting the terminal, large vessels are maneuvered by tugs in the turning basin, and then exit through the maintained channel section. Backing out of the berth and turning 180 degrees normally takes 45 minutes to complete, which results in costs to the shipper and the vessel agent/owner. Smaller vessels do not have to be turned to exit this terminal. As shown in the lower part of Figure 3.4, shallow draft vessels normally exit the terminal using a remnant channel, which is approximately 28 to 30 feet deep. This channel once provided access to the MPA's Produce Wharf, which is no longer in operation. The old channel is currently marked by the U.S. Coast Guard but is not maintained by MPA. Vessels drafting less than 26 feet can exit the South Locust Point berth using this remnant Produce Wharf channel, rather than turning and exiting the maintained channel.

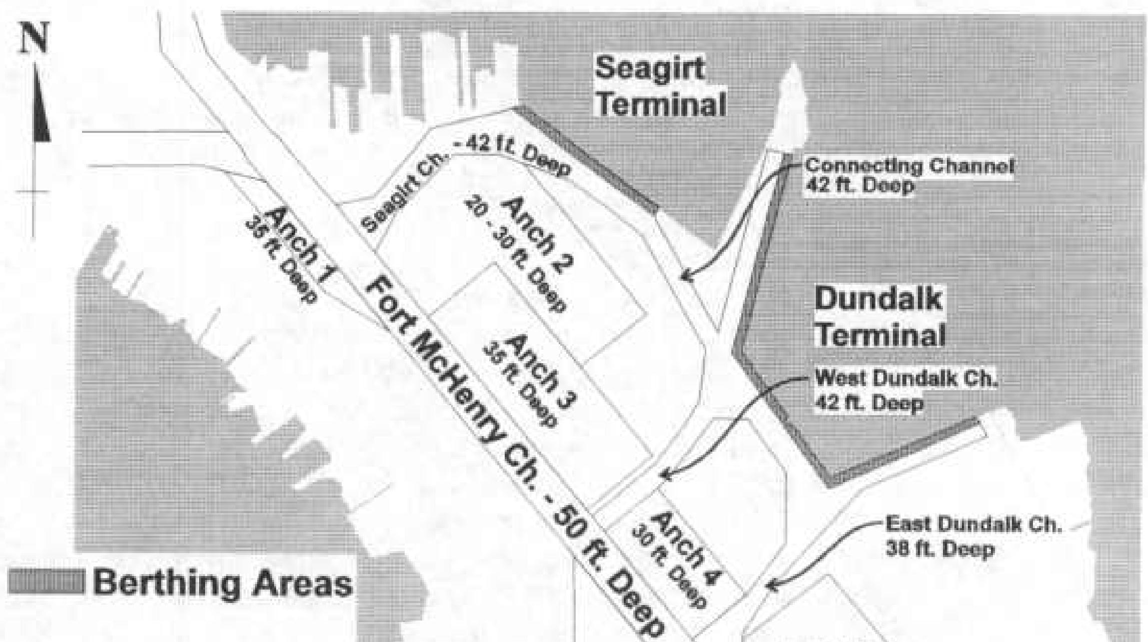


Figure 3.5
Seagirt and Dundalk Branch Channels

3.2.3.b Seagirt/Dundalk Marine Terminals. The branch channels leading to the public marine terminals at Seagirt and Dundalk are 42 and 38 feet in depth; however, the widths of the channels vary significantly (Figure 3.5). The west branch channel leading to the Seagirt Marine Terminal is 500 feet wide by 42 feet deep and was designed to accommodate one-way movement of a 135-foot-beam post-Panamax container vessel. The west branch channel leading to the Dundalk Marine Terminal and the connecting channel between Seagirt and Dundalk are both 350 feet wide by 42 feet deep. The East Dundalk Branch Channel is 38 feet deep and 300 feet wide. The berths at Seagirt are up to 42 feet deep and are up to 38 feet deep at Dundalk.

The channel system serving the Seagirt and Dundalk Marine Terminals provides a series of options for pilots when they are maneuvering vessels to and from the docks. Consideration was made as to whether the current branch channel system was designed in the optimum fashion. It may be argued that the East and West Dundalk branch channels may not both be necessary. Figure 3.5 shows the current layout of the channels and anchorages in the Seagirt and Dundalk area. This layout allows for the pilot to have a choice of ingress and egress routes based on factors such as wind and currents, the location of cargo on the ship (i.e. which side of the vessel should face the berth), the location of other vessels in the system, and the intended destination of the vessel. This layout also minimizes the number of required tug-assisted turns within the system.

As discussed in the previous paragraph, the Seagirt and Dundalk channels act as a system. Options for consideration, however, include the elimination of either the East or West Dundalk Branch Channel. Either of these actions would save on maintenance costs and dredged material placement requirements.

Figure 3.6 represents the Seagirt and Dundalk area if the West Dundalk Branch Channel were eliminated. If this were the case, the East Dundalk Branch Channel, including the area in front of the berths at Dundalk, would have to be deepened to 42 feet to accommodate the movement of vessels to the 42-foot Seagirt berths. MPA studies have shown that the deepening of the berths 7,8,9, and 10 at Dundalk to 42 feet is not possible without reconstructing the bulkheads. This improvement would be quite costly and require dredging substantial quantities of material. Even if the East Dundalk Branch Channel and in front of the berths was deepened to 42 feet, the benefits of time savings would be lost. Due to hydrodynamic forces, the pilots try to avoid passing other moored vessels. As a vessel passes a moored vessel at any speed, these forces can result in dangerous conditions, such as causing the berthed vessel to collide with the dock, or causing the cargo to shift as it is being loaded or unloaded by the workers. Pilots will avoid passing other vessels by using other routes to the docks whenever possible. Figure 3.6 shows that the required egress (or ingress) of a vessel berthed at the Seagirt Marine Terminal passes moored vessels at Dundalk. The use of the West Dundalk Branch Channel would eliminate the safety concerns associated with passing the Dundalk berths.

With the West Dundalk channel being eliminated, vessels at both Dundalk and Seagirt would have to pass the other terminal upon ingress or egress. The only alternative would be to perform a time-consuming and dangerous 180 degree turn within the channel system. Many larger vessels could not perform this maneuver at all. Finally, the elimination of the West Dundalk Branch Channel would present added traffic concerns. With most vessels using the same two channels, which are not suitable for two-way traffic, delays caused by the need to wait for vessels to clear the channels would be likely to occur.

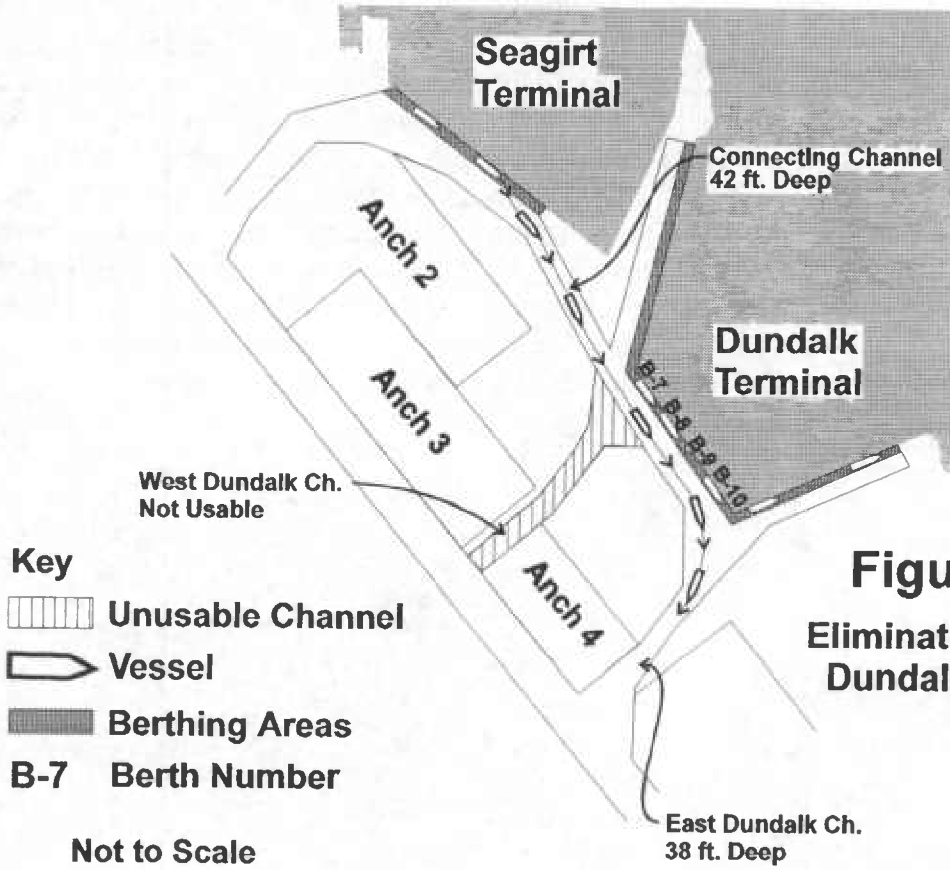


Figure 3.6

Elimination of West Dundalk Channel

Figure 3.7 represents the situation if the East Dundalk Branch Channel were eliminated. As the figure shows, the elimination of the East Dundalk channel would require most of the vessels moored at the Dundalk Marine Terminal to perform a dangerous and time-consuming turning maneuver. Some of the larger ships may be unable to perform the maneuver. Such a maneuver would block the channel for a prolonged period causing potential traffic problems. This scenario also would require a tremendous increase in the use of the West Dundalk Branch Channel. The increase in usage (ingress or egress from Seagirt and ingress and egress from Dundalk) would create back-ups and traffic congestion. The lack of two-way traffic through the channel would require vessels to wait until the channel was clear before proceeding in the opposite direction. Such backups could affect traffic in the Fort McHenry Channel as well. If a vessel going to Dundalk were so delayed that it opted to use the Seagirt Channel for ingress then it would have to pass the vessels moored at Seagirt. Also vessels moored on the east side of Dundalk would have to pass the other vessels moored at Dundalk upon ingress and egress. As discussed above, such passages create an unsafe situation for the cargo on the moored vessel, the crew working on the docks, and the moored vessels themselves.

For the reasons discussed in the preceding paragraphs, it was determined that the current layout is appropriate. Potential problems and opportunities for improved efficiency lie in the current dimensions of the branch channels. The narrowness of these channels presents potential navigational hazards during unfavorable weather conditions and generally increases the amount of time required for maneuvering vessels in the channel. In order to allow for safe and consistent one-way movement of vessels through these channels, the MPA and the AMP suggested widening the west Dundalk branch channel and the connecting channel between Seagirt and Dundalk to 500 feet. The modification would create a consistent loop channel 500 feet in width and 42 feet in depth, while providing safe and efficient access to both Seagirt and Dundalk terminals. During the feasibility investigation, various width and depth configurations were evaluated to identify the most cost-effective combination.

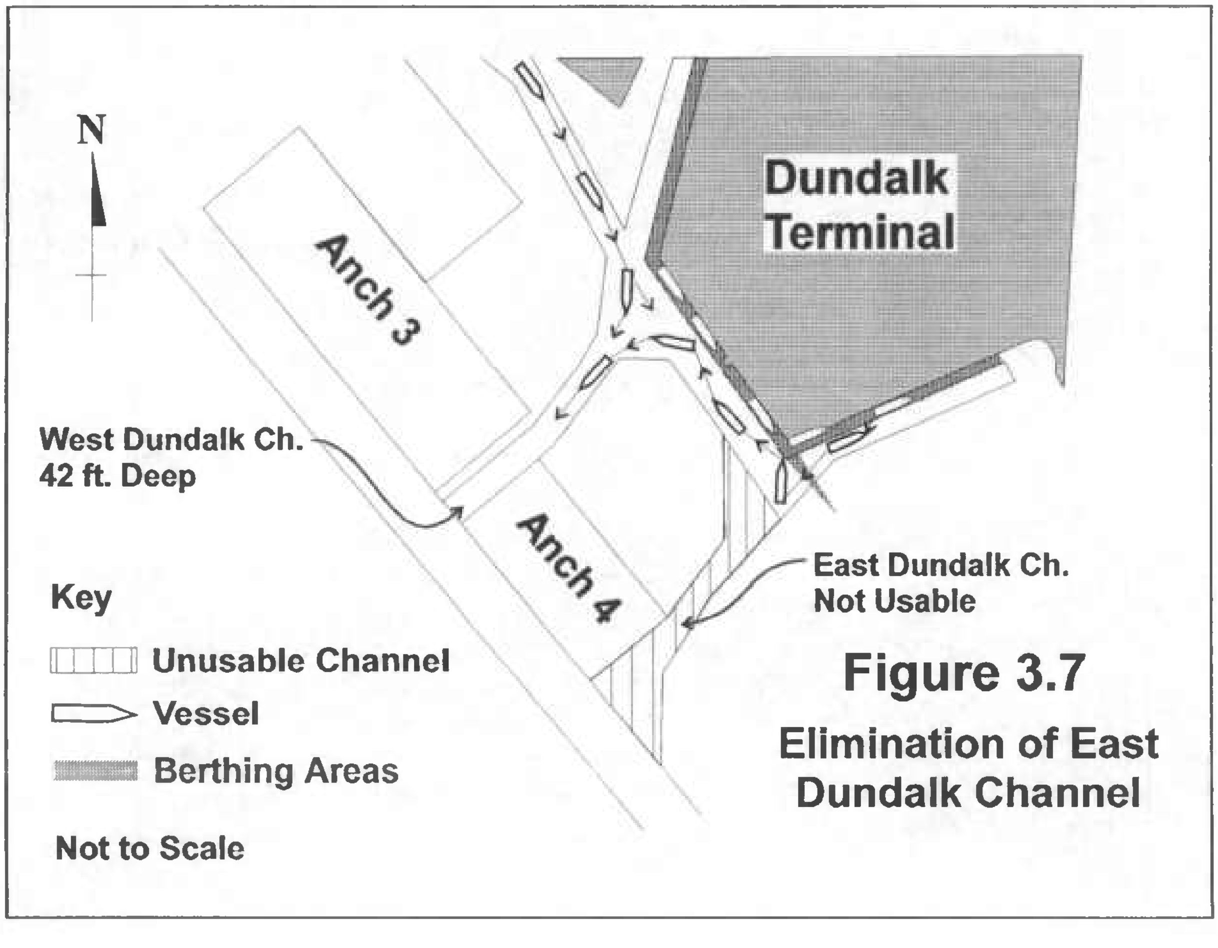


Figure 3.7
Elimination of East Dundalk Channel

The east branch channel to Dundalk is 38 feet deep and 300 feet wide. The width of this channel also presents navigational difficulties to vessels. A strong northwest wind can cause vessels to be blown into the bank due to the narrowness of the channel. The docking pilots and the towing companies have suggested widening this channel in order to accommodate a 106-foot-beam Panamax vessel.

A flared opening at the entrance to the east branch channel leading to the Dundalk Marine Terminal was previously constructed to allow safe navigation for vessels entering and exiting the channel. A similar flared opening was recommended for the west branch channel leading to Dundalk. Safety and efficiency are often a concern as vessels negotiate the 90-degree turn at the channel entrance at the intersection with the Fort McHenry Channel. The pilots also suggested providing a flared cut-off angle at the intersection of the connecting channel and the berths on the west side of the Dundalk Marine Terminal to facilitate the navigation of vessels entering and exiting the berths. The cut-off is part of any good channel design. It is required for engineering and safety-related reasons to improve maneuverability when a vessel is turning into a new channel segment. The proposed improvements to the connecting channel and the West Dundalk Channel are shown in Figure 3.8.

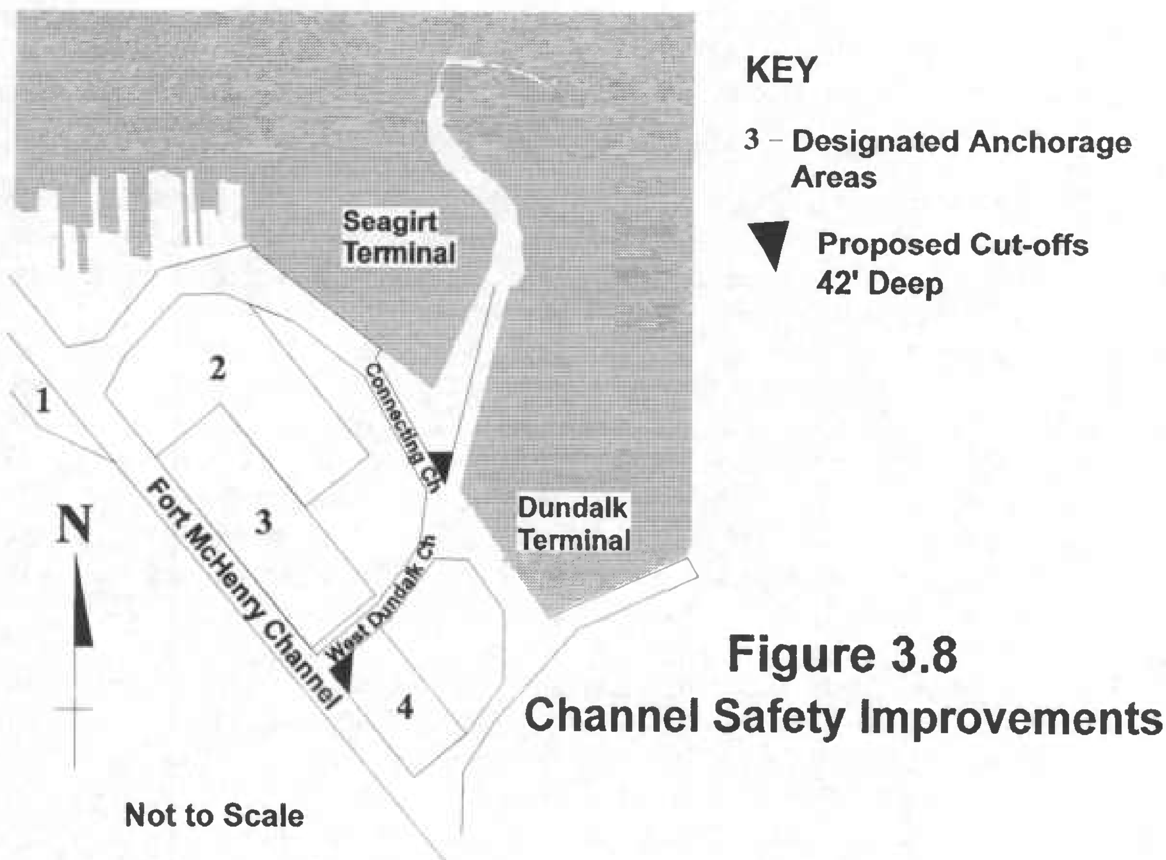
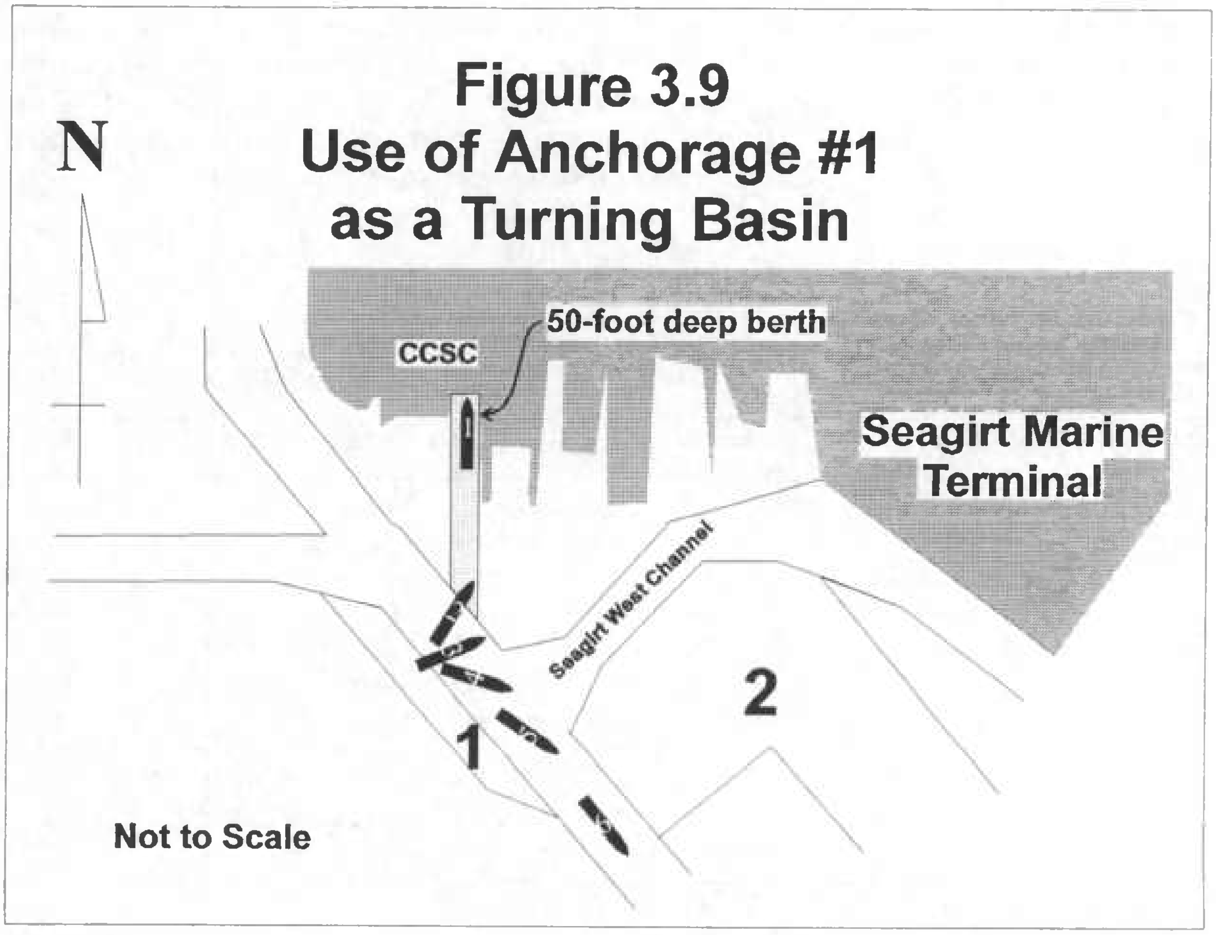


Figure 3.8
Channel Safety Improvements

3.2.3.c <u>Turning Basins</u>. The 35-foot deep Anchorage #1, located just south of the intersection of the Fort McHenry Channel and the Ferry Bar Channel, is frequently used to turn vessels exiting the Consolidation Coal Sales Company (CCSC) 50-foot-deep berth (Figure 3.9). There currently is no turning basin in this location; the current operations are considered unsafe and inefficient by the pilots and tug operators. The pilots have reported that potentially dangerous conditions exist when attempting to turn vessels exiting the CCSC 50-foot deep pier. In this location, large vessels sometimes in excess of 1000 feet LOA are backed out of the CCSC berth and turned in the main channel. These vessels can draft up to 47.5 feet when exiting the berth loaded and require the full depth of the existing 50-foot channel system. To negotiate the turn out of the berth and into the main channel, the stern is maneuvered dangerously close to the channel bank and could result in significant damage to the vessel. This maneuver also requires a significant amount of time with full tug assistance. Often times the propellers of the larger vessels performing the turns cause material from the bank of Anchorage #1 to wash into the access channels of the private businesses to the south-west of Anchorage #1 creating the necessary expense of more frequent maintenance dredging. A turning basin in this location would facilitate safe maneuvering of these larger vessels; improve efficiency of the turning operation, as well as the entire system, by reducing the amount of time the vessel is in the channel system and obstructing other vessels; and improve the safety of other moving and anchored vessels nearby. The advantages of a turning basin in this location can not be provided by the existing turning basin at the terminus of the East Channel (Figure 1.2) since the existing basin is located approximately 3,000 feet north of the turning area and the depth of the water in that section is only 49 feet.

The CCSC facility does not constitute a single-user; the terminal is used for coal distribution to customers throughout the entire world. Multiple vessels from multiple shipping lines call on this facility year round; approximately 95 percent of the vessels calling on this facility in a given year are independent charter traffic and are not affiliated with a specific line. In addition to deepening its berth and access channel to 50 feet, CCSC has provided other modifications to its channel in efforts to improve navigation. The modifications were designed to facilitate the use of the main channel and Anchorage #1 as a turning basin, and were coordinated with the AMP, the tug companies, and the docking pilots. The turning basin would also provide benefits for the *U.S.N. Comfort* and vessels calling on the MPA's Fairfield Marine Terminal, Hobelmann Port Services, Inc.'s pier, and ST Services, Inc.'s pier. Provision of a turning basin would reduce delays experienced by existing (and future) vessel traffic north of the Fort McHenry Channel.

3.2.3.d Navigation Aids. The maritime community provided additional suggestions for improvements to the connecting channel between Seagirt and Dundalk terminals. The existing channel is poorly marked and presents navigation problems to vessels. Additional channel markers or range lights are needed to aid in navigation. A determination of the need for Federal aids to navigation, and installation and maintenance of such aids is the responsibility of the U.S. Coast Guard. However, in the absence of sufficient Coast Guard funding or justification, the non-Federal interests may be required to provide the navigation aids.



3.2.3.e Vessel Traffic Management. The Baltimore Maritime Exchange is responsible for tracking the Estimated Time of Arrival (ETA) for vessels calling on the Port of Baltimore. The AMP communicates expected arrival and departure times to more effectively track the movement and location of other vessels. However, in today's commercial shipping industry, scheduling of vessel movements is subject to significant delays, both at berth and at sea. Vessels are often delayed while waiting for a letter of credit or due to mechanical difficulties. As a result, attempting to pass large Cape-size vessels in the angles of the main shipping channel (currently, the only area between Baltimore and Annapolis that is wide enough to attempt this maneuver) is difficult to coordinate and generally not practiced by the pilots.

Additional problems with scheduling and traffic management for the existing anchorage areas at Baltimore were identified. Improved enforcement of the limits on anchorage use is needed. In many situations, vessels occupy the anchorage areas longer than the standard 2- or 3-day limit authorized by the U.S. Coast Guard. Other vessels in need of safe anchorage are required to travel to the Annapolis Anchorage, 25 miles south of Baltimore. This practice creates delays and additional costs for the shipper and vessel agent/owner.

3.2.3.f Vessel Accidents. As part of the reconnaissance effort, the U.S. Coast Guard was contacted to determine the number of vessel accidents that occurred in the Port of Baltimore navigation system. Between 1980 and 1989, 70 accidents were recorded as having occurred in various locations within the Port of Baltimore navigation system (excluding the C&D Canal and its approach channels). These 70 accidents involved almost 100 vessels, including container vessels, tanker vessels, bulk vessels, passenger vessels, and barges.

Table 3.1
Summary of Structural Problem Identification

Problem Location	Summary of Problem
Anchorage Areas	
Anchorage #1	Designed to accommodate vessels drafting up to 33 feet. Too narrow to accommodate free-swinging motion of vessel.
Anchorage #3	Designed to accommodate vessels with drafts up to 33 feet and lengths under 550 feet. Insufficient for today's vessels.
Anchorage #4	Designed to accommodate vessels with drafts up to 28 feet and lengths under 450 feet. Insufficient for today's vessels.
Non-Federal Anchorages #2,5,6,8	Too shallow for larger vessels.
Curtis Creek Channel	Too shallow for vessels drafting over 33 feet. Lightering required for petroleum products. Potential environmental hazard.
Branch Channels	
South Locust Point	Produce Wharf channel not maintained thereby requiring larger ships to back out of berth and turn during egress.
Seagirt/Dundalk	Narrow widths of East and West Dundalk Channels and Connecting Channel cause delays. Lack of cut-off angles in portions of the system create difficulty in maneuvering.
Turning Basins	Lack of true turning basin at north end of Fort McHenry Channel requires unsafe turning maneuver in Anchorage #1 and main channel.

Estimated damages were $1,808,000 or an average of $18,400 per vessel. However, not all of the vessels experienced damage. The nature of the accidents reported by the Coast Guard included groundings, collisions, engine failure, fires, and steering system failures, among others. About 25 of these recorded vessel accidents (more than 30 percent) occurred in or required the use of Anchorages #2, #3, #4, or the Annapolis Anchorage. This indicates that reliable and usable anchorages are needed to accommodate vessels requiring layover due to accidents, accident repair, mechanical failures, and investigation. The completion of the Baltimore Harbor 50-Foot Project and the trend toward larger commercial vessels may not result in increased frequency of accidents, but it does underscore the need for usable anchorages sufficiently sized to safely harbor the larger commercial vessels.

As part of the feasibility study investigation, the U.S. Coast Guard provided updated information on vessel accidents in the Port of Baltimore through calendar year 1993.

3.2.3.g Recreation. The City of Annapolis is a haven for recreational boating, and conflicts between commercial and recreational vessel traffic are sometimes a problem, specifically in the area of boater safety. The AMP noted that conflicts with recreational boaters can be a problem when commercial vessels are anchored in deep water outside of Annapolis. Recreational boaters are often unaware of the potential use of this area for anchorage of large commercial ships. A serious safety hazard exists when a ship gets underway and the recreational boaters do not perceive the gradual movement of the vessel. The AMP suggested designating an official U.S. Coast Guard-regulated anchorage in this area for commercial shipping vessels in addition to the established Naval Anchorage. This would serve to increase the recreational boaters' awareness of the potential use of this area for commercial shipping by providing information on the U.S. Coast Charts. This effort will be coordinated with the U.S. Coast Guard.

3.2.4 Impacts to Industry

Problems with existing anchorage depth or width can significantly affect the Port of Baltimore coal industry. Coal exports comprise the largest portion of commerce at the port. Due to the nature of coal exports, vessels transporting coal typically require anchorage prior to loading. These vessels must oftentimes wait for berth availability, for coal to arrive at the port, for labor crews, or for bunkering of fuel. Colliers of the type calling on the Port of Baltimore typically draft 36 to 38 feet prior to loading. As discussed above, many of the larger coal vessels are unable to use the existing anchorages in Baltimore Harbor. Vessels which can not use the existing Baltimore Harbor anchorages because of their excessive length or draft are required to anchor at the Annapolis Anchorage Grounds, which are located in naturally deep water south of the Chesapeake Bay Bridge (see Section 2.3.3, Figure 2.5). In some instances, vessels traveling from the C&D Canal will incur increased operating costs from detouring 25 miles to the Annapolis Anchorage Grounds, although the frequency of this occurrence is somewhat lessened due to the limited 35-foot depth of the C&D Canal channel. Requiring vessels to anchor at the Annapolis Anchorage Grounds results in vessel delays.

Deepening and widening of the existing anchorages is needed for these vessels to safely anchor closer to the port facilities.

Other problems affecting the coal industry include the current operation for safe vessel passage in the channels. The existing Baltimore Harbor and Channels project provides for a main shipping channel 50 feet deep and 700 feet wide, extending from Fort McHenry in Baltimore Harbor to naturally deep water south of the Chesapeake Bay Bridge. The AMP is reluctant to pass two Cape-size vessels (e.g., large coal vessels) in these channels due to the extreme size of the vessels in relation to the width of the channel. The existing channel was initially designed to allow a 150-foot-wide Cape-size vessel to safely pass a 106-foot-wide Panamax container vessel. On numerous occasions, Cape-size vessels which anchor at Annapolis are unable to proceed to berth because another vessel of similar dimensions is already at the destined berth or in the upstream leg of the channel. A vessel anchored at the Annapolis Anchorage Grounds is normally required to wait until the vessel-in-transit clears the downstream leg of the channel and passes the anchored vessel at Annapolis. This operating practice can result in delays for the vessel, the shipping agent, the shipper, and the labor crews. These delays could be avoided if a large deep-draft anchorage were available in Baltimore Harbor.

The AMP's intent to provide the best service available to the Baltimore maritime community has resulted in experimentation with passing of Cape-size vessels. During extremely favorable conditions, the AMP has successfully passed two large vessels in the channel bends (angles) between Baltimore and Annapolis, which are slightly larger than the current channel width. However, given the complexity of shipping schedules and the potential for unforeseen delays, such as engine failure or adverse weather conditions, timing passings is usually not practical. The inherent risks associated with such a passing and the potential for collision further emphasize the AMP's reluctance to pass these vessels. Passing can be expected to occur on an irregular basis until a better and safer solution to these problems becomes available.

At the South Locust Point Terminal, vessels drafting less than 26 feet normally exit the berth using the remnant Produce Wharf Channel. This maneuver allows the vessels to continue in the same direction instead of expending time turning around and heading back out of the channel. The ships that draft deeper than 26 feet, thereby utilizing the 36-foot entrance channel, are required to make the 180-degree turn in order to exit. This creates a significant expenditure of time for the deeper-draft, and usually, higher tonnage vessels that call on the terminal. South Locust Point handles roll on/roll off, steel, and other break bulk cargo that are all affected by this limitation.

It is anticipated that deeper-draft container ships will call on the Port of Baltimore, especially the Seagirt Terminal. The liner services require that delays that can be avoided, should be avoided. Container ships travel the world, yet maintain exacting schedules. It is in the liner services' interest to seek out efficient ports; therefore, it is in the interest of the Port of Baltimore to reduce the turnaround time for these vessels. Widening and potentially deepening the channels serving Seagirt and Dundalk would increase the efficiency of the port today as well as position Baltimore to attract more container traffic in the future.

3.3 PROBLEMS IDENTIFIED FOR FURTHER STUDY

As discussed previously in this section, the Baltimore District conducted extensive studies and coordination to determine the problems which have the greatest impact on efficient transit of vessels through the Port of Baltimore system. Section 5 discusses the process of determining the recommended plan for addressing the problems. The problems identified included insufficient anchorage area in the Inner Harbor, insufficient dimensions of branch channels, the lack of a convenient turning basin, and the need for channel angle cut-offs for the sake of vessel safety. Specifically, the following problems were identified for further study in the plan formulation phase of the study: the depth of the remnant Produce Wharf Channel at South Locust Point is insufficient; Inner Harbor anchorages are not capable of providing safe anchorage for the majority of the vessels calling on the port; the dimensions of the branch channels to Seagirt and Dundalk are too small, especially the width of the East and West Dundalk Channels and the Connecting Channel; cut-offs are required at the southeast side of the intersection between West Dundalk and the Fort McHenry Channel, and along the Connecting Channel; and a turning basin capable of handling 1000-foot LOA colliers is required in the area of Anchorage #1.

Section 4

FUTURE WITHOUT PROJECT CONDITION

4.1 FEDERAL OBJECTIVE

The Federal objective of water and related land resources project planning is to contribute to national economic development (NED) consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. This objective was established by the *U.S. Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* published on 10 March 1983.

Water and related land resources project plans are to be formulated to alleviate problems and to take advantage of opportunities in ways that contribute to this objective. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units (i.e., benefits exceed costs). Contributions to NED are the direct net benefits that accrue in the study area and the rest of the nation. Contributions to NED include increases in the net value of those goods and services that are marketed (vendible) and also of those that may not be marketable.

Generally, several alternative plans are formulated to address a particular set of water resource problems. The alternative plan which maximizes the net contribution (amount by which annual benefits exceed annual costs) to the NED objectives, consistent with environmental objectives, is defined as the NED plan. The goal of the feasibility phase for the Baltimore Harbor Anchorages and Channels Study is to evaluate outputs of alternative plans in order to identify the NED plan. One of the alternatives to be considered and evaluated is the "without project" condition.

4.2 PLANNING OBJECTIVES AND CONSTRAINTS

Planning objectives and constraints are used as a guide for the formulation of alternative plans and to evaluate the effectiveness of those plans. The objectives and constraints result from analyses of the existing and most probable future conditions within the context of the physical, environmental, economic, and social characteristics of the study area. They are expressions of public and professional concerns about the use of water and related land resources in a particular study area. For the Baltimore Harbor Anchorages and Channels study, the following objectives and constraints were identified:

- Provide adequate and safe anchorages.
- Provide safe and efficient branch channels.
- Provide additional opportunities for users to benefit from the existing Baltimore

Harbor and Channels project.

- Minimize the adverse impacts to the natural environment.
- Develop a project that will contribute to the growth of the Nation.

4.3 ESTABLISHMENT OF THE WITHOUT PROJECT CONDITION

The primary problem identified in the reconnaissance study was one of delays. Delays in vessels arriving and departing the Port; delays experienced by terminals waiting for vessels to arrive; delays in loading and unloading commodities. Delays incurred by a vessel, or to a vessel, would have ramifications to the rest of the vessel activity and possibly to the infrastructure activities providing support to that vessel and its commodity cargo. These delays increase vessel time in the system and increase cost of the voyage and the commodities being transported. To properly evaluate this problem (and its impacts) more completely in the feasibility study, it had to be better defined and examined.

Given the limited scope of the reconnaissance study effort and its focus on 1989 existing traffic, no long range scenarios of activity in the Port were developed. In order to more fully assess the impacts of alternative improvements on the Port of Baltimore navigation system, it was necessary to develop a "without project" condition that appropriately depicts the activities, interrelationships, and interdependencies that comprise the navigation system. The "without project" condition is the most likely condition expected to prevail over the length of the planning period in the absence of the Federal government implementing plans for improvement. Not only is development of this alternative important to a good understanding of the system components and how the system works, but also because the "without-project" condition provides the baseline against which alternative Federal improvements to the port system are evaluated.

To develop the "without-project" condition, current operations and future activity likely to be experienced by the Port of Baltimore to the year 2050 (a 50-year planning horizon) were identified. Through detailed discussions with the representatives of the Association of Maryland Pilots, the Baltimore Maritime Exchange, tug operators, docking pilots, vessel agents, and terminal operators, an understanding was obtained of the navigation practices and procedures in place in the Port of Baltimore. This effort traced the generic movement of vessels in the system, identified decision points in the voyage, routes taken, operating speed, distance and elapsed time. This effort, and accompanying flow diagram, is presented in detail in Appendix C-Economics.

To improve on the 1989 vessel data used previously, a more current data set was developed encompassing the three-year period of 1991-1993. This was an important element of the overall analysis because the data set reflected increasing use of the newly-constructed 50-foot main channel into the Port of Baltimore (completed in late 1990); provided information on vessels requiring use of anchorages; provided a pattern of arrivals, departures, and time in port; and provided terminal destination and cargo.

To further assist in defining the "without-project" condition, long-range commodity forecast models were specifically developed for this study. These models provided detailed forecasts of the commodity types and commodity tonnages likely to flow through the Port of Baltimore for the years 2000-2050. Given the forecast commodity mix, commodity tonnages and the Port's existing channel constraints, a detailed vessel fleet profile was also forecast. This forecast provided estimates of vessel types, sailing drafts, and number of vessels likely to call on the Port of Baltimore. This data set was also developed in ten-year increments for the period 2000-2050. Additional effort focused on identifying labor costs, pilot fees, vessel operating costs, time in port, and dispatch and demurrage costs.

4.3.1 Land and Water Use

Land use in and around the Baltimore harbor area will continue to be of a highly developed nature. Sites that formerly supported heavy industrial and commercial use will continue to be in demand. Land use will continue to shift away from heavy industry toward commercial (service oriented activities) and residential use. Warehousing and distribution will likely become one of several high employment growth sectors in the region. The shoreline redevelopment of the late 1970's and 1980's that started with the inner harbor commercial ventures will move eastward into the 21st Century. "Brownfield" areas will also spark interest in growth and development opportunities.

Together with the likely transitioning of economic sectors, there will also be increasing attention given to leisure and recreational activities and the infrastructure necessary to support this development. Increased use of public and private marina facilities will lead to increases in the number of recreational vessels in the Baltimore harbor waterways. The location of this growth along the waterfront speaks not only to the rediscovery of the vitality of the Baltimore urban core but also to the integration of site specific characteristics and aesthetics into the potential uses available for redevelopment.

4.3.2 Population

Recent forecasts prepared by the Bureau of Economic Analysis (BEA)for various metropolitan areas indicate that the study area will continue to experience growth in the "without project" condition. As presented in BEA's June 1996 issue of the *Survey of Current Business*, population for the United States as a whole is forecast to be 276.2 million by the year 2000 increasing to 288.3 million by the year 2005. This forecast represents an average annual growth rate of slightly less than one percent per year given the 1993 base year. Population in the Washington-Baltimore Consolidated Metropolitan Statistical Area (CMSA) is forecast to be 7,594,000 by the year 2000 increasing to 7,996,000 by the year 2005. This represents an average annual growth rate of 1.2 percent given the 1993 base year. Population forecasts for the Baltimore, MD, Primary Metropolitan Statistical Area (PMSA) are 2,597,000 for the year 2000 increasing to 2,693,000 by the year 2005. Given the 1993 estimate of 2,444,000, this represents an average annual growth rate of slightly less than one percent per year.

4.3.3 Employment and Industry

Nationwide employment is also projected to increase steadily through the year 2005. Based on BEA employment forecasts presented in the June 1996 issue of *Survey of Current Business*, employment is forecast to be 157.7 million by the year 2000 increasing to 167.8 million by the year 2005. This forecast represents an average annual growth of about 1.5 percent given the 1993 base year of the forecast. Employment in the Washington-Baltimore CMSA is forecast to grow to 4,931,000 by the year 2000 increasing to 5,264,000 by the year 2005. This represents an average annual growth rate of 1.7 percent given the 1993 base year. This rate of employment growth is higher than that of the nation as a whole. Employment forecasts for the Baltimore, MD PMSA are 1,491,000 by the year 2000 increasing to 1,569,000 by the year 2005. Given the 1993 base year, this represents an average annual growth rate of slightly less than 1.5 percent per year.

Job growth in the State of Maryland is forecast to grow to 3,005,000 by 2000 increasing to 3,200,000 by the year 2005. This represents an average annual growth rate of 1.5 percent from the 1995 base year. Industrial sectors forecast to experience high rates of job growth include: Services; Agriculture, Forestry, and Fishing; Retail Trade; State and local government; and Wholesale Trade and Distribution. Accompanying this job growth is an increase in the Gross State Product which is forecast by BEA to grow from $111.4 billion (1987 dollars) in the year 2000 to $121.7 billion (1987 dollars) by the year 2005. This represents an average annual growth rate of 1.9 percent. The forecast growth in Gross State Product is to supported by industrial sectors experiencing large revenue growth and include: Agriculture, Forestry, and Fishing; Services; Wholesale Trade and Distribution; and Transportation and Public Utilities.

4.3.4 Income

Recent BEA forecasts of personal and per capita income indicate moderate growth rates for the nation and the metropolitan areas. Per capita income for the United States is forecast to grow to $17,718 (1987 dollars) by the year 2000 with an increase to $18,752 by the year 2005. This forecast represents an average annual growth in income of 1.3 percent given the 1993 base year. This amounts to an increase of $2,500 (1987 dollars) over the forecast period. Per capita income for the Washington-Baltimore CMSA is forecast to be $21,910 (1987 dollars) by the year 2000 with an increase to $23,041 by the years 2005. These estimates represent an increase of $2,800 (1987 dollars) and an average annual growth of 1.1 percent given the 1993 base year. Per capita income for the Baltimore, MD PMSA is forecast to be $19,724 (1987 dollars) by the year 2000 increasing to $20, 793 by the year 2005. Given the 1993 base year estimate, this represents an average annual rate of increase of 1.3 percent and a $2,700 (1987 dollars) growth in per capita income.

4.3.5 Future Operations & Maintenance Activities

The continued viability of the Port of Baltimore is dependent on many factors one of which is ensuring that channels, berths, anchorages, and turning basins are maintained by periodic dredging and removal of sediments and other material. Due to the public-private nature of the various port operations, responsibility for the continued operation and maintenance (O&M) of the port rests with the owners of the private terminals and the owners of the public terminals. All publicly-owned terminals are the responsibility of the Maryland Port Administration (MPA). As part of the definition of the "without project" condition, shoaling of sediments into the publicly-owned portions of the harbor was examined to identify current and future dredging requirements associated with continuing O&M activities. The areas included in this effort are the several public channels, berths, turning basins, and anchorages described in Section 3. Maintenance dredging activities are programmed to recur every few years depending on the rate of deposition and the frequency of use for a particular element of the port system. As part of the feasibility study, historic shoaling rates and dredging frequency were examined to estimate future requirements of the MPA for dredging, transport, and placement of material in the absence of any Federal improvements. A brief explanation of the results of this analysis is presented below for the harbor elements considered.

4.3.5.a Seagirt West Channel. For this harbor element, an annual dredging requirement of 14,800 cubic yards (cy) of material was identified. Because current practice is to dredge once every few years, given the annual sediment volume, a six-year dredging cycle was identified for the Seagirt West Channel. Therefore, every six years, approximately 89,000 cy would be removed from this channel at a cost of $4.92 per cubic yard. Over the 50-year planning period (2000-2049), total quantity estimated to be removed is 712,200 cubic yards.

4.3.5.b Connecting Channel. An annual dredging requirement of 2,500 cubic yards and a six-year dredging cycle was identified for this element of the harbor system. Every six years, approximately 15,000 cubic yard of material would be dredged from Connecting Channel to maintain its operational viability at an estimated cost of $4.92 per cubic yard. Over the 50-year planning period, total quantity to be removed is estimated to be 121,200 cubic yards.

4.3.5.c Dundalk West Channel. An annual dredging volume of approximately 7,600 cubic yards and a six-year dredging cycle was identified for the Dundalk West Channel element of the harbor system. Every six years, an estimated volume of 45,500 cubic yards would be dredged and placed elsewhere to ensure safe passage through this section at an estimated cost of $4.92 per cubic yard. Over the 50-year planning period, total quantity to be dredged is estimated to be 364,200 cubic yards.

4.3.5.d Dundalk East Channel. For the East Channel of Dundalk Marine Terminal, an estimated 7,300 cubic yards of material would deposit annually. Given a six-year dredging cycle for this channel, an estimated amount of 43,700 cubic yards would be removed and placed elsewhere at a cost of $4.92 per cubic yard. Total quantity to be dredged over the 50-year planning period is estimated to be 349,800 cubic yards.

4.3.5.e South Locust Point. For the channel section supporting terminal operations at South Locust Point Marine Terminal, 1,500 cubic yards of material is estimated to be deposited annually. With a 6-year dredging frequency, an estimated 9,000 cubic yards would be removed from the channel and placed elsewhere at a cost of $4.92 per cubic yard. Over the 50-year planning period, this amounts to an estimated 72,000 cubic yards of material to be removed.

4.3.5.f Main Channel - Anchorage # 1. To ensure maintenance of authorized dimensions in the Main Channel -Anchorage #1 element of the harbor system, estimated annual shoaling of 10,000 cubic yards would be removed every 5 years. Therefore, an estimated 50,000 cubic yards of material would be removed from this area every 5 years at a cost of $4.92 per cubic yard. Over the 50-year planning period, this amounts to an estimated 500,000 cubic yards of material to be removed.

4.3.5.g Anchorage # 3. For the harbor element identified as Anchorage #3, shoaling is estimated to be 25,000 cubic yards on an annual basis. Given a 10-year dredging frequency, an estimated quantity of 250,000 cubic yards would be removed at a cost of $4.92 per cubic yard. This amounts to an estimated 1,250,000 cubic yards of material to be removed and placed elsewhere.

4.3.5.h Anchorage # 4. For Anchorage #4, annual shoaling is estimated to be 7,000 cubic yards. With a 10-year dredging cycle, 70,000 cubic yards of material would likely be removed at an estimated cost of $4.92 a cubic yard. Over the course of the 50-year planning period, this amounts to an estimated 350,000 cubic yards of material to be removed and placed elsewhere to maintain continued operational viability of this element of the harbor system.

4.3.5.i Cumulative O & M. With the dredging volumes and dredging frequencies identified for each of the system elements above, cumulative operation and maintenance requirements can be estimated for the 50-year planning period. Given current dimensions of the channel, anchorage, and berth elements of the harbor system and the continued use of these elements, total estimated dredging requirements over the 50-year planning period are estimated to be 3,719,000 cubic yards. This information is summarized in Table 4-1.

4.3.6 Water Quality

Water quality in the Baltimore harbor has shown trends of improvement in recent years due to increased treatment of industrial and domestic pollution sources. There is strong potential for further improvements that should enhance the presence of fish and crabs in the study area. Recovery of the benthic community is more difficult because of the persistence of contaminants in the bottom sediments.

4.3.7 Sediment Quality

The contaminated conditions in the area will gradually improve but still be contaminated. Sediments deposited in the harbor by the shoaling process of several millimeters per year would likely be cleaner due to compliance with improved environmental regulations and reduction in point-source discharges. This thin layer of cleaner sediment would be mixed by the churning of the sediment in the Bay traffic and would not be observed for many years. All sediments deposited in the harbor by the shoaling process can be assumed to be very soft, highly plastic, silty clays.

Table 4.1
Cumulative O&M Requirements

LOCATION	ANNUAL MAINTENANCE REQUIREMENT	MAINTENANCE DREDGING CYCLE	QUANTITY PER DREDGING CYCLE	TOTAL AMOUNT FOR PLANNING PERIOD
SEAGIRT WEST	14,838	6 YEARS	89,028	712,224
CONNECTING CHANNEL	2,525	6 YEARS	15,150	121,200
DUNDALK WEST CHANNEL	7,588	6 YEARS	45,528	364,224
DUNDALK EAST CHANNEL	7,288	6 YEARS	43,728	349,824
SOUTH LOCUST POINT CHANNEL	1,500	6 YEARS	9,000	72,000
MAIN CHANNEL-ANCHORAGE #1	10,000	5 YEARS	50,000	500,000
ANCHORAGE # 3	25,000	10 YEARS	250,000	1,250,000
ANCHORAGE # 4	7,000	10 YEARS	70,000	350,000
TOTAL	**75,739**			**3,719,472**

4.3.8 Commodity Trends

Analyses conducted by DRI/McGraw Hill show that the movement of commodity tonnages worldwide is forecast to grow at a healthy rate as population increases and expansion of trade among world partners occurs. Less developed countries will continue to move toward manufacturing goods for export while those areas of the world with abundant fossil fuel reserves will mine and market them to the world. The United States export trade with the world is forecast to grow from a 1993 amount of 355,400,000 metric tons to 537,400,000 metric tons by the year 2010, ultimately increasing to 1,870,600,000 metric tons in 2050. Imports to the United States are forecast to grow from 538,600,000 metric tons in 1993 to 978,100,000 metric tons in 2010, and to 3,938,900,000 metric tons by the year 2050. This increase in trade at the world and national levels will positively impact the commodity and vessel activity at the Port of Baltimore.

Commodities and tonnages handled through the Port of Baltimore will increase steadily through the year 2010. From a 1993 total commodity flow of 22,900,000 metric tons, commodity flows through Baltimore are forecast to be 37,590,000 metric tons by the year 2010. This approximates an average annual growth in tonnage of 2.95 percent. Beyond 2010, commodity flows are projected to grow at an average annual rate of 2.93 percent by the year 2050 to a total of 118,787,000 metric tons. Major commodities expected to move through Baltimore are grain; coal and coke; lumber and plywood; iron and steel; automobiles; cement and lime; and light industrial equipment. The forecasts of commodities and tonnages flowing through the Port of Baltimore are derived from a global view of international trade. As explained more fully in Appendix C-Economics, the Port of Baltimore forecasts are dependent on forecasts of U.S. total trade and North Atlantic regional trade. The regional trade forecasts are allocated to the various east coast ports based on a fixed port share of the individual coastal forecast (in this case, the North Atlantic). Forecasts are not tied to infrastructure. Any required facilities or capacities are assumed to be available. Table 4.2 presents Port of Baltimore tonnage forecasts for the "without project" condition.

Table 4.2
Port of Baltimore Total Trade Forecast
(Metric Tons in Thousands)

	1993	2000	2010	2020	2030	2040	2050
Outbound	11,644.7	13,749	16,154	23,311	29,641	31,759	36,358
Inbound	11,259.6	16,038	21,436	33,624	42,139	59,084	82,429
Total	22,904.3	29,787	37,590	56,935	69,780	90,843	118,787

4.3.9 Vessel Fleet Trends

To move these increasing commodity flows through the Port of Baltimore, vessel calls and vessel sizes are projected to increase in the "without project" condition based on the results of analyses conducted by DRI/McGraw-Hill. Total vessel calls to the Port of Baltimore, based on the commodity flows discussed above, are forecast to increase from a 1993 total of 2,200 vessels to over 3,400 vessels a year by the year 2000. The vessel fleet calling on Baltimore is forecast to be 4,800 vessels by the year 2010, almost doubling by the year 2020 to a total of 7,700 vessels, and reaching more than 20,000 annual vessel calls by the year 2050. The mix of vessels forecast to call on the Port of Baltimore will continue to comprise various sizes of container vessels; dry bulk vessels; tankers; general cargo-break bulk vessels; and vehicle carriers. For purposes of this analysis, the vessel fleet was disaggregated to 38 vessel classes defined by ranges of design capacities. Based on these vessel classes, the vessel fleet likely to call on the Port of Baltimore was identified as well as the relative share provided by the differing vessel classes.

4.3.10 Future Port Facilities

The Port of Baltimore will continue to function as one of America's busiest deep-water ports. Its waterside and landside infrastructure will continue to accommodate a diverse mix of commodities and vessel types throughout the planning period. Both public and private terminal operations in the Port of Baltimore are undergoing improvements in landside and waterside infrastructure to accommodate forecast growth in trade. Additionally, the State of Maryland continues to improve its network of highways widening major portions of the interstates to accommodate increases in trucking and automobile use. Cargo handling facilities at BWI Airport are also being upgraded. Double-stacking of containerized cargo on rail systems servicing Baltimore is almost a reality with most of the aerial constrictions eliminated. The Seagirt terminal, opened in 1990, is experiencing much success in loading/unloading containerized cargo. Productivity rates are increasing along with vessel calls.

The Maryland Port Administration continues to plan for the long term. An additional berth is being constructed at the state-of-the-art Seagirt Marine Terminal facility to accommodate the future traffic calls. It is likely that the additional Seagirt berth will be operational by the year 1998. A detailed engineering study is currently being prepared to determine if the berths at the Dundalk Marine Terminal can be deepened. Preliminary information suggests that deepening to 42 feet is possible. Deepening of the berths at Seagirt Marine Terminal has also been considered; however, it is unlikely that the berths could be deepened more than one foot due to the structural limitations of the bulkhead. Furthermore, plans for a new terminal facility are being considered. This new terminal would be oriented toward handling automobiles and general cargo vessels and likely will not be fully operational until the 2010-2020 time frame. A location being proposed for this facility is the land area known as Masonville which is across the Ferry Bar Channel section from South Locust Point.

Improvement of port facilities is not focused only on capital infrastructure; rather it is focused on the entire system of delivery, loading, unloading, and departure. While the port community continues to improve its capital equipment both on land and in water, concomitant efforts will occur to continue productivity gains in landside loading and unloading. Port maritime employers and employees have already realized gains in productivity due to increases in working hours at various terminals coupled with more flexibility in loading and unloading vessel cargo. This has had the effect of moving vessels through the Port system faster--and getting cargo to its ultimate destination sooner. For the purpose of identifying the "without project" operating condition, known plans for infrastructure improvement cited above have been incorporated into its definition. Furthermore, given the landside productivity gains that will continue to be realized over time, an average vessel time "at berth" of 24 hours for vessels expected to call the Port has been incorporated into the "without project" condition.

Use of anchorages is a factor that influences the Port system ability to move vessels through the system. While regulations exist governing and limiting use of anchorages in the Port of Baltimore, anecdotal data and vessel movement records indicate non-enforcement of these existing regulations. This existing use and enforcement scenario is also incorporated into the "without project" condition.

4.3.11 Future Dredged Material Placement Areas

In addition to the continued use of Hart-Miller Island, the MPA plan for future placement of dredged material includes development of two adjacent sites, known as the CSX and Cox Creek sites, which will be used for material from the harbor and anchorages project. The MPA has acquired the CSX site and is negotiating the purchase of the Cox Creek site. The existing dikes surrounding the containment area of each site will be raised in order to provide 6 million cubic yards of capacity. The current MPA schedule indicates that the CSX site will be ready for use in the 1997 dredging season. The Cox Creek site is scheduled to be ready for use in 1997-98. In the absence of a project from this study, the sites would still be made available to accept material from other Federal and non-Federal dredging projects within the harbor. The MPA continues to work to identify more sites for future use, see Section 2.10.

4.4 ANALYSIS OF WITHOUT PROJECT CONDITION

While the aforementioned analyses were being conducted, the means for identifying and quantifying key parameters was being developed. During the review and approval of the Reconnaissance study, queuing analysis and simulation modelling were identified as the best techniques with which to identify waiting (queuing) times and quantify costs associated with queues. Simulation modelling was selected as the more appropriate of the two techniques and a detailed simulation model of the Port of Baltimore was developed. Simulation modelling allows for a system-wide assessment of the impacts of various alternatives at various locations within the port system. Simulation is a way to perform sampling experiments on a system. Rather than solving analytically (such as through use of a static queuing model) for time spent in the system and associated operational costs, simulation modelling solves for a discrete "length of time" for any number of vessel arrivals and services. The result is a simulation of actual operation of the queuing process where the aggregate results of these individual events are recorded. Simulation provides the ability to capture the dynamics of the system.

Simulation modelling is usually required in those situations which possess a great deal of complexity and some level of uncertainty or variability. The problems encountered in the Port of Baltimore are highly variable including such factors as vessel arrival and departure times, loading and unloading, origins and destinations, and route selection. It is important to indicate that the computer program simulates vessel traffic movement; it does not mimic traffic movement. However, the simulation program is calibrated to actual traffic for key characteristics (such as vessel type, length, breadth, and terminal destination). In this fashion, program runs will produce vessel flows (i.e. movements) that have characteristics similar to that observed in the real world. The average number of simulated departures from a given port will be close to that of the actual port. The average number of vessels in the simulated channel system at any point in time will be similar to that observed. By simulating the environment in this manner, one can analyze the effect of alternative scenarios on the system effectiveness without physically implementing the changes.

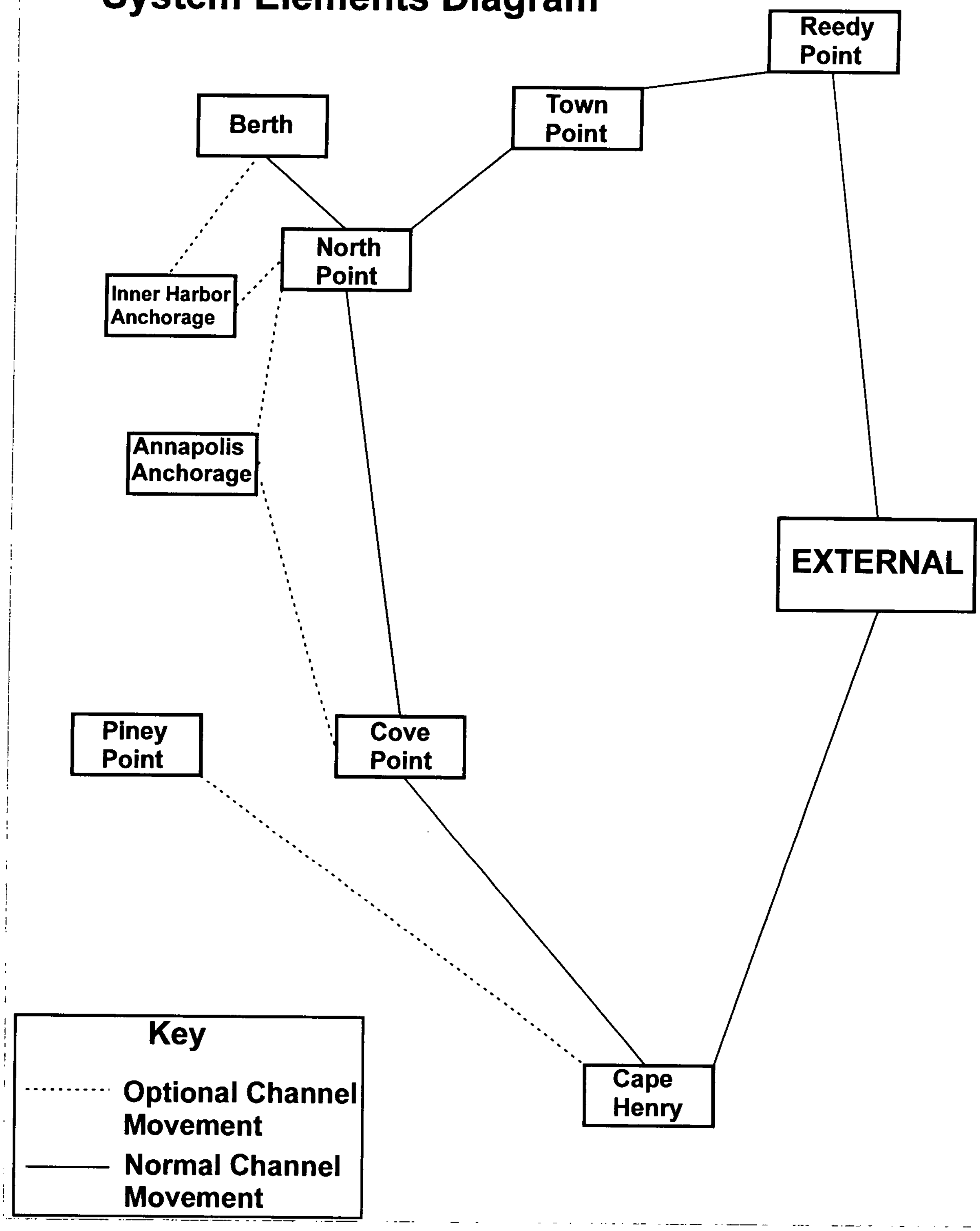
Another important aspect of simulation modelling is that a single run of the simulation does not provide a definitive answer. Within each environment, several simulation runs of several simulate days must be executed. Multiple runs are required to determine the variability present. For the analyses undertaken as part of this feasibility study, five simulation runs were produced for the "without project" condition (and each alternative considered). Each simulation routine was executed for a 150-day period of activity in the Port of Baltimore.

A number of factors are potentially influential in simulating channel and anchorage operations. These may include items such as vessel data, channel and anchorage configuration, berth and terminal location and operation, operating policies, weather, and accidents. For this feasibility study, the primary items are the first four factors. No attempt was made to account directly for weather conditions over time, and casualty effects were not critical to the analysis. The simulation model developed for the Port of Baltimore vessel movement system consists of 3300 lines of code which define the typical and optional movement patterns that occur in the Port system. Figure 4.1 provides an overview of the system and the options available to vessels.

Figure 4.1 reflects the basic elements of vessel transit in the Port of Baltimore Harbor system. There are two entry points; one by means of the Chesapeake and Delaware (C&D) Canal, and one through Cape Henry. Any vessel entering the Baltimore Harbor system is either destined for Piney Point, MD, or one of the many terminal and docking facilities in the Port of Baltimore. The system developed and used in this feasibility study ignores all Piney Point traffic. Some vessel movements and stops are fundamental, undertaken by every vessel that enters the system. These activities are represented in Figure 4.1 by solid lines and rectangles. Such fundamentals include: transit time from entry point to dock; maneuvering within a branch channel; berthing and deberthing activities; servicing of vessel at dock; and departure. Other movements and stops are auxiliary or optional, in the sense that they facilitate the effectiveness of the Baltimore Harbor system, but are not undertaken by every vessel during a trip. Such auxiliary elements are entry into, departure from, or use of an anchorage, and layovers at docks.

The opportunity for vessel interactions are abundant and are illustrated within Figure 4.1. Interactions may be either flow-oriented or facility-based. Flow-oriented interactions include vessel meetings on channels, vessel passings on channels, and vessel holds for transit completions. Facility-based interactions include anchorage exclusions and dock departure holds. Anchorage exclusions occur when a vessel is precluded form using an anchorage because of the

Figure 4.1
System Elements Diagram



presence of another vessel in the anchorage. Specifics of these interactions and their relationships to branch channels and anchorage modifications will be discussed later.

The simulation input files contain information on the various terminals servicing the vessels calling on the Port of Baltimore. Anchorage and branch channel "data cells" are also identified by ship count and ultimate terminal destination. Ship classes calling on the Port for the period of time(s) considered are represented by the 38 vessel types referred to in previous sections. Figure 4.2 provides a definition of these various vessel types.

Figure 4.2
Definition of Vessel Types

AA - General Cargo > 10,000 DWT
AB - General Cargo < 10,000 DWT
A1 - Cellular < 1000 TEU
A2 - Cellular 1000-2499 TEU
A3 - Cellular 2500-3999 TEU
A4 - Cellular 4000-5999 TEU
A5 - Cellular 6000-7999 TEU
A6 - Cellular > 8000 TEU
AE - Roll On/Roll Off > 10,000 DWT
AF - Roll On/Roll Off < 10,000 DWT
BA - Reefer (Refrigerated Vessel)
DA - Bulk < 20,000 DWT
DB - Bulk 20-40,000 DWT
DC - Bulk 40-80,000 DWT
DD - Bulk 80-100,000 DWT
DE - Bulk 100-175,000 DWT
DF - Bulk > 175,000 DWT
EA - Combination < 20,000 DWT
EB - Combination 20-40,000 DWT
EC - Combination 40-80,000 DWT
ED - Combination 80-100,000 DWT
EE - Combination 100-175,000 DWT
EF - Combination > 175,000 DWT
FA - Tanker < 10,000 DWT
FB - Tanker 10-40,000 DWT
FC - Tanker 40-80,000 DWT
FD - Tanker 80-100,000 DWT
FE - Tanker 100-175,000 DWT
FF - Tanker 175-250,000 DWT
FG - Tanker > 250,000 DWT
PA - Product Tanker < 10,000 DWT
PB - Product Tanker 10-40,000 DWT
PC - Product Tanker 40-80,000 DWT
PD - Product Tanker 80-100,000 DWT
PE - Product Tanker > 100,000 DWT
GA - Gas Tanker
HB - Vehicle Carrier
XX - Other

Note: DWT = Deadweight Tonnage, TEU = Twenty Foot Equivalent Units

To assist in defining capacity requirements in anchorages and branch channels, the vessel classes forecast to call on the Port of Baltimore were defined in terms of averages for width, draft, length overall, and vessel operating costs. Figure 4.3 provides a listing of the vessel dimensions by particular class. This information reflects the average size of all vessels in each class and is taken from information contained in the FY 1995 Corps of Engineers Planning Guidance for Deep Draft Vessel Costs. This information also served as the basis for determining operating costs for the vessels. Figure 4.4 provides a listing of the vessel class distributions forecast to call on the Port of Baltimore over the study period.

Various simulation runs using the 1991-1993 vessel movement data set were produced to identify the most appropriate year, season or period to use as the starting point for full establishment of the "without project" condition. The following periods were considered: winter 1991; spring 1991; summer 1991; fall 1991; cumulative 1991; cumulative 1992; cumulative 1993; and 1991-1993 cumulative. The 1991-1993 smoothed period, and its vessel operating characteristics, served as the basis for simulating the "without project" condition alternative and the various improved condition runs.

Figure 4.3
Class Definitions

Class	Width (feet)	Draft (feet)	Length Overall (LOA, feet)
A1	73	25	482
A2	94	34	676
A3	112	41	853
A4	117	43	905
AA	76	32	542
AB	64	25	447
AE	76	32	542
AF	64	25	447
DA	67	28	478
DB	83	34	583
DC	105	43	717
DD	119	49	780
DE	136	55	910
EC	109	42	585
ED	125	47	800
FA	76	30	519
FB	87	34	585
FC	109	42	585
FD	125	47	800
HB	64	25	447
PA	76	30	519
PB	87	34	585
PC	109	42	585
PD	125	47	800

The distribution of vessel types and vessel calls found in this period provided the basis for allocating vessel activity to the various terminals and berths expected to exist during the planning period. This was done for each of the benchmark years of 2000-2050 and includes terminals and berths not present in the existing condition but likely to be operational during the planning period.

Figure 4.4
Vessel Calls Per Day

	2000	2010	2020	2030	2040	2050
Number/day	9.4	13.2	20.8	28.6	40.0	55.6
Percentage By Class	%	%	%	%	%	%
AA	11	9				
AB	2	1				
A1	3	4	5	6	6	5
A2	23	22	20	19	18	17
A3	6	7	9			
A4	3	6	9	12	16	20
AE	16	17	16	15	15	14
AF	1					
DA	5	6	4	3	2	1
DB	6	6	6	5	4	3
DC	3	3	2			
DD	1					
DE	2	3	4	4	5	7
EC	1					
ED	1					
FA	1					
FB	1					
FC	1					
FD	1					
HB	8	8	8	8	7	7
PA	1					
PB	1					
PC	1					
PD	1					

Shown in Figure 4.5 is a sample simulation output file which summarizes the results of one 150-day simulation of vessel activity in the Port. System operating costs include: vessel operating costs; pilotage costs; dispatch - demurrage costs; and total operating costs. To develop the "without project" condition operating costs for vessels using the Port of Baltimore navigation system, randomly-generated simulations produced a minimum of 5 output scenarios for each benchmark year. During the course of the simulation modelling process, total cost outputs indicated increasing demands were being placed on the available port infrastructure. This is due to a combination of factors including but not limited to, increased vessel calls, limited loading/unloading capacity, and loading/unloading productivity rates. In several instances beginning in the 2030 time frame, the modelling efforts revealed Port infrastructure limitations were creating queues resulting in unreliable output. Because of this, the outputs and benefits identified were truncated at year 2030 and were held constant for the 2040 and 2050 benchmark years. This "without project" condition served as the basis for subsequent evaluation of branch channel improvements and anchorage berth improvements and is quantified in Figure 4.6.

Figure 4.5
Sample Simulation Output File

```
SMOOTH Baltimore existing condition 2000          S00A091      119

Existing condition rand1

        anchorage #      1 is anc1
        anchorage #      2 is anc2
        anchorage #      3 is anc3
        anchorage #      4 is anc4
        anchorage #      5 is anc5
        anchorage #      6 is anc6
        anchorage #      7 is annap
doing       1 runs, each of       150 days
```

~~~~~~~~~~~~~~~ SYSTEM COSTS ~~~~~~~~~~~~~~~

CLASS	TRIPS	TIME (HRS)	OP.COST ($)	PIL.COST ($)	D.D.COST ($)	TOTAL ($)
A1	41	1361.	1004274.	43865.	0.	1048139.
A2	324	10768.	13675481.	279470.	0.	13954951.
A3	98	3260.	4864130.	86174.	0.	4950305.
A4	39	1281.	2131285.	32172.	0.	2163457.
AA	143	4836.	3632109.	125108.	-1265538.	2491679.
AB	29	989.	569576.	24806.	-256686.	337696.
AE	220	7569.	5684207.	179287.	0.	5863494.
AF	17	557.	320598.	15051.	0.	335649.
DA	73	2519.	1420514.	92113.	-636078.	876549.
DB	107	3926.	2716911.	100359.	-867132.	1950137.
DC	46	1900.	1687208.	105643.	-285763.	1507088.
DD	19	700.	734812.	52891.	-145085.	642618.
DE	30	1960.	2416115.	32243.	47542.	2495900.
EC	20	773.	895136.	15844.	-152435.	758545.
ED	14	788.	1018771.	10252.	-27002.	1002021.
FA	12	451.	401420.	11209.	-97406.	315222.
FB	12	398.	386799.	9627.	-107333.	289093.
FC	16	598.	692874.	14357.	-130821.	576411.
FD	15	548.	708148.	13248.	-126373.	595023.
HB	123	4585.	2640793.	97890.	-1000196.	1738488.
PA	19	697.	621400.	12991.	-159131.	475260.
PB	18	616.	597829.	16906.	-159122.	455613.
PC	11	428.	495890.	8490.	-84580.	419800.
PD	14	492.	636571.	10708.	-119534.	527745.
TOW	0	0.	0.	0.	0.	0.
TOTAL	1460		49952852.	1390705.	-5572673.	45770885.

~~~~~~~~~~~~~~~ SYSTEM COSTS ~~~~~~~~~~~~~~~

CLASS	TRIPS	TIME (HRS)	OP.COST ($)	PIL.COST ($)	D.D.COST ($)	TOTAL ($)
A1	41	1361.	1004274.	43865.	0.	1048139.
A2	324	10768.	13675481.	279470.	0.	13954951.
A3	98	3260.	4864130.	86174.	0.	4950305.
A4	39	1281.	2131285.	32172.	0.	2163457.
AA	143	4836.	3632109.	125108.	-1265538.	2491679.
AB	29	989.	569576.	24806.	-256686.	337696.
AE	220	7569.	5684207.	179287.	0.	5863494.
AF	17	557.	320598.	15051.	0.	335649.
DA	73	2519.	1420514.	92113.	-636078.	876549.
DB	107	3926.	2716911.	100359.	-867132.	1950137.
DC	46	1900.	1687208.	105643.	-285763.	1507088.
DD	19	700.	734812.	52891.	-145085.	642618.
DE	30	1960.	2416115.	32243.	47542.	2495900.
EC	20	773.	895136.	15844.	-152435.	758545.
ED	14	788.	1018771.	10252.	-27002.	1002021.
FA	12	451.	401420.	11209.	-97406.	315222.
FB	12	398.	386799.	9627.	-107333.	289093.
FC	16	598.	692874.	14357.	-130821.	576411.
FD	15	548.	708148.	13248.	-126373.	595023.
HB	123	4585.	2640793.	97890.	-1000196.	1738488.
PA	19	697.	621400.	12991.	-159131.	475260.
PB	18	616.	597829.	16906.	-159122.	455613.
PC	11	428.	495890.	8490.	-84580.	419800.
PD	14	492.	636571.	10708.	-119534.	527745.
TOW	0	0.	0.	0.	0.	0.
TOTAL	1460		49952852.	1390705.	-5572673.	45770885.

FIGURE 4. 6

WITHOUT PROJECT CONDITION
PORT OF BALTIMORE
SYSTEM OPERATING COSTS
(1995 PRICES)

	YEAR 2000	VESSEL CALLS	YEAR 2010	VESSEL CALLS	YEAR 2020	VESSEL CALLS	YEAR 2030	VESSEL CALLS	YEAR 2040	VESSEL CALLS	YEAR 2050	VESSEL CALLS
RUN 1	$48,710,769	1,459	$71,159,552	2,017	$226,316,363	3,093	$330,897,105	4,137	$330,897,105	4,137	$330,897,105	4,137
RUN 2	$44,671,334	1,366	$68,222,643	1,963	$229,457,244	3,026	$312,699,516	4,086	$312,699,516	4,086	$312,699,516	4,086
RUN 3	$44,976,301	1,402	$71,491,084	1,968	$228,061,025	3,065	$317,353,645	4,130	$317,353,645	4,130	$317,353,645	4,130
RUN 4	$42,054,849	1,303	$66,477,635	1,867	$178,021,316	2,992	---------	---	---------	---	---------	---
RUN 5	$46,841,511	1,401	$73,024,495	1,960	$217,788,858	2,959	---------	---	---------	---	---------	---
AVERAGE	$45,450,953	1,386	$70,075,082	1,955	$215,928,961	3,027	$320,316,755	4,118	$320,316,755	4,118	$320,316,755	4,118
TOTAL COSTS	**$110,597,318**	**3,373**	**$170,516,032**	**4,757**	**$525,427,139**	**7,366**	**$779,437,438**	**10,020**	**$779,437,438**	**10,020**	**$779,437,438**	**10,020**

NOTE: AVERAGES SHOWN ARE BASED ON A 150-DAY SIMULATION OF DAILY VESSEL MOVEMENTS IN THE PORT OF BALTIMORE. THE RESULTANT OPERATING COST CHANGES ARE CONVERTED TO A 365-DAY BASIS TO REFLECT ANNUAL SYSTEM COSTS.

Section 5

PLAN FORMULATION

Plan formulation is the process of considering all possible measures or alternatives for improvement and systematically evaluating them in order to determine the recommended plan. This includes a comprehensive screening program followed by more detailed analysis. The final recommended plan (see Section 6) is the one that best satisfies the Federal objective (see Section 4). This section also serves as the alternatives analysis required for NEPA documentation.

5.1 MANAGEMENT MEASURES

There are numerous measures which can impact the efficient movement of waterborne commerce. A variety of structural and non-structural measures were evaluated to include various aspects of the waterborne transportation systems. Some of these non-structural waterway measures are currently part of the existing operating practices. Management measures include those which are within the authority of the Federal government to implement, as well as those which are within the authority of the non-Federal entities, port authorities, port communities, pilots, and shipping agents.

5.1.1 Structural Measures

Formulation of structural alternatives were focused on identifying improvements to the anchorages and branch channels serving the Port of Baltimore. Various measures were screened to determine the least costly and most beneficial means of improvement. The types of measures which could be considered for improvements to the Baltimore Harbor anchorages and branch channels are discussed in the following sections.

Many of the measures discussed below were first evaluated during the reconnaissance study. Some of these measures were eliminated for various reasons. For example, fixed moorings did not appeal to the pilots or the MPA because of safety concerns. Interviews with the pilots indicated that a fixed mooring anchorage was not a viable alternative due to the need for a launch and crew to assist in handling the mooring lines. The climate in this region of the U.S. allows for typically cold winters with periods of ice and severe winter storms, which create hazardous conditions. In addition, the pilots were unaware of any other local ports with a mooring design for large deep-draft vessels that they could use for comparison. For these reasons, fixed moorings were not considered further during the reconnaissance study.

One of the purposes of the feasibility study is to evaluate as many potential plans of improvement as practical in an effort to identify the most viable alternative. In order to limit the number of alternatives addressed in this report, only structural measures that appeared reasonable for implementation based on engineering judgement in Baltimore Harbor were examined in detail.

5.1.1.a Fixed Moorings. Fixed moorings allow a vessel to be held in place by lines attached to the bow and stern, thus requiring a mooring area relative to the length and beam of the vessel. The use of fixed moorings is generally constrained to areas where space is limited, either physically or economically, or where other considerations dictate this option. Fixed moorings can be constructed of conventional pile structures, sheet pile cells, beams, flexible dolphins, or any combination of these structures.

Sea islands are similar to a conventional pier. The main components are berthing and mooring dolphins, which are designed to absorb the impact load when a vessel is moored against the island. A diagram of a sea island is provided in Figure 5.1. Berthing and mooring procedures at sea islands are similar to those at conventional piers. Mooring a vessel at a sea island requires the use of tugs to maneuver the vessel and a crew on the sea island to secure the lines. A launch is normally used to transport the crew to and from the sea island.

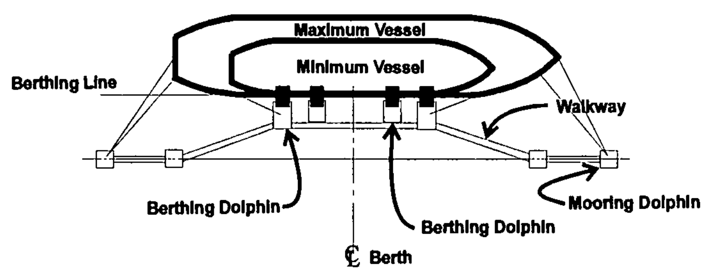
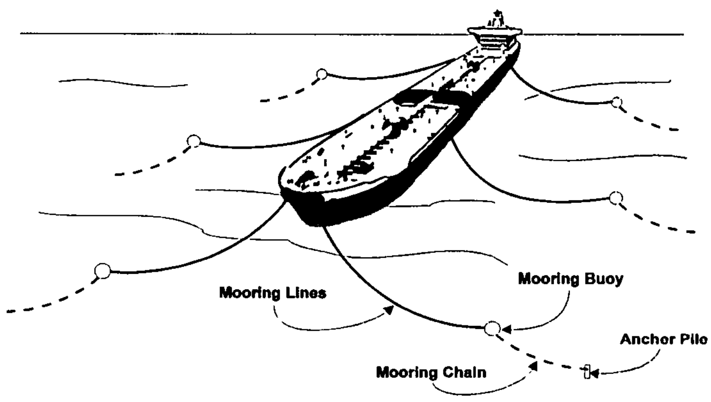


Figure 5.1
Sea Island - Fixed Mooring

The major advantage of a sea island over other types of moorings is that a vessel can be held in a relatively small area, thereby reducing initial and maintenance dredging requirements. This is especially beneficial in areas where shoaling is a problem. However, there are numerous disadvantages to sea islands, including an extremely high initial construction cost, as well as continued costs for maintenance of the sea island, the launch, and the crew. In addition, sea islands can not be used for berthing if weather conditions prevent the tugs from maintaining complete control of the vessel. The need for a crew to access the island when mooring a vessel is another disadvantage to the sea island, especially in moderate climates where conditions for ice and storms exist.

5.1.1.b Multiple-Point Moorings. Multiple-point moorings are designed to hold a vessel in position using a series of buoys in a circular pattern around a desired location. An example of a multiple-point, or spread mooring, is shown in Figure 5.2. While this configuration allows greater ship movement than a sea island, it is generally more rigid than a single-point mooring system. Another advantage of the spread mooring is that vessel movement remains controlled even if one of the mooring lines fail. However, there are several disadvantages to spread moorings. Maneuvering a vessel into a spread mooring configuration is a tedious process that requires exact control of the vessel both under its own power and with tug assistance. The use of a launch and crew is also required to attach the vessel mooring lines to the fixed buoys, which contributes to the cost of this alternative. Maneuvering into a spread mooring can become difficult as well as hazardous for the crew during periods of moderate seas, wind, and/or icy conditions. Sufficient maneuvering area similar to a free-swinging mooring is also required for spread moorings in the event that a vessel begins to swing on the bow or stern line. Finally, costs for construction of spread moorings can be high given that the fixed moorings must be sufficiently anchored to absorb the stresses associated with vessel movement.

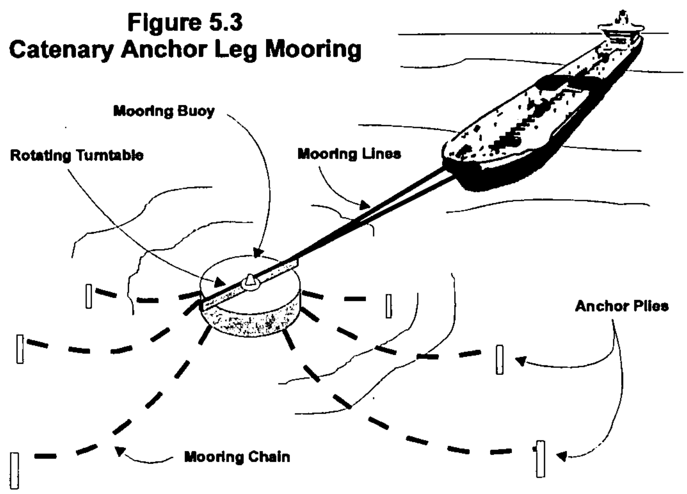
Figure 5.2
Multiple-Point Mooring



5.1.1.c Single-Point Moorings. A single point mooring is designed to allow the free-swinging movement of a vessel about a single point. The design permits the ship to adjust to changes in wind direction and current without having to adjust the mooring lines or vessel orientation. As the wind and/or currents change, the vessel simply rotates about a central point thereby assuring that the ship does not swing into the channel, bank, or another vessel. Single-point moorings require a dredged area having a minimum radius equal to the ship's length plus the length of the mooring lines. There are generally two types of single-point moorings: a fixed-point mooring and a ship's anchor (unfixed) mooring. Within the category of fixed moorings, two types are commonly used: the Single Anchor Leg Mooring (SALM) and the Catenary Anchor Leg Mooring (CALM).

Fixed moorings have been used widely by the petroleum industry. The CALM is the most widely used type of fixed mooring; an example of a CALM is shown in Figure 5.3. The CALM is composed of a moored buoy to which a vessel is connected by a mooring line. The buoy remains relatively fixed in place, while a turntable on top of the buoy allows the vessel to rotate in response to changes in wind and/or currents. A SALM is similar in concept to the CALM, as shown in Figure 5.4. The major differences between the two are that a CALM utilizes between four and eight anchored catenary chain legs, while the base of the SALM itself is anchored utilizing piles. In addition, the buoy in the SALM actually rotates, while a turntable in the CALM rotates and the buoy remains fixed.

Figure 5.3
Catenary Anchor Leg Mooring



The procedures for maneuvering a vessel into a fixed single-point mooring usually involves the use of a launch and crew as well as tug assistance. The vessel is maneuvered to a point approximately 100 to 300 feet from the mooring. The launch crew is responsible for attaching the ship's lines to the mooring. Fixed single-point moorings are relatively stable and can normally retain a vessel in position during periods of severe weather. However, there are several disadvantages to these types of moorings. First, these types of structures require a significant foundation for supporting the stresses created by the moored vessels, and the construction of these foundations can be very costly. The structures also require a large dredged area to allow the vessel to rotate about the mooring. Fixed single-point moorings are not always accessible for use. Due to the need for launch assistance to handle mooring lines, vessels moored to a fixed single-point mooring can not depart during periods of severe weather and/or high waves, nor can an incoming vessel be moored to the structure.

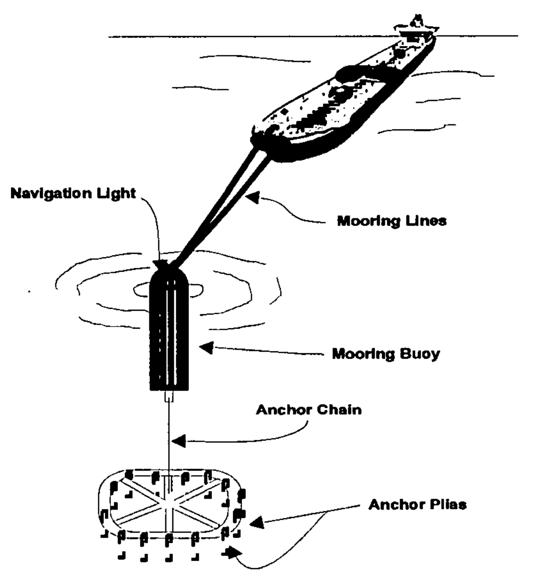
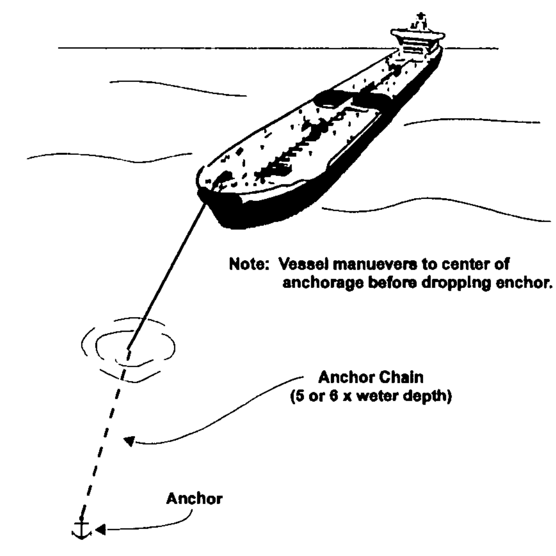


Figure 5.4
Single Anchor Leg Mooring

Another type of single-point mooring which is more commonly used is the ship's anchor and chain, or free-swinging mooring. This type of mooring is the simplest in concept and usually the least expensive option since it does not require any structures, nor does it require a launch and crew for mooring. The major difference between the anchor mooring and a fixed single-point mooring, such as the CALM, is that the mooring device is placed by the crew of the moored vessel by simply dropping anchor in a specified location, as shown in Figure 5.5. The procedures for maneuvering and anchoring a vessel are relatively straightforward, and can be accomplished in nearly any weather condition, as long as the vessel can be positioned under its own power or with tug assistance. Normally, the ship is positioned near the center of the anchorage area, heading into the prevailing wind and/or current. The ship's anchors are then dropped and the chain is payed out. To leave the anchorage, the vessel simply pulls forward, and the chain is hoisted until the anchor breaks free. As mentioned previously, the major advantage of the anchor mooring is that there are no structural costs other than dredging of the anchorage. In addition, anchor moorings can be used in nearly any weather condition as long as the vessel can be positioned properly. As the vessel rotates in response to wind and currents, the forces applied against the anchor and lines are reduced. In severe conditions, the ship can utilize its own power to reduce the net effect of the forces on the anchor and chain.

Figure 5.5
Anchor Mooring



5.1.1.d Channel Modifications. Channel modifications can benefit the existing navigation system by preventing or reducing the occurrence of vessel accidents and damages, by improving efficiency for current users, and by attracting more and larger vessels to the port. Channel deepening and/or widening can allow increased maneuverability, increased speed, and larger vessel beam and/or draft; it can also reduce the potential for accidents. Other types of channel modifications include flared entrances, or cut-off angles, which allow greater maneuverability when entering or exiting a branch channel from the main channel system, and, therefore, add to the safety of vessel maneuvering.

5.1.1.e Passing Zones. Passing zones are areas of the channel that have been widened to allow two vessels to pass at a specific location. Passing zones are constructed for channels where maneuvering of larger vessels is restricted due to channel width. The advantage of a passing zone is that the overall width of the main channel system can be reduced by designating a location for passing, thereby significantly reducing the total volume of dredged material removed, contained and managed. The major disadvantages of passing zones are related to the timing of vessel passing and the ultimate safety risks associated with passing and controlling two large vessels. Normally, commercial vessels try to maintain a strict schedule and will often re-route their port of call schedule in order to avoid any known delays. However, in some instances, sudden delays are encountered for a variety of reasons, such as mechanical failure, sudden weather changes, late arrival of cargoes, or landside equipment failure. Timing a passing of two vessels in a small section of channel can be extremely difficult. In addition, forces against the channel walls created by large deep draft vessels can have profound impacts on other vessels and on the currents in the channel. Experienced pilots with a good knowledge of the channel features can normally compensate for these forces. Nevertheless, the opportunity for accidents increases significantly when passing two large bulk vessels in a restricted space with limited maneuverability.

5.1.1.f Turning Basins. Turning basins are channel areas widened to allow the maneuvering of vessels in and out of branch channels while minimizing obstruction of the main channel. Turning basins are especially useful in channels that were designed for one-way traffic movement. The major advantages of a turning basin are that maneuverability of a vessel is improved, thereby reducing the time required to turn a vessel, and safety is increased since channel obstruction is reduced or eliminated. The major disadvantages of a turning basin for large deep draft vessels are the costs associated with providing a large dredged area.

5.1.1.g Navigation Aids. Navigation aids include range lights, buoys, lightships, beacons, maritime radio beacons, fog signals, and sunken vessel markings, all of which are installed and maintained by the U.S. Coast Guard. These aids mark navigation channels and maneuvering areas for safe movement of vessels and provide reference points with which pilots determine vessel position. Such measures can be recommended by the Corps or pursued apart from the Corps' authority.

5.1.2 Non-Structural Measures

Shippers are expected to make maximum use of non-structural practices such as waiting for the tide or lightloading in order to minimize transportation costs. The following non-structural measures were considered in the formulation of recommended plans.

5.1.2.a Vessel Traffic Management Systems (VTMS). Many problems affecting a port's existing navigation system can be improved by implementing or altering vessel traffic management practices. VTMS are being used in many ports and waterways worldwide as a means to reduce operational and environmental risk in marine transportation. VTMS typically combine a system operator with radar; electronic charting system displays; closed-circuit television cameras; a computer workstation; and voice, telephonic, and electronic communications equipment to track vessels entering, leaving, or maneuvering within a port system. Effective management of vessel traffic can greatly improve safety and efficiency by controlling congestion in the harbor, anchorage and berth occupancy, passing of vessels, and safe maneuvering during poor weather conditions. Improved management and scheduling can allow vessels the option to detour to another destination prior to arrival or to adjust their transit speed to control their time of arrival and fuel usage.

Precision navigation systems are also currently available for regulating marine traffic and can greatly impact safety and efficiency. Global Positioning Systems (GPS) are designed to provide extreme accuracy in vessel positioning and tracking. Currently, fewer than 12 major ports in the U.S. have Vessel Information and Positioning Systems (VIPS). The VIPS technology combines traditional radar with GPS data, which is transmitted and displayed on portable computers carried on board by the vessel pilot. Such advances in technology allow the pilots constant access to precision navigation data, without having to rely on land-based systems. This ultimately increases safety and efficiency of traffic regardless of weather conditions.

VTMS provide benefits to a port by overlaying its service area with an organizational structure for interdependent decision making and, where feasible, traffic separation schemes that can result in improved system order, continuity, and predictability. VTMS currently operating in the U.S. only provide advisory control over vessels through passive measures such as interactive communications in prescribed areas. VTMS have only been implemented in a few select U.S. ports to date, but have been gaining wide acceptance in many European and Pacific Rim ports. Currently, VTMS are operated in the United States either by government authorities such as the U.S. Coast Guard or the COE, or by private operators such as marine pilot associations.

5.1.2.b Anchorage Regulations. Anchorages maintained by both the Federal and non-Federal government are regulated by the U.S. Coast Guard. The Coast Guard has the responsibility for regulating use of the various anchorages, as well as identifying established anchorage areas by providing navigation aids and ensuring that the anchorages are properly identified on coastal navigation charts. More strict enforcement of the regulations relating to duration of use as well as the draft of the vessel using the anchorage are examples of ways to potentially improve navigation through efficient use of the anchorages.

5.1.2.c Pilot Regulations. Vessel movements are regulated through the identification of procedures to maximize safety and efficiency. The regulations are usually established through meetings between the pilots, tug operators, shippers, and the U.S. Coast Guard. As vessel sizes and/or channel dimensions change, these regulations are sometimes modified to maintain safe and efficient passage of vessels. Other reasons for modification of regulations may include increased pilot experience and familiarity with the channel system.

5.1.2.d Tug Assistance. Using tugs for turning, docking, and navigating in restrictive waterways is a common way of minimizing the need for larger channels and maneuvering areas. Tug assistance is used for most large, deep draft vessels maneuvering in the Port of Baltimore, although many of the newer container vessels are equipped with bow and stern thrusters for greater maneuverability. Even with tug assistance, large vessels can encounter significant problems when maneuvering in narrow channels and/or in unfavorable weather conditions.

5.1.2.e Modification of Vessels. Rather than modifying or enlarging the anchorages and channels due to vessel characteristics, modification of vessels is also possible. Vessels can be designed or modified to carry additional tonnage as an alternative to waterway improvements. An example is the Panamax size vessel which is designed around the constraint of operation through the Panama Canal. Other examples include extension of container ships, special barge designs to include loading equipment, or special vessel control features such as stern or bow thrusters to increase vessel maneuverability in restricted waterways. Some navigation-oriented entities are currently examining the feasibility of decreasing vessel size and tonnage capability to gain traveling speed of up to 40 knots per hour.

5.2 FORMULATION AND EVALUATION CRITERIA

Alternative plans are formulated and evaluated on the basis of technical, economic, social, and environmental criteria. These criteria, along with tangible considerations, permit the development of options which best respond to the planning objectives. Specific technical, economic, social, and environmental criteria were developed by the study team during the formulation and evaluation of alternative plans for the Baltimore Harbor Anchorage and Channels feasibility study. Lists of these criteria follow:

5.2.1 Economic and Social-Political Criteria

- Protect public health, safety, and well being.
- Respond to consumer concerns and desires.
- Identify alternatives preferred by the Baltimore maritime community.
- Identify alternatives that address the needs of the existing and future fleets.
- Identify alternatives that maximize terminal throughput capacity.

5.2.2 Environmental Criteria

- Avoid detrimental impacts to the environment and/or include features to mitigate any adverse effects.
- Minimize impacts to recreation.
- Minimize aesthetic impacts.
- Provide alternatives that are acceptable to other Federal, state, and local environmental agencies.

5.2.3 Engineering and Design Criteria

- Ensure that alternative plans are complete, efficient, safe, and economically feasible.
- Ensure that alternatives are designed in a cost-effective manner.
- Ensure that designs are in accordance with design criteria outlined in EM 1110-2-1613, *Engineering and Design- Hydraulic Design of Deep Draft Navigation Projects*.
- Ensure that computations of dredged material quantities allow 2 feet below the anchorage and branch channel design depth (overdepth) as a tolerance for inaccuracies in the dredging operation.

- Coordinate designs and layout of alternatives with the pilots, tug companies, vessel operators, and the Maryland Port Administration (MPA).

5.3 PRELIMINARY SCREENING OF ALTERNATIVES

In order to limit the alternatives available to those which are reasonable for implementation in the Port of Baltimore, an initial screening of potential structural and non-structural alternatives was completed. This evaluation, though predominantly subjective, is based on the relative advantages and disadvantages of the various systems, in accordance with the objectives of the study and the criteria identified in the previous section. Potential alternatives may include structural and/or non-structural changes to the existing Baltimore Harbor and Channels project, other non-Federally maintained channels and anchorages, and existing commercial shipping operations. All of the alternatives represent viable options to the problems identified; however, not all of these alternatives are equally feasible to implement.

5.3.1 Structural Measures

As discussed in Section 5.1, there are numerous structural measures which could be implemented to improve the existing Port of Baltimore navigation system. Not all of these measures are feasible for implementation in the Port of Baltimore.

5.3.1.a Fixed Berth. The major advantage of the sea island or fixed berth is the limited spatial requirements for initial dredging and maintenance dredging. Initial costs for construction of a sea island, however, can be significant due to the depth of the water in which the structure is built. Water depths adjacent to the structure must be adequate to accommodate the vessels which are to be moored to the island, similar to landside berths. The structure must also be capable of supporting the tremendous loads placed by a vessel in the 150,000 DWT (dead weight tons) class. This results in the need for a substantial foundation design which extends well below the harbor bottom. According to analysis conducted by Norfolk District, COE, costs for construction of a sea island in water depths exceeding 40 feet are estimated to be well over $10 million, plus operation and maintenance costs. Sea islands are not commonly used in the United States, presumably due to the high cost of construction and operation. Local pilots reported that they were not familiar with sea islands or their use in other U.S. ports.

Berthing and mooring at a sea island requires the use of tugs to position the vessel and a launch/crew on the island to attach the mooring lines. Weather and/or wave conditions which prevent the tugs from maintaining complete control of the vessel will result in closing of the sea island. In the Port of Baltimore, storm conditions, including changes in wind direction and currents, can occur suddenly. The pilots also noted that construction of sea islands in Baltimore Harbor would create unsafe navigation conditions. Since sea islands are normally placed adjacent to the main channel, as would be the case in Baltimore Harbor, the potential for accidental collisions with passing vessels increases significantly. In addition, the safety of the launch crew as they access the island during periods of ice and storms is another area of concern. For these reasons, sea islands were not considered in further detailed analysis.

5.3.1.b Multiple-Point Moorings. Spread moorings are not useful during moderate to poor weather conditions due to the difficulty associated with maneuvering and mooring a large vessel in this configuration. Normally, six to eight moorings must be accessed to adequately hold the vessel in position. The spread mooring is designed to be placed in a confined area, thereby decreasing dredged area requirements. Placement of a spread mooring in Baltimore Harbor would require a larger maneuvering area, similar in size to a free-swing berth, to allow safe access to the mooring buoys without causing obstruction of the main channel. Similar to the concerns associated with sea islands, the pilots noted that accessing the mooring buoys by launch and crew could potentially result in a hazardous situation during poor weather conditions. Further, moderate to poor weather conditions during winter months would render this type of mooring useless. Since a deep draft mooring would likely be required during these times, spread moorings would not be an acceptable alternative for the Port of Baltimore. Therefore, no further analysis was conducted for spread moorings.

5.3.1.c Single-Point Moorings. Fixed-point moorings offer a versatile mooring configuration that normally is accessible during most weather conditions. The SALM, CALM, and swing-anchor mooring all are designed to allow the moored vessel to adjust to changes in wind and/or currents by rotating around a central mooring point.

The major disadvantage of the SALM and CALM is the high initial construction cost. Similar to the problems identified with the sea island, a significant foundation is required to adequately anchor these types of moorings to the harbor floor. In addition, the buoy itself is an added cost, which is susceptible to damage from storms as well as collisions with passing vessels. Other disadvantages of the SALM and CALM include the added cost of a launch and crew to attach the mooring lines to the buoy and operation and maintenance costs. The pilots also noted that this type of mooring will create unsafe conditions for the launch crew during periods of bad weather. The fact that the SALM and CALM may not be usable during periods of poor weather makes this option unacceptable for the Port of Baltimore. For these reasons, the SALM and CALM were not considered further in this analysis.

The most commonly used method of mooring a deep draft commercial vessel is the ship's anchor and chain. This alternative is normally the least costly to implement since there are no structural features other than dredging. Construction essentially requires dredging a free-swinging berthing area to the minimum required depth. Furthermore, this type of mooring is already in use for the existing anchorage areas in Baltimore Harbor, and both the pilots and shippers fully understand its operation and costs for maintenance dredging have been minimal. For these reasons, anchor-and-chain, or free-swinging, mooring was selected as the best structural alternative for further detailed analysis.

5.3.1.d Channel Modifications. Branch channel modifications include such aspects as deepening, widening, and providing flared angles at the entrances to channels, and/or any combination of these measures. All of these measures were determined to be potentially useful improvements in the Port of Baltimore and were evaluated in further detail. The alternatives, or combination of alternatives considered, were generally limited by the controlling depth and width of the existing 50-foot main shipping channel and the design and structural integrity of the marine terminals.

5.3.1.e Passing Zones. Portions of a channel may be widened to allow two vessels to pass. The necessary width is determined by the combined beam of the vessels, vessel controllability, current and wind conditions, and channel sediments. Sections of a channel of sufficient width are sometimes designated for vessel passage. A clearance lane, normally 80 percent of the design vessel beam, is provided between vessels. Currently, the main shipping channel in Baltimore Harbor is 700 feet wide, extending from Fort McHenry to Annapolis, and is insufficient for the safe passage of two large bulk carriers. However, the passage of two bulk-cargo vessels in the angles of the main shipping channel is sometimes practiced by the pilots.

Based on the findings of the Baltimore Harbor and Channels feasibility study (1981), the main shipping channel for the 50-foot project was authorized to a width of 800 feet in the State of Maryland. At that time, the estimated cost for construction of the 800-foot-wide channel led to discussions among the MPA, the AMP, and the Corps to determine cost-saving alternatives. As a result, the width of the main shipping channel was reduced to 700 feet, at an estimated savings of $40 million. In addition, the reduced channel width also provided the benefit of reducing the volume of dredged material by 7 million cubic yards, thereby reducing problems associated with dredged material management.

Pilots are still familiarizing themselves with the 50-foot channel and have successfully passed two large Cape-sized vessels in the angles of the main shipping channel. However, as noted in Section 3, the timing of these passages as well as the inherent risks associated with passage continues to impact the Baltimore maritime industry. Construction of a passing zone would not address these concerns, since the timing of passing vessels is normally not very precise. Implementation of the authorized dimensions of the main channel would address these concerns but would also create other concerns, such as dredged material management and the high cost of construction. This option would utilize tremendous amount of existing placement capacity, assuming Federal and state governments could afford the high cost of implementation. For these reasons, neither widening of the main channel nor construction of passing zones was considered further.

5.3.1.f Turning Basins. The widening of a channel to allow easier maneuvering and turning of a vessel would provide improved safety and efficiency in the Port of Baltimore. Large coal vessels currently exiting Consolidation Coal Sales Company (CCSC) are turned near Anchorage #1 and the head of the Fort McHenry channel (see Section 3.2.3.c). This procedure normally results in obstruction of the main channel, places the vessel in a position with the potential for grounding against the channel bank, and causes increased shoaling in the privately-owned access channels to the southwest of Anchorage #1. Construction of a turning basin in this area could alleviate the problems associated with this action. For these reasons, this alternative was evaluated in further detailed analysis.

5.3.1.g Navigation Aids. During the formulation of both the reconnaissance study and the feasibility study, the pilots and tug operators made several suggestions for improvements to the existing navigation aids for the non-Federal branch channels. The suggestions included the addition and relocation of markers to better enable the pilots to assess their location relative to the channel. One such location included the markers for the connecting channel between the Seagirt and Dundalk marine terminals. Potential modifications and/or the need for additional navigation aids will be addressed as part of the recommendations in this report.

5.3.2 Non-Structural Alternatives

5.3.2.a Vessel Traffic Management Systems (VTMS). The existing Port of Baltimore VTMS is based predominantly on radio communication between the AMP and the Baltimore Maritime Exchange. Radar is also used to some extent in tracking vessels approaching the 50-foot channel near Cape Henry; however, there are no real-time tracking systems in place to provide instantaneous vessel information. The Delaware Pilots operate a VTMS-like system in the Delaware Bay area where vessels are subject to advisory control. The COE also operates a VTMS-like system in the C&D Canal to assist in managing vessel traffic there. In addition, the AMP has an office on the C&D Canal in Chesapeake City that provides vessel information to the pilot office in Baltimore. None of these systems employs the latest in technological advances for monitoring vessel traffic.

The principal benefits of current VTMS technology include improved order, predictability, and collision avoidance within a port community. Since time is critical to the commercial navigation industry, improving the overall order and predictability of vessel movements can be extremely beneficial to pilots, tugs, shipping agents, terminal operators, and vessel and cargo owners/operators.

Several major U.S. ports, including New York and New Orleans, have successfully implemented VTMS. However, to date, there are fewer than 20 VTMS operating throughout the United States; the major impediment to expansion appears to be cost. Most VTMS equipment is fairly sophisticated and requires an experienced staff to operate. Based on the potential for improved safety and efficiency, implementation of a GPS-based VIPS was considered for further evaluation. Such a VIPS would improve tracking and maneuvering of vessels in the Port of Baltimore.

5.3.2.b Anchorage Regulations. Management of anchorage use is the responsibility of the U.S. Coast Guard. According to the Code of Federal Regulations, anchorage use in the Port of Baltimore is generally limited to periods ranging from 12 to 72 hours, unless a written permit is obtained from the Captain of the Port. Periods of extended anchorage use have been reported by the pilots and tug operators, which may indicate limited regulation. An example of extended use is the vessel *Durmitor* (Yugoslavian flag), which has been moored in Anchorage #2 since 1992, following the political changes in Yugoslavia. Inadequate anchorage regulation could significantly impact the maritime community if, for example, a large deep-draft anchorage was occupied by a small vessel and a large bulk carrier was in need of anchorage within the harbor. Any potential plans of improvement to the anchorages resulting from this study will include recommendations for improved anchorage regulation and use.

5.3.2.c Pilot Regulations. Regulations for safe movement of vessels in the Chesapeake Bay and C&D Canal are published in the Code of Federal Regulations and are established through a rather lengthy process which includes public meetings and formal review and comment periods. The regulations govern port and waterway safety, deepwater port operations (located beyond the territorial sea and off the coast of the United States), use of anchorages, international navigation rules, aids to navigation, and other areas of concern. Modifications to these regulations are possible; however, they have been established with safety and efficiency of operation in mind. The Notice to Mariners issued by the U.S. Coast Guard updates any changed depth conditions or vessel restrictions in Baltimore Harbor. Modifications to the AMP guidelines for maximum length, vessel draft, and combined beam transits have been made through the years as a means of increasing efficiency. These non-structural approaches have been implemented and, therefore, will not be addressed further.

5.3.2.d Tug Assistance. The use of tugs for safe and efficient maneuvering of large deep-draft vessels is an integral part of the Port of Baltimore navigation system. There are currently three tug companies serving the Port of Baltimore: McAllister Towing, Moran Towing, and Krause Towing. These companies, in cooperation with the pilots, have identified several areas of needed improvement in the port. Based on the problems that have been identified, it is unlikely that any changes in the current use of tugs could improve the efficiency and/or safety of operation without providing structural improvements to the channel system in which the tugs operate. It is assumed that the tugs and pilots are currently operating at maximum efficiency for the existing channel system. For this reason, alternate uses of tugs other than for current modes of operations were not included in the formulation of potential plans.

5.3.2.e Modification of Vessels. To remain efficient, U.S. ports must have the ability to accommodate shipping lines as technology improves and new lines of vessels are developed. Efforts to attract shipping lines through the continued development of the Port of Baltimore is one of the major focus points of the MPA. Recent construction of the 50-foot main shipping channel and the Seagirt Marine Terminal are examples of this continued development. It is unlikely that shipping lines will modify their vessels to accommodate an individual port, given the competitive nature of the business, but rather will seek a port that can accept their vessels. For these reasons, vessel modifications were not considered viable alternatives to the problems identified.

5.3.3 Summary of Alternatives

The following alternatives were evaluated in further detail:

- Free-swing Anchorage (ship's anchor)
- Channel Modifications
- Turning Basins
- Navigation Aids
- VTMS
- Enforcement of Anchorage Regulations

5.4 ALTERNATIVES ANALYSIS

Following the initial screening of structural and non-structural alternatives described above, study efforts were focused on developing a list of potential alternatives for further detailed analysis. Formulation of alternatives was accomplished through a series of study team meetings, evaluation of results from simulation model runs, and a comparison of the costs and benefits. As discussed in the previous section, non-structural measures are anticipated to provide only marginal improvements at best, whereas structural improvements are anticipated to make the most significant impact on the problems associated with the existing navigation conditions.

5.4.1 Free-Swing Anchorages

5.4.1.a Design Considerations. Recommendations by the AMP were useful in guiding the direction of the anchorage formulation analysis, although the actual demand for anchorage space was determined through simulation analysis, as discussed later in this report. Based on the problems identified, one of the objectives of this study was to provide an anchorage area in Baltimore Harbor that is large enough to accommodate a Cape-sized bulk carrier prior to loading. The AMP indicated that at least one anchorage (mooring space) was necessary to accommodate ships up to 1,000 feet LOA, and any additional large anchorages (spaces) that could be provided would be useful during periods of peak usage.

Presently, large deep draft vessels requiring anchorage that can not be accommodated in Baltimore Harbor normally anchor at Annapolis. Analysis of vessel fleet information indicates that 95 percent of the vessels anchoring at Annapolis were 875 feet LOA or less. Reasons for anchoring at Annapolis may vary. In some instances, the captain of a vessel may elect to anchor at Annapolis due to delays in arrival of cargo, to bunker fuel, or because the vessel is too large to anchor in Baltimore Harbor. To accommodate a large percentage of the vessels calling on Baltimore, preliminary designs for a free-swing anchorage were made to accommodate vessels in the range of 875 feet LOA. The draft of these vessels will vary significantly, however, depending on the length and beam, type of vessel, and whether it is fully loaded or in ballast. According to an analysis of the data, the average design draft of the vessels that anchored at Annapolis was 37 feet. The design draft is the submerged depth of vessel under a maximum design load. Large bulk vessels in the Cape-size class normally draft between 36 and 38 feet when unloaded, according to the pilots. These same vessels can draft up to 47.5 feet upon leaving the Port of Baltimore. Since bulk carriers normally require anchorage prior to loading, design efforts were focused on the unloaded draft of a Cape-sized bulk carrier, which is 36 feet, plus 2 feet of underkeel clearance for safety.

The design of a free-swinging anchorage is largely dependent on the length and draft of the largest vessel that will be moored in the anchorage. The radius of a free-swing anchorage is determined by adding the length of the ship plus the anchor chain, which is normally five times the depth of the water. For example, the required anchorage dimensions for an 875-foot LOA vessel anchored in 38 feet of water would be as follows:

$$\text{vessel length} + (5 * \text{water depth}) = \text{anchorage radius}$$

$$875 + (5 * 38) = 1{,}065 \text{ ft}$$

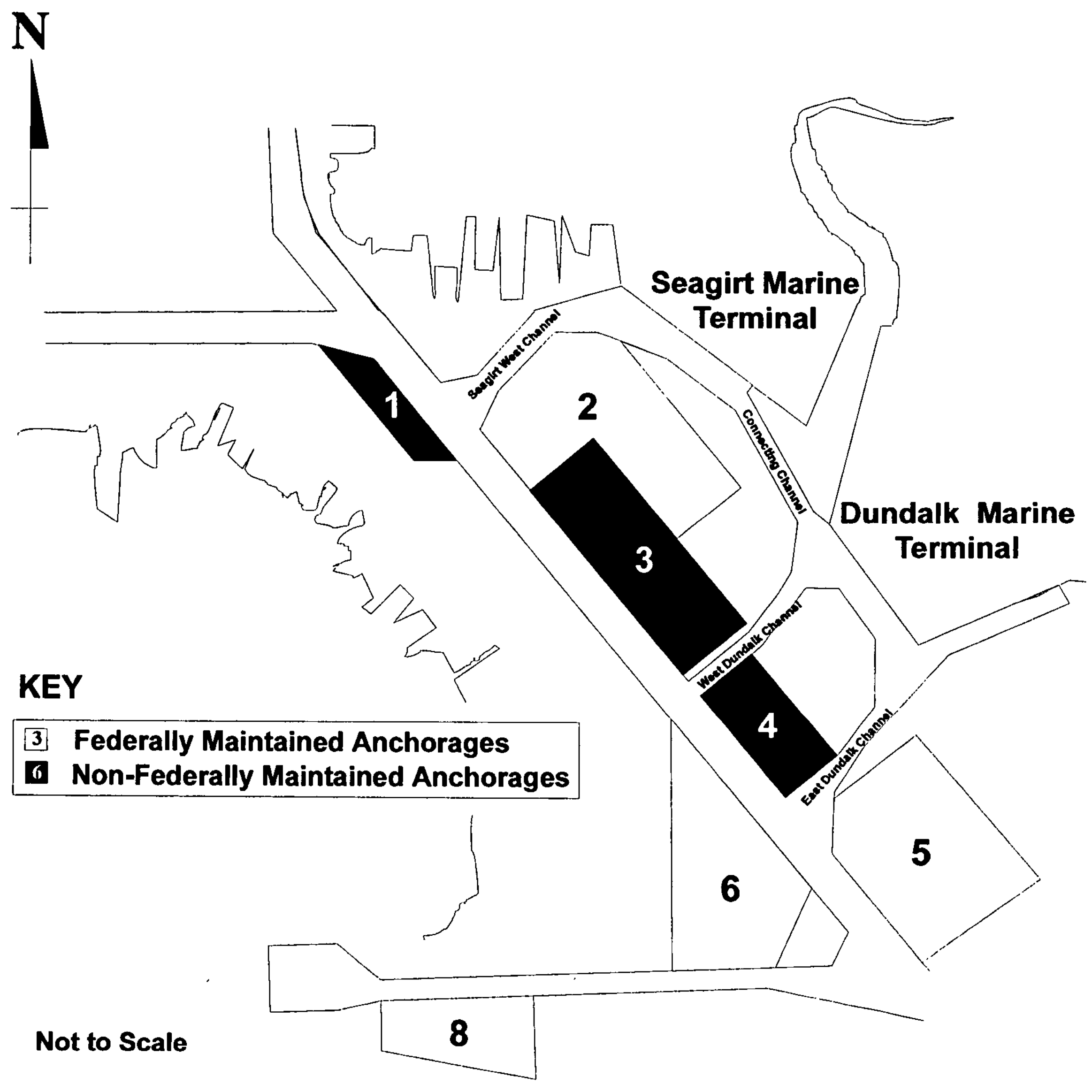
$$2 * 1{,}065 = 2{,}130 \text{ ft diameter}$$

The depth of the anchorage is calculated by determining the largest draft that will be anchored and adding 2 feet to account for underkeel clearance. Normally, a minimum of 2 feet of underkeel clearance is provided to prevent potential groundings and damage to vessel propellers and rudders. The final dimensions of the anchorage areas selected for improvement will be determined through a detailed analysis of the benefits and costs of each alternative.

5.4.1.b Initial Screening. Initial screening efforts were focused upon identifying the best locations in Baltimore Harbor for construction of a large free-swing anchorage. Various anchorage alternatives were developed to accommodate vessels in the range of 875 feet LOA. The improvements could include modification of existing areas, combining existing anchorages to create a larger anchorage, or provision of new anchorage areas. Since the majority of Baltimore Harbor is shallow water (depths less than 20 feet) with the exception of previously dredged areas, it was determined that the provision of new anchorage areas would be impractical from both economic and environmental perspectives. Therefore, screening efforts were focused on the existing anchorages serving the Port of Baltimore, three of which are maintained by the Federal government (Figure 5.6):

- Anchorage #1 (Federally maintained)
- Anchorage #2
- Anchorage #3 (Federally maintained)
- Anchorage #4 (Federally maintained)
- Anchorage #5
- Anchorage #6
- Anchorage #8
- Annapolis Anchorage Grounds

Figure 5.6
Baltimore Harbor Anchorages



The anchorages that are maintained by the Federal government are the deepest anchorages in Baltimore Harbor, ranging from 30 feet in Anchorage #4 to 35 feet in Anchorages #1 and #3 (authorized depth; actual depths may be slightly greater in some locations). For this reason, formulation efforts were concentrated on improving these areas.

Although Anchorage #1 is one of the deepest anchorages in Baltimore Harbor, it is also the narrowest. Currently, no vessels are moored in this anchorage, although it is used to some extent for the turning of vessels exiting Consolidated Coal Sales Company (CCSC). Due to its width, Anchorage #1 was eliminated from consideration of anchorage improvements; however, this area was considered for the development of a turning basin, as discussed later in this section.

Anchorage #3 is another of the deepest anchorages; however its width is not adequate to moor a large deep draft vessel in a free-swinging fashion. Anchorage #2 ranges in depth from 20 to 35 feet and adjoins Anchorage #3 on the north and east sides. Expansion of Anchorage #3 into Anchorage #2 appeared to present the most viable option for providing a larger anchorage in Baltimore Harbor and was considered as the basis for developing some of the anchorage alternatives for further detailed analysis.

Anchorage #4 is relatively deep, but has a limited area for expansion in width and length due to its proximity to the main shipping channel, surrounding branch channels, and the Dundalk Marine Terminal. Moderate expansion of this anchorage could be accomplished in order to accommodate smaller vessels, thereby leaving the larger anchorage areas available for larger vessels. For this reason, modification of Anchorage #4 was considered as an alternative.

Other anchorages in Baltimore Harbor that are not maintained by the Federal government, such as #5 and #6, are currently very shallow, with depths averaging between 15 and 20 feet. Developing a deep-draft anchorage area in these locations would be impractical due to associated dredging costs. Dredging of these areas to match the depth and width that is currently available in Anchorages #3 or #4 would require deepening of the area by approximately 10 to 15 feet. Preliminary estimates indicate that providing one free-swing anchorage area in Anchorage #5 with dimensions similar to the existing area at Anchorage #3 would require the removal of approximately 1.3 million cubic yards at a cost of more than $6.0 million. Expansion of Anchorage #6 to similar dimensions would require removal of approximately 1.2 million cubic yards at a cost of more than $5.5 million. When considering the additional costs to improve these areas beyond what is currently available at Anchorage #3, it is clear that neither Anchorage #5 nor #6 presents a viable option for providing a deep draft anchorage in Baltimore Harbor. Anchorages #5 and #6 may, however, be appropriate for providing a mooring area for smaller sized vessels. This option would leave the larger and deeper anchorages available for larger vessels. But further analysis showed that even minor modifications to Anchorages #5 and #6 considered in the development of alternatives resulted in relatively high construction costs. Since there are currently deeper areas in Baltimore Harbor which would be much less expensive to improve, improvements to Anchorages #5 and #6 were determined to be unnecessary at this time. Without structural improvements, these areas will continue to provide anchorage for small shallow draft vessels and barges.

Anchorage #8 is currently reserved as a Dead Ship Anchorage for vessels having mechanical problems, and was therefore not considered for further improvements. The Annapolis

Anchorage, although not officially designated by the U.S. Coast Guard, does not require structural improvements due to the vast areas of deep water available for anchoring. Designation of this area as a commercial anchorage will be included in the recommendations made as part of this investigation to aid the general public in awareness of its use.

5.4.1.c Alternatives. Based on the results of the initial screening of anchorages, the following areas were selected as locations to be evaluated in further detail:

- Anchorage #2
- Anchorage #3
- Anchorage #4

An extensive list of alternatives for potential improvements to the selected anchorage areas was developed for these locations. The alternatives were intended to include improvements which are reasonable for implementation in the Port of Baltimore, such as anchorage deepening, widening, and combinations of both. As mentioned in Section 5.4.1.a, the design vessel for anchorage improvements was determined to be 875 feet LOA and the design depth was determined to be 38 feet. Based on these criteria, alternatives were developed which bracket these ranges in order to ensure thorough analysis of potential anchorage improvements. A list of the preliminary alternatives is included in Appendix C and includes plans ranging from minimum-level of improvement to the maximum feasible widths and depths. The maximum depth which would be feasible for potential anchorage deepening was determined to be 50 feet, based on the controlling depth of the main shipping channel. The maximum length and width for a single anchorage area (space) was determined to be approximately 2,500 feet, based on an assumption that the largest vessels calling on Baltimore will be in the range of 1,000-feet LOA. These dimensions were used as the basis for selecting preliminary alternatives for further analysis in the simulation model.

The objective of the initial model runs was to identify a range of alternatives which provide economic benefits that are comparable to the anticipated costs of the improvement. Several alternatives were selected for Anchorages #2, 3, and 4 and input into the simulation model, as shown in Table 5.1. The alternatives were selected based on the maximum vessel size that could be accommodated in an enlarged anchorage area, which is a function of the water depth as defined in Section 5.4.1.a. The maximum vessel size for each anchorage is also shown in Table 5.1. Several alternatives were identified to accommodate vessels in the range of 800, 900, and 1,000-foot LOA for Anchorages #2/3 at depths ranging from 36 to 42 feet. Similarly, alternatives were also identified for Anchorage #4 to accommodate vessels in the 600, 700, and 800-foot LOA range at depths ranging from 30 to over 40 feet. These alternatives were intended to bracket the optimum anchorage design The simulation analysis was used to identify the true demand for anchorage space and to evaluate various improvements that were proposed for implementation.

Table 5.1
ANCHORAGE ALTERNATIVES
(Dimensions in Feet)

Alternative		Max. Ship Size	Anchor Chain	Dimensions length	Dimensions width	Depth
Anchorages #2/3						
1	One anchorage	820	180	2000	2000	36
2	One anchorage	800	200	2000	2000	40
3	One anchorage	890	210	2200	2200	42
4	Two anchorages	890	210	2200	2200	42
5	One anchorage	920	180	2200	2200	36
6	One anchorage	900	200	2200	2200	40
7	One anchorage	930	220	2300	2300	42
8	One anchorage	1020	180	2400	2400	36
9	One anchorage	1000	200	2400	2400	40
10	One anchorage	1030	220	2500	2500	42
Anchorage #4						
1	One anchorage	550	150	1400	1400	30
2	One anchorage	540	160	1400	1400	32
3	One anchorage	580	170	1500	1500	34
4	One anchorage	680	170	1700	1700	34
5	One anchorage	690	180	1700	1700	38
6	One anchorage	690	190	1800	1800	42
7	One anchorage	735	215	1900	1900	43
8	One anchorage	815	235	2100	2100	47
9	One anchorage	945	205	2300	2300	41

5.4.2 Channel Modifications

5.4.2.a Design Considerations. Channel widths should be designed to provide for the safe and efficient movement of the vessels that are expected to use the channel during the project life. The minimum acceptable width is dependent upon many factors, including size and maneuverability of the vessel, channel alignment, traffic congestion, wind, waves, currents, visibility, channel substrate, and types of navigation aids. Since vessel traffic in the branch channels is predominantly one-way, vessel passing was not considered in the design of alternatives.

Branch channel modifications were considered in the areas of the South Locust Point and the Seagirt/Dundalk Marine Terminals (Figure 5.7). Designs for channel widening and/or deepening and construction of turning basins and channel entrances were developed based on criteria established in ER 1100-2-1613. The decision to evaluate specific channel improvements in Baltimore Harbor was based predominantly on recommendations by the

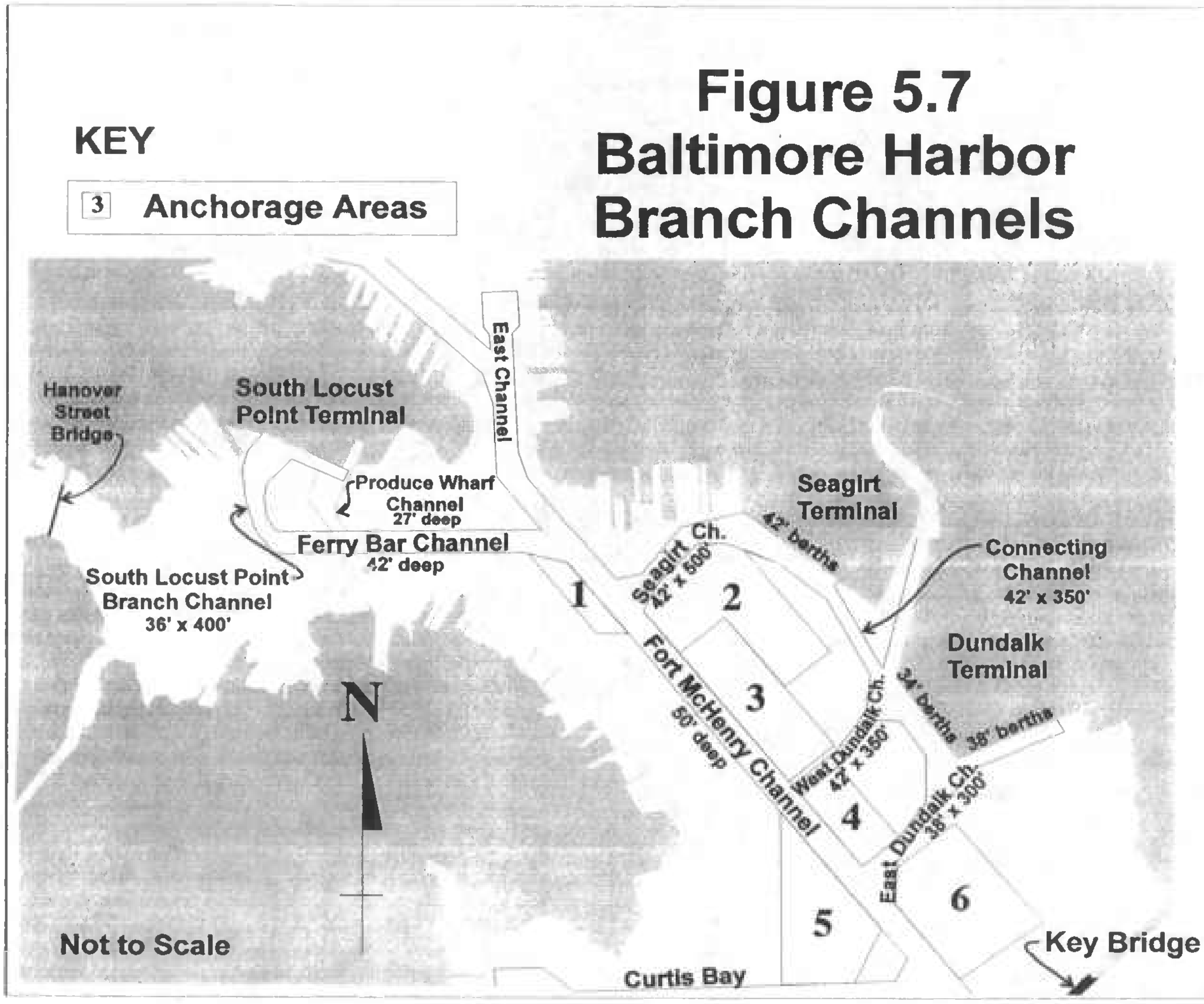


Figure 5.7 Baltimore Harbor Branch Channels

pilots and tug operators in the interest of improving safety and efficiency. Physical models or numerical ship simulation models will be used in the future development of project designs to further assess the safety and efficiency of any recommendations. Dredging of berthing areas and associated access channels is the responsibility of the non-Federal sponsor; therefore, the design of Federal access channels includes a 125' separation from the dock.

5.4.2.b Initial Screening. Coordination with the maritime community assisted in the identification of problems and the development of potential branch channel alternatives. Potential structural alternatives include deepening and/or widening of branch channels, construction of flared entrance channels, and construction of a turning basin.

South Locust Point

The existing channel configuration at South Locust Point includes a single one-way entrance/exit channel, turning basin, and berths, all at a depth of 36 feet. Potential structural improvements to address problems associated with maneuvering could include deepening and widening of the remnant Produce Wharf Channel to provide a consistent loop channel configuration, deepening of the entire loop (Figure 5.8), widening of the entire loop, or deepening and widening of the entire loop. Since all of these options could potentially improve safety and efficiency at South Locust Point, these alternatives and various combinations of them were developed for further detailed analysis.

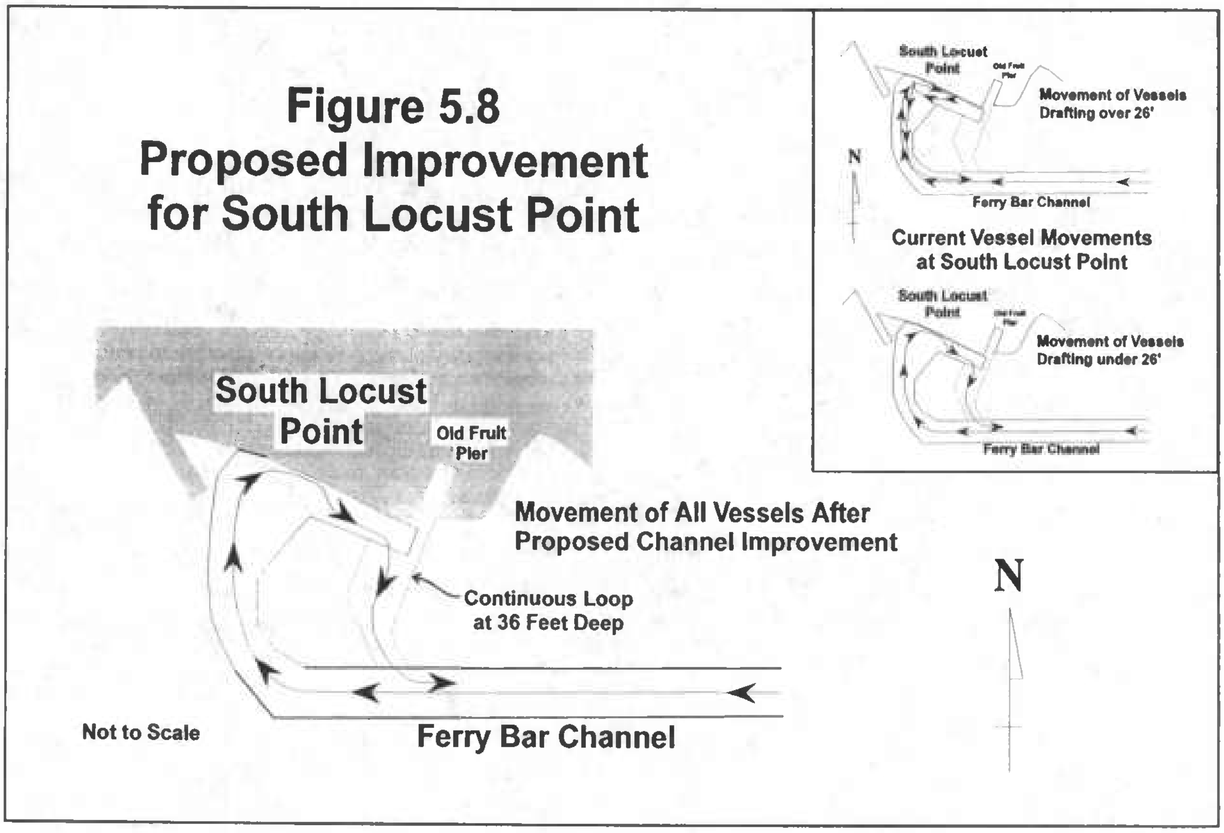


Figure 5.8 Proposed Improvement for South Locust Point

Improvements involving channel deepening are currently limited by the existing depth of the Ferry Bar Channel, which is authorized to a depth of 42 feet, and potential structural limitations associated with deepening of the MPA's berths. Since the depth of the Ferry Bar channel currently exceeds the depth of the channels at South Locust Point, further deepening of the Ferry Bar channel was not considered at this time. Deepening of the South Locust Point berths beyond the current depth is an option; however, MPA has indicated that this may result in the undermining of the pier foundation and failure of the bulkhead structure. MPA would be required to perform a detailed engineering study to determine the feasibility of deepening the berths. Although detailed costs have not been determined at this time, improvements to the bulkhead and foundation structures to accommodate deepening of the berths, if needed, would result in significantly high project costs. Since costs associated with deepening the bulkhead/foundation structure would be so high, if even possible, deepening alternatives were not considered at this time.

Seagirt and Dundalk

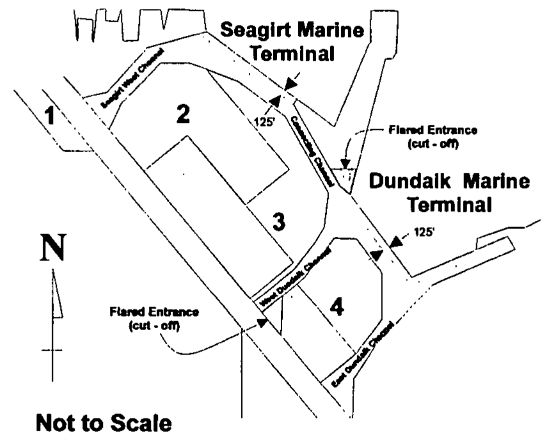
The existing channel configuration at Seagirt and Dundalk includes a series of channels designed for one-way movement of vessel traffic in either direction, with depths ranging from 38 to 42 feet (Figure 5.7). Potential structural improvements to address problems associated with maneuvering could include widening, deepening, or both widening and deepening of the branch channels serving Seagirt and Dundalk. Various combinations of these alternatives were developed for further detailed analysis, as discussed below.

Deepening improvements to the branch channels are limited by the depth of the existing Federal channel, which is currently 50 feet, and by structural constraints associated with undermining and failure of the bulkhead adjacent to the existing terminal facilities. The berths at Dundalk Marine Terminal currently range in depth from 34 feet on the west side and in front of the terminal to 38 feet on the east side of the terminal. Deepening of the berths beyond the current depths is a potential option; however, MPA has indicated that this may result in the undermining of the pier foundation and failure of the bulkhead structure. MPA representatives have suggested that the results of the study will likely indicate the berths can only be deepened to a maximum of 42 feet on the east side, which is the current depth at the Seagirt Marine Terminal. Further deepening would likely require significant and costly structural modifications. It is unlikely that the berths in front of Dundalk Marine Terminal can be deepened to 42 feet without costly improvements to the bulkheading. For these reasons, alternatives for potential branch channel improvements at Dundalk Marine Terminal were limited to combinations of widening and deepening to a maximum depth of 42 feet.

According to representatives of MPA, the berths adjacent to Seagirt could likely be deepened one foot to a maximum of 43 feet without the requirement of significant structural modifications. Since the maximum depths at Dundalk can not exceed 42 feet, controlling depths at Seagirt were also limited to 42 feet. The west Seagirt branch channel is currently 500 feet in width. Since no maneuverability problems have been identified in this location, 500 feet was determined to be the controlling limit for channel widening at Seagirt and Dundalk. In addition to channel widening and deepening, alternatives were developed for implementation of flared entrances for the branch channels at Seagirt and Dundalk. A flared entrance channel is already in place for the east Dundalk channel. The additional areas which have been proposed for implementation of flared entrances include the intersection of the west Dundalk channel and the main shipping (Fort McHenry) channel, and the intersection of the connecting channel and the berths on the west side of the Dundalk Marine Terminal, as shown in Figure 5.9.

5.4.2.c Alternatives. A comprehensive list of potential branch channel improvements was developed for the South Locust Point, Seagirt, and Dundalk terminals; this list is provided in Appendix C. The initial list of alternatives was intended to encompass all potential improvements which would be reasonable for implementation in the Port of Baltimore. These alternatives ranged from a moderate to maximum level of improvements within the constraints previously identified and were used in the initial screening to select preliminary alternatives for further analysis. The controlling depth was determined to be 36 feet at South Locust Point and 42 feet at Seagirt and Dundalk, which are the current depths of these channels, and also represent the limitations associated with deepening MPA's berths. Based on the existing width of the west Seagirt channel, widening alternatives were limited to a maximum of 500 feet. These criteria were used to limit development of alternatives.

Figure 5.9
Flared Channel Improvements



The list of alternatives was then reduced to identify a range of alternative improvements for potential input into the simulation model, and are shown in Table 5.2.

5.4.3 Turning Basins

5.4.3.a Design Considerations. A turning basin is normally designed to allow a vessel to turn either under its own power or with tug assistance. In the Port of Baltimore, pilot and tug assistance is provided during maneuvering operations. The turning basin is normally a minimum of 1.5 times the vessel length and must be deep enough to accommodate the design vessel.

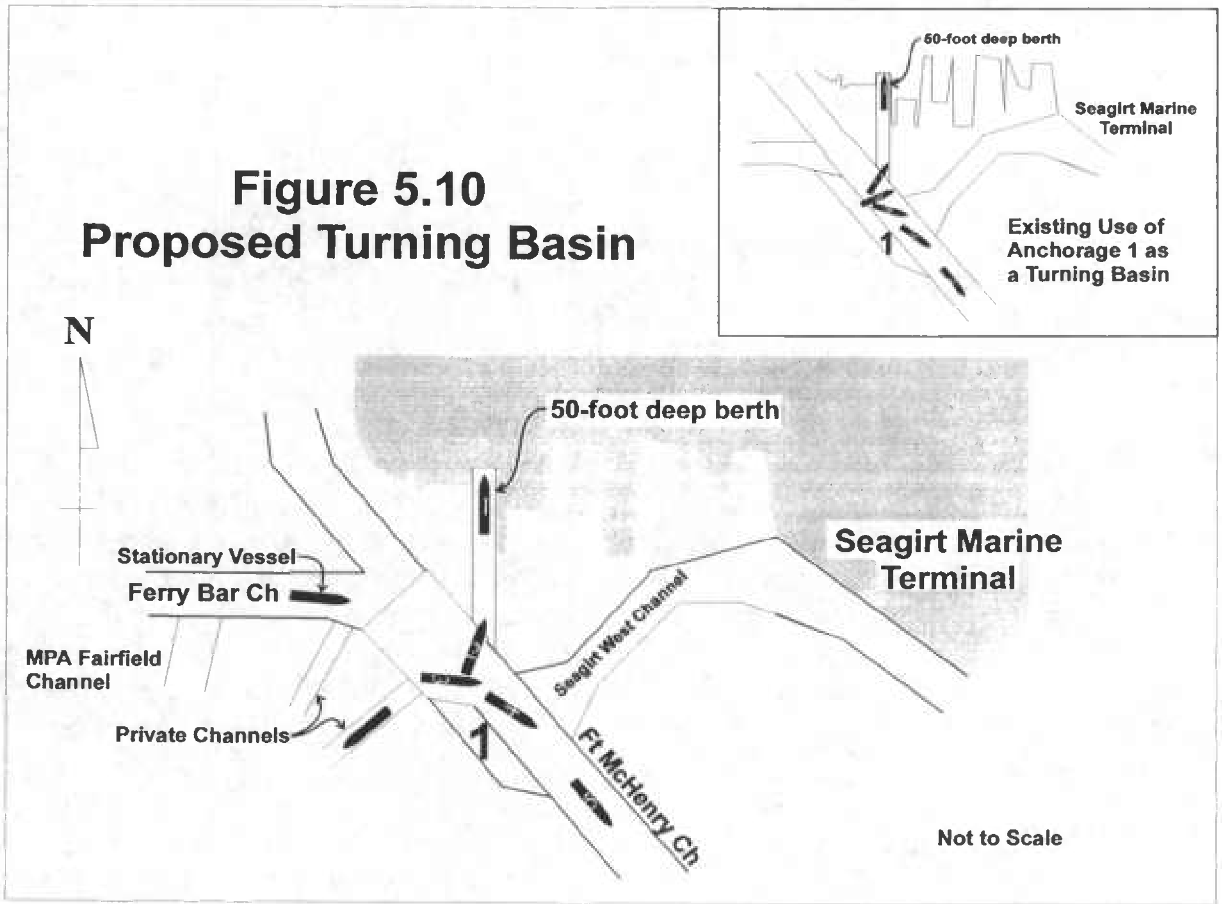
5.4.3.b Initial Screening. On numerous occasions, the Baltimore District has been contacted by various members of the Baltimore maritime community regarding turning problems in the area of Consolidation Coal Sales Company (CCSC), near the head of the Fort McHenry Channel and Anchorage #1. Although the extent of the problem has not been fully evaluated, there is evidence of a problem maneuvering large vessels exiting and/or entering the 50-foot-deep berth at CCSC. Increases in future vessel traffic will likely contribute to congestion in this area, resulting in unsafe conditions. Refer to Section 3.2.3.c for a more detailed discussion of the problems identified in this area.

Table 5.2
BRANCH CHANNEL ALTERNATIVES
(Dimensions in Feet)

Alternatives		Channel Width Existing	Channel Width New	Depth
South Locust Point				
1	Deepen/Widen Spur	n/a	350	36
2	Deepen/Widen Spur	n/a	400	36
West Dundalk				
1	Maintain Existing Condition	350	350	42
2	Widen West Dundalk Channel	350	400	42
3	Widen West Dundalk Channel	350	450	42
4	Widen West Dundalk Channel	350	500	42
East Dundalk				
1	Maintain Existing Condition	300	300	38
2	Widen East Dundalk Channel	300	350	38
3	Widen East Dundalk Channel	300	400	38
4	Widen East Dundalk Channel	300	450	38
5	Widen East Dundalk Channel	300	500	38
6	Deepen/Widen East Dundalk Channel	300	400	39
7	Deepen/Widen East Dundalk Channel	300	400	40
8	Deepen/Widen East Dundalk Channel	300	400	41
9	Deepen/Widen East Dundalk Channel	300	400	42
10	Deepen/Widen East Dundalk Channel	300	450	39
11	Deepen/Widen East Dundalk Channel	300	450	40
12	Deepen/Widen East Dundalk Channel	300	450	41
13	Deepen/Widen East Dundalk Channel	300	450	42
14	Deepen/Widen East Dundalk Channel	300	500	39
15	Deepen/Widen East Dundalk Channel	300	500	40
16	Deepen/Widen East Dundalk Channel	300	500	41
17	Deepen/Widen East Dundalk Channel	300	500	42
Connecting Channel				
1	Maintain Existing Condition	350	350	42
2	Widen Connecting Channel	350	400	42
3	Widen Connecting Channel	350	450	42
4	Widen Connecting Channel	350	500	42
Seagirt West Channel				
1	Maintain Existing Condition	500	500	42
Cut-off Angles				
1	Cut-off at Entrance to W. Dundalk	n/a	n/a	42
2	Cut-off near Dundalk Berths	n/a	n/a	38

COE policy dictates that all Federally-funded improvements must serve multiple users. Although CCSC is a private user of the Harbor system, the many shipping lines calling on the Port of Baltimore represent multiple users. In addition, the turning basin would provide a maneuvering area for the *USN Comfort* and vessels calling on the MPA's Fairfield Terminal, Hobelmann Services, Inc.'s pier, and ST Services, Inc's pier. When considering the magnitude of people affected by commercial water transportation, from direct labor to the end-of-line consumer, this number grows significantly. Therefore, a turning basin constructed in this area would improve the safety and efficiency of the port system to many entities (Figure 5.10). In addition, other commerce in this section of the harbor may eventually re-establish, thereby contributing to the need for a turning basin.

Figure 5.10
Proposed Turning Basin



5.4.3.c Alternatives. Alternative plans for implementation of a turning basin at the head of the Fort McHenry Channel are limited by the depth of the existing channel, which is 50 feet, the CCSC terminal to the northeast, and Anchorage #1 to the southeast. Since Anchorage #1 is generally not usable due to its width, it could be incorporated into the design for a turning basin area with no negative impact to the existing anchorage use in Baltimore Harbor. For these reasons, alternative plans were developed for a turning basin near Anchorage #1 and at the head of the Fort McHenry Channel, and are shown in Table 5.3. Anchorage #1 could then be deauthorized.

Table 5.3
TURNING BASIN ALTERNATIVES
(Dimensions in Feet)

Turning Basin		Channel Width Existing	Channel Width New	Depth
1	Construct Turning Basin - Anch #1	n/a	1200	50
2	Construct Turning Basin- Anch #1	n/a	1500	50

5.4.4 Navigation Aids

5.4.4.a Design Considerations. Many factors influence the placement of navigation aids, including wind and currents, cost, visibility, geometry of the channel, and maneuverability of vessels and tugs. One of the best ways to ensure effectiveness of navigation aids is to maintain close coordination with the U.S. Coast Guard, since this agency is responsible for the placement and maintenance of these aids.

The Baltimore Harbor project incorporates the use of various navigation aids, including range lights and buoys. Range lights are fixed structures located along the centerline, outside the end of a straight reach of channel. Since they are fixed structures, ranges are located well out of the traffic area. Buoys are floating markers that are anchored in the water to mark the channel boundaries, hazards, and turns. Buoys are sometimes subject to movement since they are only anchored in the water. The spacing of buoys is affected by a number of factors, including the type of vessel maneuvering in the channel and the type of onboard navigational equipment. To extend their detection range, buoys are sometimes fitted with radar reflectors, transponders, and lights.

5.4.4.b Initial Screening. The need for additional navigation aids in the connecting channel between Seagirt and Dundalk was first identified by the pilots during the reconnaissance study. The existing channel is poorly marked and sometimes presents difficulties for pilots when they attempt to navigate this section of the channel. Additional channel markers or range lights are needed based on the existing configurations, and will likely still be needed following implementation of any improvements to the anchorages and channels. A determination of the need for navigation aids and their installation and maintenance is the responsibility of the U.S. Coast Guard.

Although these additions will improve navigation conditions in the branch channels, the benefits will likely be limited to increased safety, with little impact on navigation time (and associated costs). For this reason, it was determined that further detailed evaluation of the impacts of additional navigation aids was not necessary. Recommendations for such aids will be provided in the recommendations section of this report and will be coordinated with the U.S. Coast Guard.

5.4.5 VTMS

5.4.5.a Design Considerations. VTMS systems are currently in operation in many major U.S. ports including New York, New Orleans, Houston, and Long Beach. As a cost-cutting move in the late 1980's, the U.S. Coast Guard reduced their involvement in operating VTMS in some major U.S. ports including New York and New Orleans. For example, in the Port of New York the Coast Guard has opened and closed the VTMS system a number of times due to budget constraints. The VTMS system in New York was re-activated after vessel accidents occurred. During this same period, tanker accidents, particularly the *Exxon Valdez* accident in Alaska, precipitated public calls for expansion of VTMS, including direct control of vessel traffic. In 1990, Congress enacted the Oil Pollution Act (Public Law 101-380), which called for re-establishment of VTMS in certain U.S. ports, and directed the U.S. Coast Guard to examine full implementation of VTMS in the largest U.S. ports, including the Port of Baltimore. In response to these actions, the *Port Needs Study* was developed in 1991 to evaluate the potential for navigation improvements as a result of implementing VTMS in 23 U.S. ports. As part of this study, overall costs and benefits, as well as overall rankings, were compiled for each of the 23 ports.

Major problems facing the Port of Baltimore at the time of the study included the potential for a catastrophic vessel collision involving petroleum or hazardous substances. This type of collision potentially could result in a spill, which, according to the study, would have a devastating effect upon areas of the Chesapeake Bay. The potential for a collision between tankers, barges, and/or petro-chemical carriers would represent the "worst case" scenario for the Baltimore/North Chesapeake area. Other problems identified in the study for the Port of Baltimore navigation system included lack of real-time knowledge of vessel movements and locations in the channels outside of Baltimore Harbor, potential for localized vessel congestion, vessel queuing, difficulties navigating channels (particularly in ice), outbound queuing, and lack of anchorage management. The implementation of a comprehensive VTMS including active surveillance sensors, radar, communications, and closed circuit television installations in the Port of Baltimore would potentially decrease the probability of a catastrophic collision, and would potentially improve queuing and maneuvering in the port system.

Implementation costs and potential benefits associated with specific VTMS were analyzed for each port as part of the 1991 *Port Needs Study*. The survey was conducted based upon interviews within the port, analysis of future economic projections, a review of pertinent literature, and analysis of navigational charts. The methodology used to produce the VTMS design entailed coupling the problems identified in the port survey with solutions offered by state-of-the-art technology.

5.4.5.b Initial Screening. The Port of Baltimore was included in the Chesapeake North/ Baltimore, Maryland geographic survey area. According to the survey, implementation of a VTMS in the Port of Baltimore could result in benefits totaling $8.6 million over an estimated 15-year project life based on the unique benefit methodologies used in the *Port Needs Study*. The total cost of implementation was estimated to be $6.9 million at the time of the study, for a net benefit of $1.7 million. The Port of Baltimore ranked 12th out of the 23 ports studied in terms of net benefits to accrue from implementation of a VTMS. The benefits that were assumed to result from VTMS implementation included avoiding and/or reducing the occurrences of vessel damages; human injuries and deaths; hazardous commodity spills; and loss of marine mammals, birds, and habitat. Since Baltimore generally ranked low in terms of priority for implementation when compared to the other ports in the study, no further consideration was given at that time.

An outcome of the 1991 *Port Needs Study* was to recommend the top 11 of the 23 ports studied for potential VTMS implementation. Implementation would likely be in conjunction with the outcomes of the 1993 *Vessel Control Study*, and the current VTMS 2000 program. The 1991 *Port Needs Study* is currently being updated.

The Coast Guard recently solicited a request for proposal (RFP) for contractor support in implementing new VTMS systems in select U.S. ports. Selections from the RFP are projected to occur in late 1995. The number of ports which are actually chosen for future VTMS implementation will be dependent on future Congressional appropriations. It appears that most VTMS systems will be implemented by private or local government initiatives. Discussions are underway among the members of the Baltimore maritime community regarding acquisition of a comprehensive VTMS for the Port of Baltimore and Chesapeake Bay areas.

5.4.5.c Alternatives. Based on efforts to date by both the U.S. Coast Guard and the Baltimore maritime community, implementation of a VTMS for the Port of Baltimore could occur in the near future. While implementation of a VTMS will likely reduce the potential for collisions and generally improve navigation conditions in the Port of Baltimore, it was determined that the extent of the improvements will have little impact on the problems identified in this study. For this reason, alternatives which address VTMS implementation were not considered further in this analysis.

5.5 SIMULATION ANALYSIS

To evaluate the impacts of channel and anchorage improvements on the overall operation of the Port of Baltimore given the without-project forecasts of commodity tonnage and vessel calls, a computer model that simulates the operating environment of the harbor system was developed. This simulation model mimics the current patterns of vessel activity once a vessel has entered the Baltimore Harbor system. Through extensive discussions with representatives of the maritime community, an understanding of the intricate operating environment in the

Port of Baltimore led to development of vessel flow diagrams. Figure 5.11 illustrates one part of this system diagram. A detailed description of the Baltimore Harbor operating environment is located in Appendix C-Economics.

This flow diagram provided the basis for defining typical operating characteristics observed in the port system such as nautical miles travelled by vessels; route used to access the terminals; bay pilot and tug interaction with vessels; and use of anchorages. Analysis and refinement of recent operational data provided information on length of stay at anchorages; vessel classes and vessel design characteristics; and distribution of vessel calls to the various terminal facilities. Average vessel time at berth to load and unload was determined through interviews with members of the port community.

5.5.1 Alternatives Evaluation

With the knowledge of the current system of operating and routing vessels, the various terminal locations and berths, and the distribution of traffic to the terminals, various simulation runs were executed for each of the six benchmark years to identify without-project elapsed time in system and associated costs. These simulations were executed based on vessels arriving and departing the Port of Baltimore system together with intermediate movements while in the port system. Most of these intermediate movements are definite, in the sense that they must occur, while some movements are optional in that they don't always occur. Figure 5.12 provides an illustration of the salient vessel movements that occur while vessels are moving within the navigation system. As discussed in Section 4, simulation of the without-project condition indicated that without-project vessel-related operating costs increased from $45.5 million in the year 2000 to more than $320 million in the year 2030. This information served as the basis for identifying impacts of proposed improvements to the without-project vessel operating system and evaluating the merits of the alternative measures.

Repeated simulations of vessels moving through the harbor system and the multiple vessel/pilot/tug/interactions that typically occur yielded estimates of elapsed time and costs incurred while in the port harbor system. This was done for the 6 benchmark years in the 2000-2050 period. Through the use of this simulation modelling capability, coupled with the forecasts of commodity tonnages and vessel calls to the Port of Baltimore, effects of proposed channel and anchorage modifications on the overall system have been evaluated to determine the viability of such modifications without actually having to construct the modification(s).

5.5.1.a Branch Channel Alternatives. Modifications considered for the branch channels servicing the terminals, as previously identified in Section 5.4.2, included deepening, widening, and various combinations of deepening and widening. The simulation model was utilized to evaluate each branch channel alternative absent other possible improvements so as to estimate total system impacts caused by each proposed alternative. Because any branch channel improvement will impact not only the specific terminal(s) adjacent to the branch channel but also the entire harbor operating system, this approach provided a means for tracing impacts on the entire harbor operating system. Figure 5.13 and Figure 5.14 illustrate this concept. The

Cape Henry Inbound to Baltimore

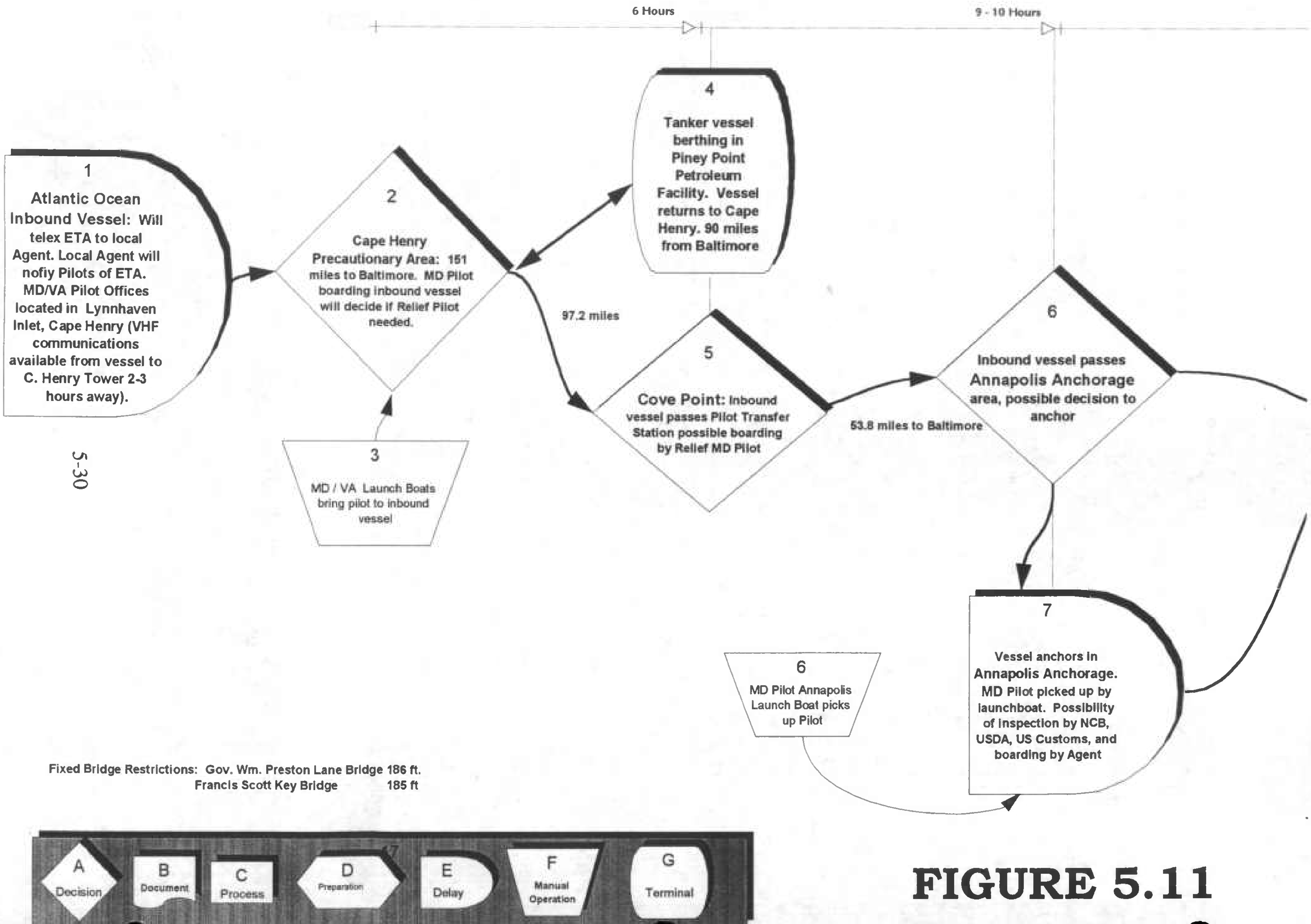


FIGURE 5.11

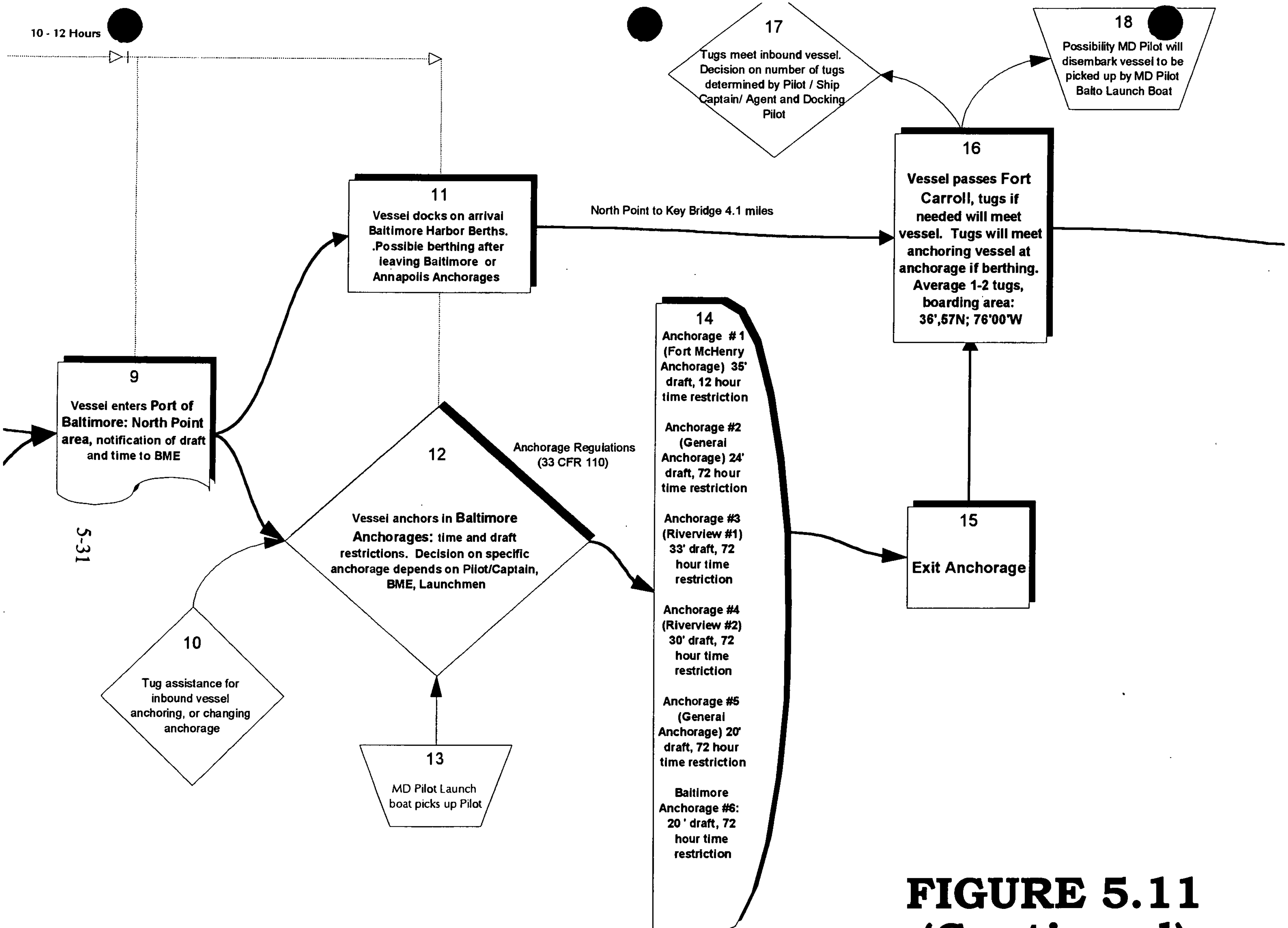


FIGURE 5.11 (Continued)

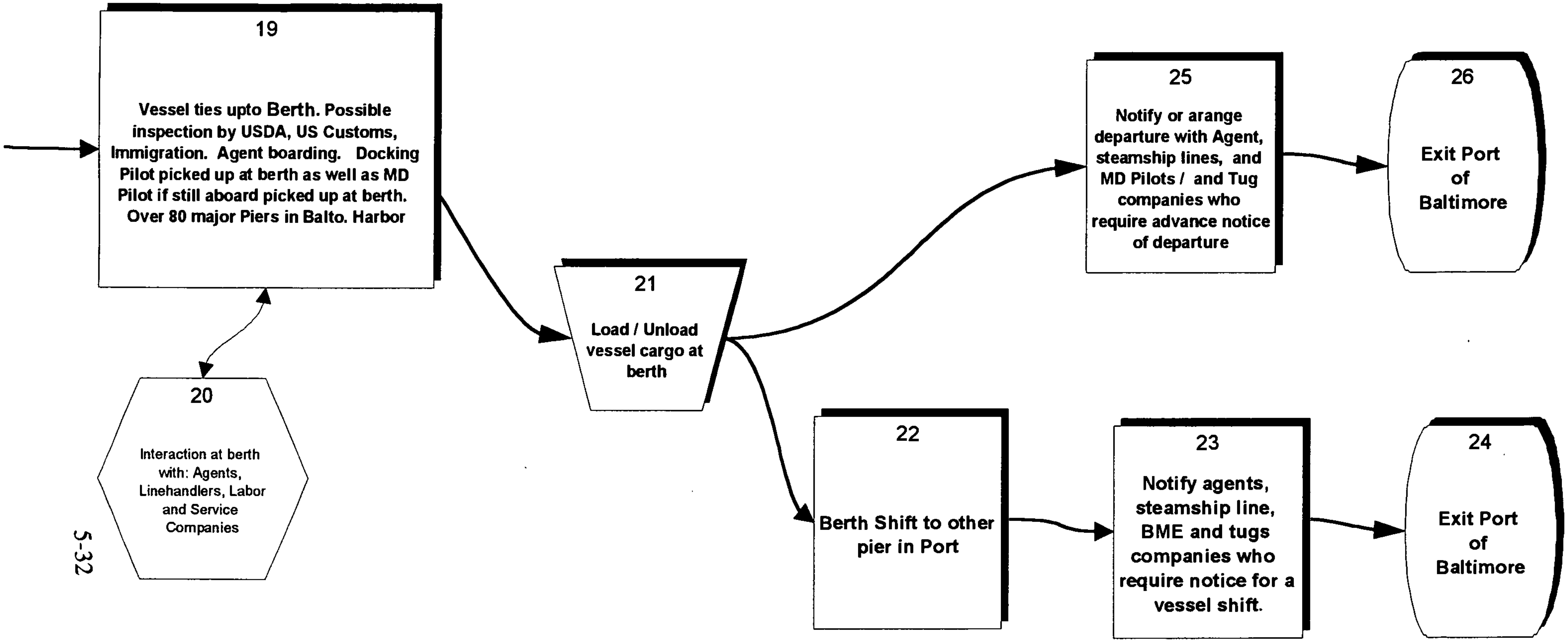


FIGURE 5.11 (Continued)

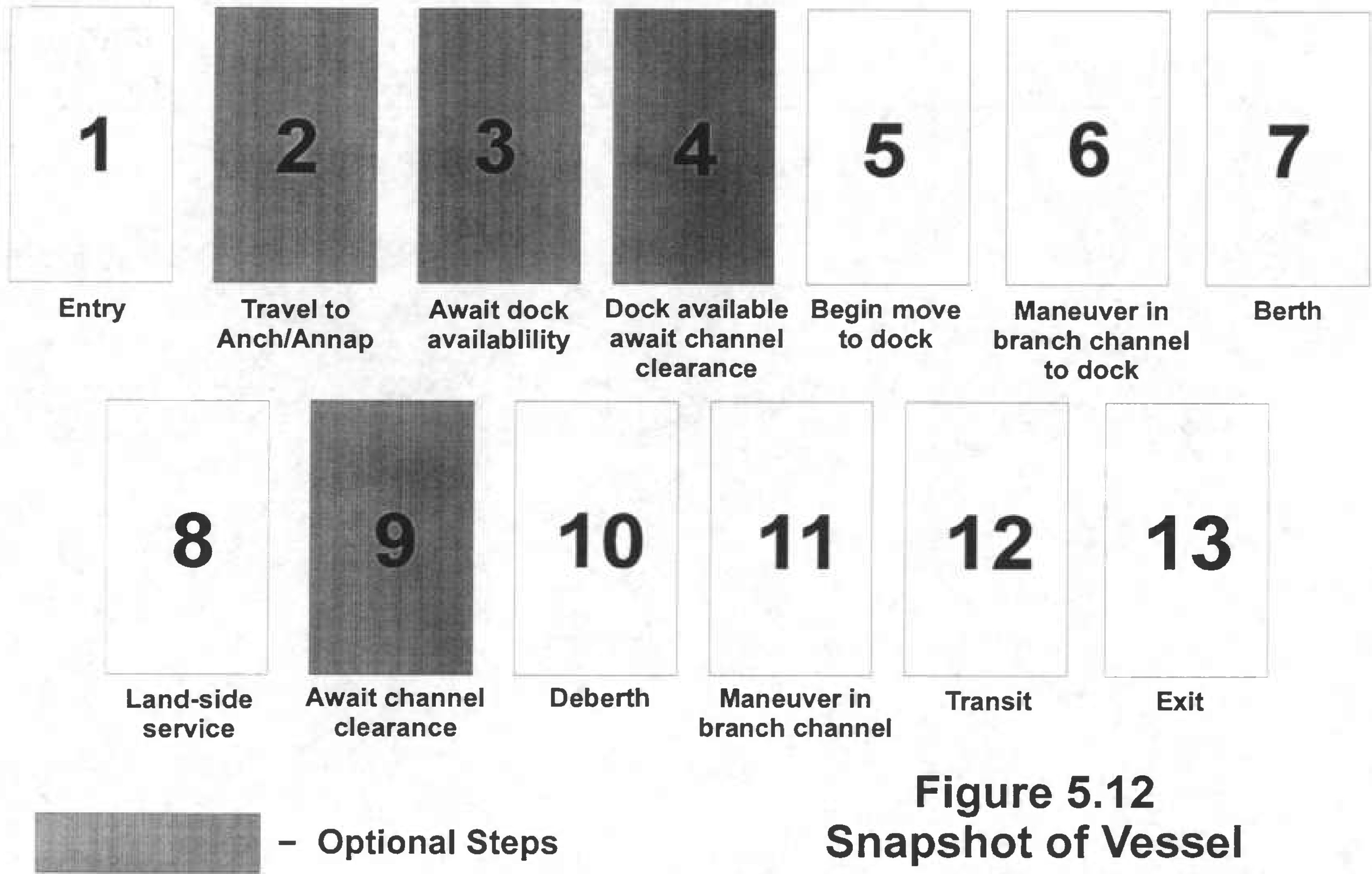


Figure 5.12
Snapshot of Vessel Movement Through System

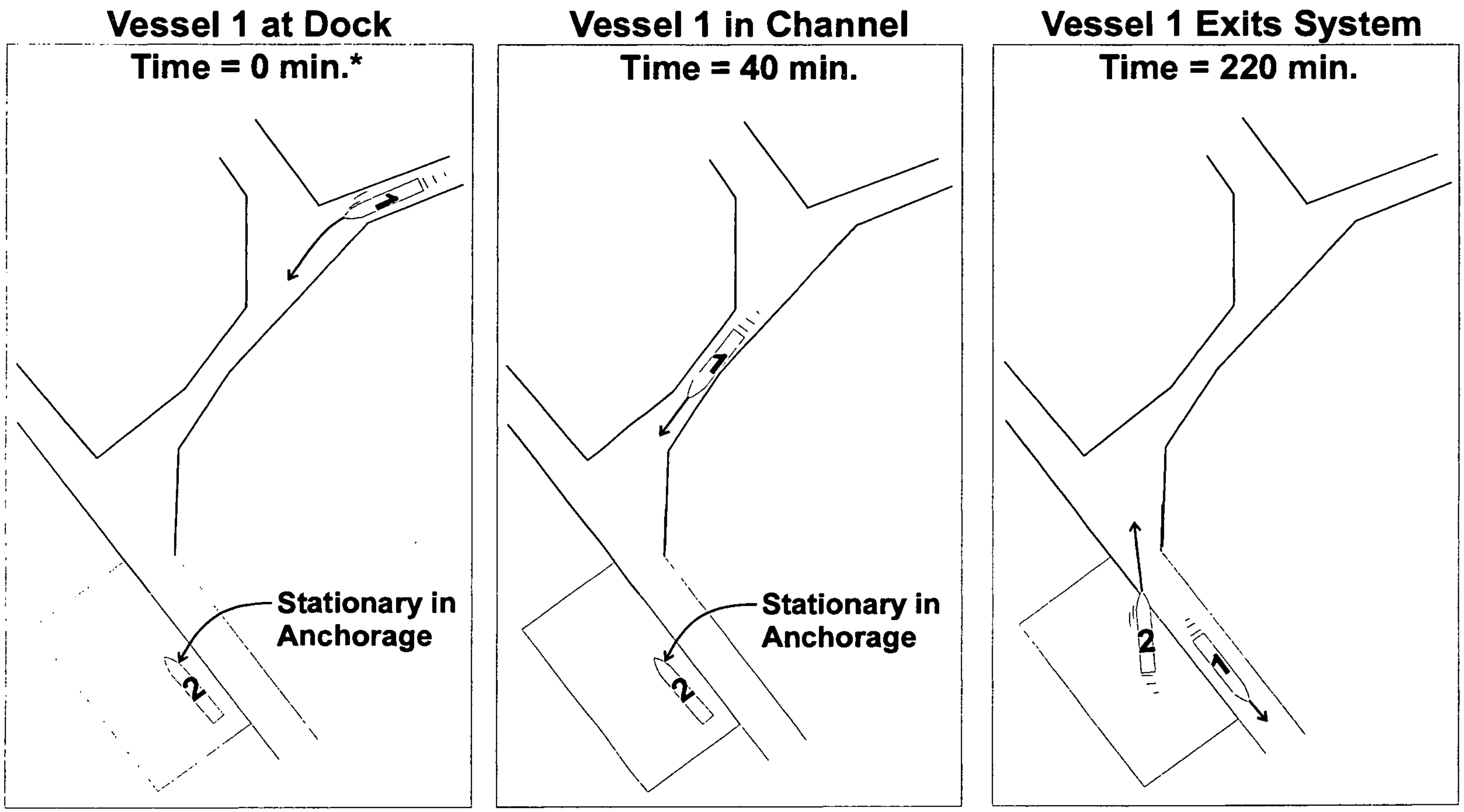
illustrations in Figure 5.13 reflect the existing and "without project" operation of a generic branch channel in the port system. At time zero, Vessel 1 prepares to depart from berth. Vessel 2 waits for Vessel 1 to pass and provide room for Vessel 2 to move toward its berth area. In this illustration Vessel 2 doesn't begin its transit until time 220 minutes. A generic branch channel improvement is illustrated in Figure 5.14. Due to a channel improvement (deepening or widening), Vessel 1 passes Vessel 2 at time 205 minutes and reduces its travel time by 15 minutes. Additionally, Vessel 2 is now able to safely proceed to its berth area at time 205 realizing time savings of 15 minutes. If the port operating system consisted of these 2 vessels, there would be a total time savings of 30 minutes realized to the system. However, there are many more than two vessels present in the port system with Vessel 1 and Vessel 2; consequently time savings caused by the generic branch channel improvement and the departure of Vessel 1 will be more than 30 minutes. Once Vessel 2 completes its loading or unloading operation and departs the berth, additional time savings accrue to all vessels in the system at that time. Figure 5.15 indicates the system areas or "frames" where impacts of branch channel improvements may be realized by the Port of Baltimore navigation system.

Seagirt Branch Channel Alternatives

For the branch channels servicing Seagirt Marine Terminal, two widening alternatives were selected for further detailed evaluation; 1) widen to 400-feet, and 2) widen to 500 feet. While many variations of width and depth were identified in Table 5.2, these alternatives were selected for evaluation by the model because they held the most potential for improving channel and harbor operating system efficiencies. This determination was based on communications with the maritime community, the limitations associated with deepening MPA berths at Seagirt, the profile of vessels forecast to call the Port, and the global trade routes influencing North Atlantic Region port calls. Each alternative was simulated as being operational in the port system to identify time and cost impacts by benchmark years over the 50-year planning horizon. Each alternative yielded significant system-wide net benefits. Figure 5.16 presents the dollar cost savings (1995 dollars) resulting from simulation of the 500-foot widening alternative. The infrastructure constraint previously identified in the "without project" condition resulted in year 2020 savings being maintained through year 2049.

Dundalk Branch Channel Alternatives

For the eastern-most branch channel servicing the Dundalk Marine Terminal, widening to 400 feet was evaluated using the simulation model. This alternative was modelled independently and in combination with widening of the Seagirt and connecting channels. These alternatives held the most potential for improving channel and harbor operating system efficiencies and yielded significant system-wide net benefits. Larger width alternatives were not modelled because a wider channel in this area likely would not yield significant additional benefits because of the size of the vessels using this channel and the associated depth limitations of several of the Dundalk berths. Figure 5.17 presents the dollar cost savings (1995 dollars) resulting from simulation of the 400-foot widening alternative. The



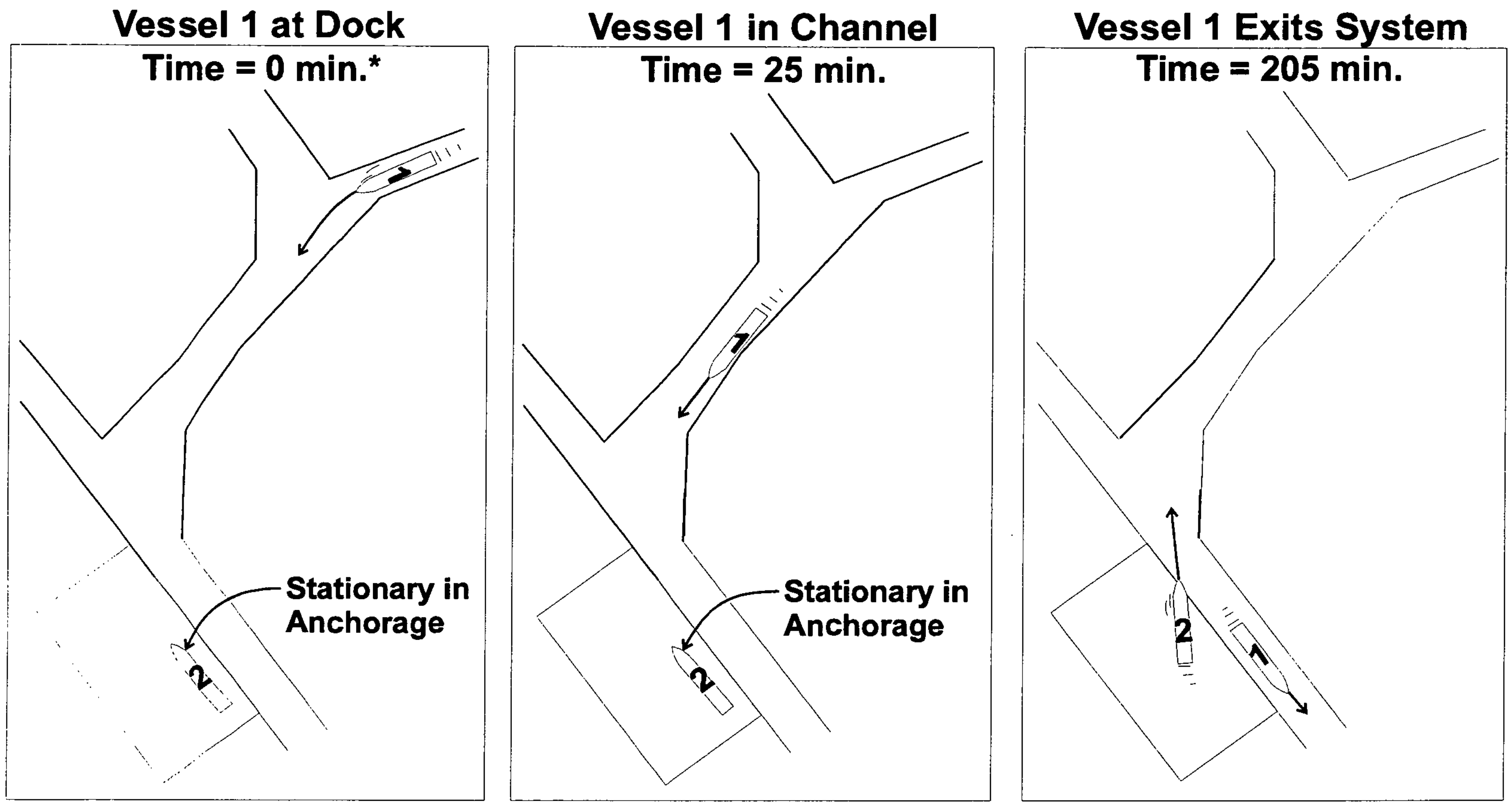
Narrative:

Vessel 1 departing Generic Branch Channel

Vessel 2 next into Generic Branch Channel

Figure 5.13
Branch Channel Existing Condition

* Time estimates are for illustrative purposes only



Narrative:

Vessel 1 departing branch channel

Vessel 2 next into branch channel

Reductions - Time Savings	
Vessel 1	15 minutes
Vessel 2	15 minutes
Total	30 minutes

* Time estimates are for illustrative purposes only

Figure 5.14

Branch Channel Improved Condition Maneuver Time Reduced 15 min.

Figure 5.15
SYSTEM ELEMENTS IMPACTED BY IMPROVEMENTS*

	Improved Branch Channels		Improved Anchorages	
System element num**	**Direct Impact**	**System Impact**	**Direct Impact**	**System Impact**
1	-	-	-	-
2	-	Y	Y - Selection	Y
3	-	Y	-	Y
4	-	Y	-	Y
5	-	-	Y	Y
6	Y	-	-	-
7	-	-	-	-
8	-	-	-	-
9	-	Y	-	Y
10	-	-	-	-
11	Y	-	-	-
12	-	-	-	-
13	-	-	-	-

* Impacts may be positive or negative
** Numbers refer to system elements shown in Figure 5.12

infrastructure constraint previously identified in the "without project" condition resulted in year 2020 savings being maintained through the year 2049.

South Locust Point Branch Channel Alternatives

The current channel servicing the South Locust Point Marine Terminal varies both in width and depth. As explained in Section 3, part of the channel is 400 feet wide at a depth of 36 feet and the channel remnant leading to the old Produce Wharf is of variable width and 28 feet

FIGURE 5.16

WITHOUT PROJECT CONDITION
SYSTEM OPERATING COSTS
(1995 PRICES)

	YEAR 2000	VESSEL CALLS	YEAR 2010	VESSEL CALLS	YEAR 2020	VESSEL CALLS	YEAR 2030	VESSEL CALLS	YEAR 2040	VESSEL CALLS	YEAR 2050	VESSEL CALLS
RUN 1	$48,710,769	1459	$71,159,552	2017	$226,316,363	3093	$330,897,105	4137	$330,897,105	4137	$330,897,105	4137
RUN 2	$44,671,334	1366	$68,222,643	1963	$229,457,244	3026	$312,699,516	4086	$312,699,516	4086	$312,699,516	4086
RUN 3	$44,976,301	1402	$71,491,084	1968	$228,061,025	3065	$317,353,645	4130	$317,353,645	4130	$317,353,645	4130
RUN 4	$42,054,849	1303	$66,477,635	1867	$178,021,316	2992						
RUN 5	$46,841,511	1401	$73,024,495	1960	$217,788,858	2959						
AVERAGE	$45,450,953	1386	$70,075,082	1955	$215,928,961	3027	$320,316,755	4118	$320,316,755	4118	$320,316,755	4118

B-5

BRANCH CHANNEL ALTERNATIVES
SEAGIRT, CONN. CHANNEL, WEST DUNDALK-500-FT
(1995 PRICES)

	YEAR 2000	VESSEL CALLS	YEAR 2010	VESSEL CALLS	YEAR 2020	VESSEL CALLS	YEAR 2030	VESSEL CALLS	YEAR 2040	VESSEL CALLS	YEAR 2050	VESSEL CALLS
RUN 1	$48,174,388	1460	$70,383,652	2018	$204,994,705	3126	$333,003,404	4205	$333,003,404	4205	$333,003,404	4205
RUN 2	$44,158,873	1367	$67,336,295	1963	$223,241,950	3093	$338,287,542	4074	$338,287,542	4074	$338,287,542	4074
RUN 3	$44,428,286	1403	$70,750,902	1969	$226,880,504	3027	$330,998,743	4136	$330,998,743	4136	$330,998,743	4136
RUN 4	$41,545,604	1303	$65,342,206	1866	$205,844,872	3015	$287,791,991	4068	$287,791,991	4068	$287,791,991	4068
RUN 5	$46,128,099	1402	$71,949,905	1960	$205,662,063	3018	$321,865,548	3951	$321,865,548	3951	$321,865,548	3951
AVERAGE	$44,887,050	1387	$69,152,592	1955	$213,324,819	3056	$322,389,446	4087	$322,389,446	4087	$322,389,446	4087
CHANGE	$563,903		$922,490		$2,604,142		($2,072,690)		($2,072,690)		($2,072,690)	
BENEFIT	**$1,372,163**		**$2,244,725**		**$6,336,747**		**($5,043,546)**		**($5,043,546)**		**($5,043,546)**	

NOTE: CHANGES SHOWN ARE BASED ON A 150-DAY SIMULATION OF DAILY VESSEL MOVEMENTS IN THE PORT OF BALTIMORE. THE RESULTANT OPERATING COST CHANGES ARE CONVERTED TO A 365-DAY BASIS TO REFLECT ANNUAL BENEFITS FROM THE IMPROVEMENT.

FIGURE 5.17

WITHOUT PROJECT CONDITION
SYSTEM OPERATING COSTS
(1995 PRICES)

	YEAR 2000	VESSEL CALLS	YEAR 2010	VESSEL CALLS	YEAR 2020	VESSEL CALLS	YEAR 2030	VESSEL CALLS	YEAR 2040	VESSEL CALLS	YEAR 2050	VESSEL CALLS
RUN 1	$48,710,769	1459	$71,159,552	2017	$226,316,363	3093	$330,897,105	4137	$330,897,105	4137	$330,897,105	4137
RUN 2	$44,671,334	1366	$68,222,643	1963	$229,457,244	3026	$312,699,516	4086	$312,699,516	4086	$312,699,516	4086
RUN 3	$44,976,301	1402	$71,491,084	1968	$228,061,025	3065	$317,353,645	4130	$317,353,645	4130	$317,353,645	4130
RUN 4	$42,054,849	1303	$66,477,635	1867	$178,021,316	2992						
RUN 5	$46,841,511	1401	$73,024,495	1960	$217,788,858	2959						
AVERAGE	$45,450,953	1386	$70,075,082	1955	$215,928,961	3027	$320,316,755	4118	$320,316,755	4118	$320,316,755	4118

B-2

BRANCH CHANNEL ALTERNATIVES
EAST DUNDALK – WIDEN TO 400-FT
(1995 PRICES)

	YEAR 2000	VESSEL CALLS	YEAR 2010	VESSEL CALLS	YEAR 2020	VESSEL CALLS	YEAR 2030	VESSEL CALLS	YEAR 2040	VESSEL CALLS	YEAR 2050	VESSEL CALLS
RUN 1	$48,475,822	1458	$70,114,658	2017	$225,801,495	3094	$339,542,587	4074	$339,542,587	4074	$339,542,587	4074
RUN 2	$44,542,628	1367	$67,948,629	1963	$227,599,913	3027	$329,956,829	4137	$329,956,829	4137	$329,956,829	4137
RUN 3	$44,825,290	1403	$71,236,285	1968	$227,616,849	3065	$286,488,295	4068	$286,488,295	4068	$286,488,295	4068
RUN 4	$41,894,246	1303	$66,193,902	1866	$181,192,133	2992	$310,886,264	4085	$310,886,264	4085	$310,886,264	4085
RUN 5	$46,656,543	1401	$72,600,483	1960	$215,730,218	3025	$308,469,995	3952	$308,469,995	3952	$308,469,995	3952
AVERAGE	$45,278,906	1386	$69,618,791	1955	$215,588,122	3041	$315,068,794	4063	$315,068,794	4063	$315,068,794	4063
CHANGE	$172,047		$456,290		$340,840		$5,247,961		$5,247,961		$5,247,961	
BENEFIT	**$418,648**		**$1,110,307**		**$829,376**		**$12,770,039**		**$12,770,039**		**$12,770,039**	

NOTE: CHANGES SHOWN ARE BASED ON A 150-DAY SIMULATION OF DAILY VESSEL MOVEMENTS IN THE PORT OF BALTIMORE. THE RESULTANT OPERATING COST CHANGES ARE CONVERTED TO A 365-DAY BASIS TO REFLECT ANNUAL BENEFITS FROM THE IMPROVEMENT.

FIGURE 5.18

WITHOUT PROJECT CONDITION
SYSTEM OPERATING COSTS
(1995 PRICES)

	YEAR 2000	VESSEL CALLS	YEAR 2010	VESSEL CALLS	YEAR 2020	VESSEL CALLS	YEAR 2030	VESSEL CALLS	YEAR 2040	VESSEL CALLS	YEAR 2050	VESSEL CALLS
RUN 1	$48,710,769	1459	$71,159,552	2017	$226,316,363	3093	$330,897,105	4137	$330,897,105	4137	$330,897,105	4137
RUN 2	$44,671,334	1366	$68,222,643	1963	$229,457,244	3026	$312,699,516	4086	$312,699,516	4086	$312,699,516	4086
RUN 3	$44,976,301	1402	$71,491,084	1968	$228,061,025	3065	$317,353,645	4130	$317,353,645	4130	$317,353,645	4130
RUN 4	$42,054,849	1303	$66,477,635	1867	$178,021,316	2992						
RUN 5	$46,841,511	1401	$73,024,495	1960	$217,788,858	2959						
AVERAGE	$45,450,953	1386	$70,075,082	1955	$215,928,961	3027	$320,316,755	4118	$320,316,755	4118	$320,316,755	4118

B-1

BRANCH CHANNEL ALTERNATIVES
SOUTH LOCUST POINT- WIDEN TO 400-FT
(1995 PRICES)

	YEAR 2000	VESSEL CALLS	YEAR 2010	VESSEL CALLS	YEAR 2020	VESSEL CALLS	YEAR 2030	VESSEL CALLS	YEAR 2040	VESSEL CALLS	YEAR 2050	VESSEL CALLS
RUN 1	$48,638,699	1459	$71,038,296	2017	$225,907,753	3093	$304,687,490	4193	$304,687,490	4193	$304,687,490	4193
RUN 2	$44,603,662	1366	$68,127,177	1963	$229,105,444	3027	$323,681,853	4206	$323,681,853	4206	$323,681,853	4206
RUN 3	$42,499,372	1403	$71,395,208	1968	$227,889,724	3065	$330,082,871	4138	$330,082,871	4138	$330,082,871	4138
RUN 4	$41,972,783	1303	$66,410,762	1867	$177,400,001	2992	$315,202,502	4129	$315,202,502	4129	$315,202,502	4129
RUN 5	$46,771,935	1401	$72,898,428	1960	$217,749,578	2959	$312,748,121	4100	$312,748,121	4100	$312,748,121	4100
AVERAGE	$44,897,290	1386	$69,973,974	1955	$215,610,500	3027	$317,280,567	4153	$317,280,567	4153	$317,280,567	4153
CHANGE	$553,663		$101,108		$318,461		$3,036,188		$3,036,188		$3,036,188	
BENEFIT	**$1,347,246**		**$246,028**		**$774,922**		**$7,388,057**		**$7,388,057**		**$7,388,057**	

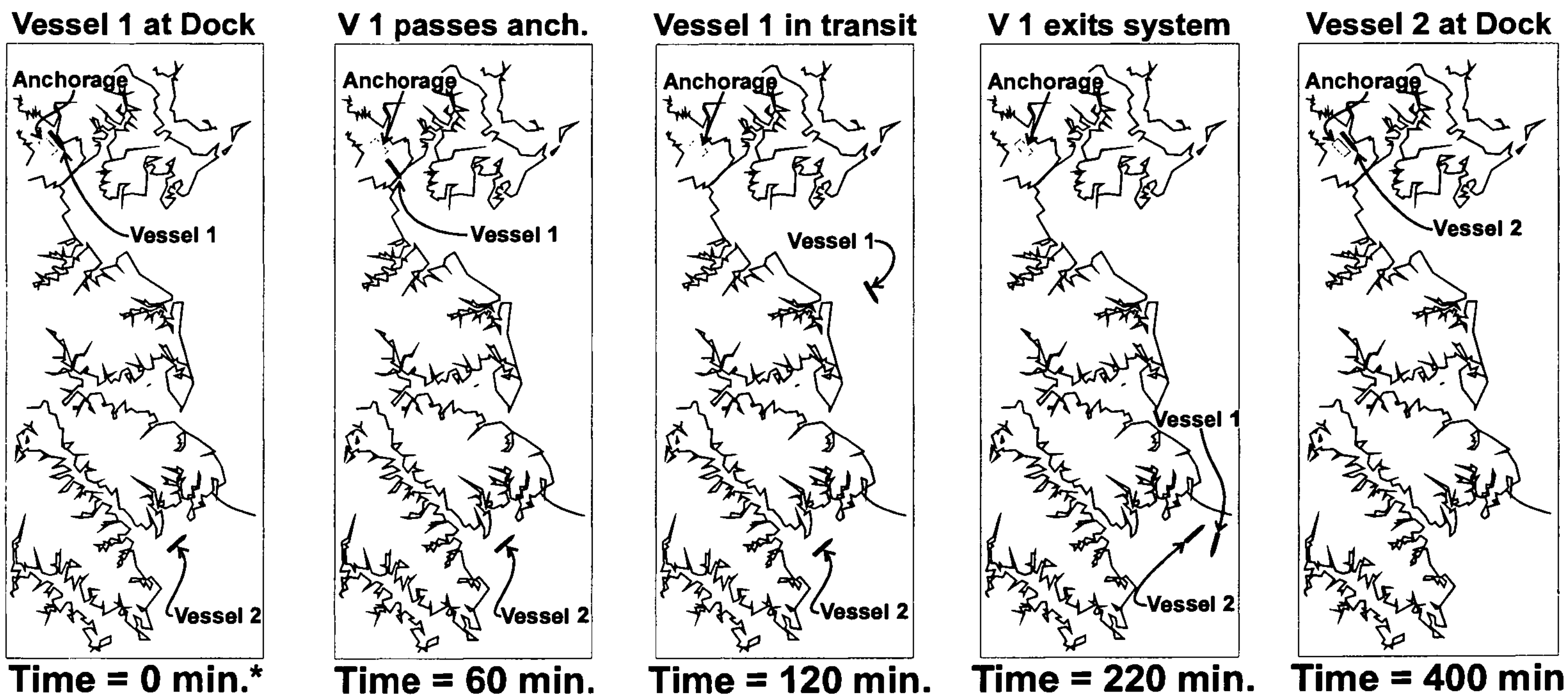
NOTE: CHANGES SHOWN ARE BASED ON A 150-DAY SIMULATION OF DAILY VESSEL MOVEMENTS IN THE PORT OF BALTIMORE. THE RESULTANT OPERATING COST CHANGES ARE CONVERTED TO A 365-DAY BASIS TO REFLECT ANNUAL BENEFITS FROM THE IMPROVEMENT.

deep. Several alternative widths and depths were considered. The alternative evaluated using the simulation model consisted of a uniform channel, 400-feet-wide with deepening of the Produce Wharf Channel to 36 feet. This alternative would provide for a usable loop branch channel having one width and depth. Figure 5.18 presents the nominal dollar cost savings (1995 dollars) resulting from simulation of this 400-foot widening alternative. The infrastructure constraint previously identified in the "without project" condition resulted in year 2020 savings being maintained through the year 2049.

5.5.1.b Anchorage Alternatives.

Modifications considered for the various anchorages servicing vessels in the Baltimore Harbor system, as previously identified in Section 5.4.2, included deepening, widening, and various combinations of deepening and widening. The simulation model was utilized to evaluate each of several anchorage alternatives absent other possible improvements so as to estimate total system impacts caused by each proposed anchorage alternative. Because any anchorage improvement will impact not only the specific terminal(s) for which the primary vessel is destined but also the entire harbor operating system, this approach provided a means for tracing impacts on the entire harbor operating system. Figure 5.19 and Figure 5.20 illustrate this concept. The illustrations in Figure 5.19 reflect the existing and "without project" interaction of a generic channel and anchorage in the port system. At time zero, Vessel 1 prepares to depart from berth. Vessel 2 waits at the Annapolis Anchorage for Vessel 1 to pass and provide room for Vessel 2 to move toward its berth area. In this illustration Vessel 2 doesn't begin its transit until time 220 minutes. A generic harbor anchorage improvement is illustrated in Figure 5.20. Due to an anchorage improvement (deepening or widening), Vessel 1 passes Vessel 2 at time 60 minutes and Vessel 2 is at its berth at time 120 minutes. This reduces travel time of Vessel 2 by 280 minutes. If the port operating system consisted of these 2 vessels, there would be a total time savings of 280 minutes realized to the system. However, there are many more than two vessels present in the port system with Vessel 1 and Vessel 2; consequently time savings caused by the generic anchorage improvement and the arrival of Vessel 2 to berth will be more than 280 minutes. Once Vessel 2 completes its loading or unloading operation and departs the berth, additional time savings accrue to all vessels in the system at that time. Figure 5.15 indicates the system areas of "frames" where anchorage improvements may be realized by the Port of Baltimore navigation system.

Simulation analysis of possible structural modifications to Anchorage #2/3 was conducted for the alternatives shown in Table 5.1. As discussed previously, several combinations of depth and area were selected for evaluation based on the varying vessel sizes that call on Baltimore. The size of the anchorage area is a function of both the vessel length and the required water depth for anchorage. It was determined that anchorage space in Baltimore Harbor is required for vessels up to 1,000 feet LOA, as well as for smaller vessels in the 600 to 800-foot range; therefore, anchorage alternatives were selected to service vessels ranging from 800 to 1,000 feet in the area of Anchorages #2 and 3, and from 600 to 800 feet in the area of Anchorage #4. Water depths for these alternatives were selected to range from 30 feet in Anchorage #4 to 42



Narrative:

Vessel 1 departing berth

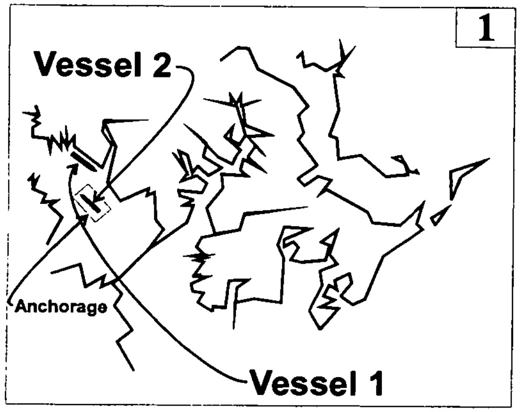
Vessel 2 next at berth; too large to anchor in harbor. Anchors at Annapolis

Figure 5.19

Anchorage Existing Condition

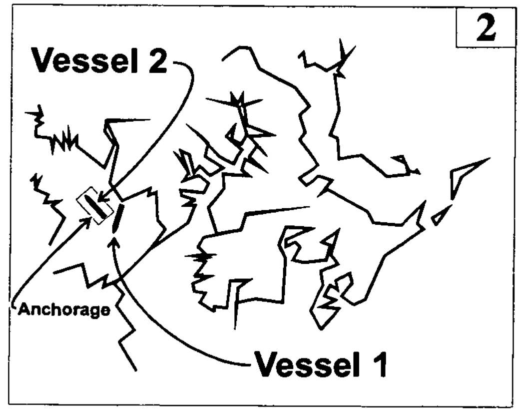
* Time estimates are for illustrative purposes only

Vessel 1 at Dock
Vessel 2 at anchorage



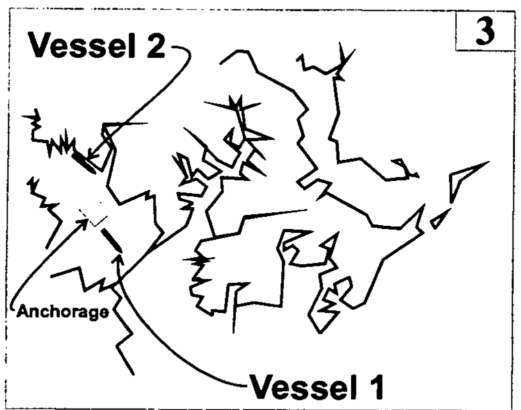
Time = 0 min.*

Vessel 2 moves toward dock
Vessel 1 passes anchorage



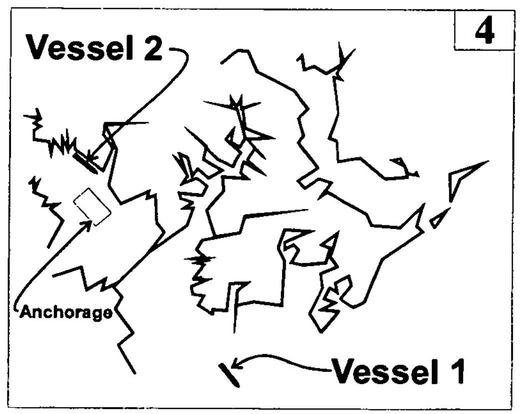
Time = 60 min.

Vessel 2 at dock



Time = 120 min.

Vessel 1 exits system



Time = 220 min.

Narrative:

Vessel 1 departing berth

Vessel 2 next at berth; anchors at enlarged anchorage in harbor

Reductions - Time Savings

Vessel 2	280 minutes
Total	280 minutes**

** Compare to Figure 5.19 in which vessel 2 arrives at the dock at time=400 minutes vs. 120 minutes in this scenario

Figure 5.20 Enlarged Anchorage in Harbor

* Time estimates are for illustrative purposes only

FIGURE 5.21

WITHOUT PROJECT CONDITION
SYSTEM OPERATING COSTS
(1995 PRICES)

	YEAR 2000	VESSEL CALLS	YEAR 2010	VESSEL CALLS	YEAR 2020	VESSEL CALLS	YEAR 2030	VESSEL CALLS	YEAR 2040	VESSEL CALLS	YEAR 2050	VESSEL CALLS
RUN 1	$48,710,769	1459	$71,159,552	2017	$226,316,363	3093	$330,897,105	4137	$330,897,105	4137	$330,897,105	4137
RUN 2	$44,671,334	1366	$68,222,643	1963	$229,457,244	3026	$312,699,516	4086	$312,899,516	4086	$312,699,516	4086
RUN 3	$44,976,301	1402	$71,491,084	1968	$228,061,025	3085	$317,353,645	4130	$317,353,645	4130	$317,353,645	4130
RUN 4	$42,054,849	1303	$66,477,635	1867	$178,021,316	2992						
RUN 5	$46,841,511	1401	$73,024,495	1960	$217,788,858	2959						
AVERAGE	$45,450,953	1386	$70,075,082	1955	$215,928,961	3027	$320,316,755	4118	$320,316,755	4118	$320,316,755	4118

C-5

ANCHORAGE 3 ALTERNATIVE
LOA 1020'; DEPTH 36'
(1995 PRICES)

	YEAR 2000	VESSEL CALLS	YEAR 2010	VESSEL CALLS	YEAR 2020	VESSEL CALLS	YEAR 2030	VESSEL CALLS	YEAR 2040	VESSEL CALLS	YEAR 2050	VESSEL CALLS
RUN 1	$48,648,982	1459	$70,704,184	2017	$220,456,714	3093	$297,516,851	4301	$297,516,851	4301	$297,516,851	4301
RUN 2	$44,451,782	1366	$67,293,550	1963	$226,988,623	3028	$327,772,406	4138	$327,772,406	4138	$327,772,406	4138
RUN 3	$44,713,741	1402	$70,573,215	1969	$224,461,471	3066	$740,616,248	3996	$740,616,248	3996	$740,616,248	3996
RUN 4	$41,821,398	1303	$65,265,142	1867	$175,388,166	2993	$297,066,285	4129	$297,068,285	4129	$297,066,285	4129
RUN 5	$46,738,059	1401	$71,847,046	1960	$217,769,899	2960	$310,212,285	4101	$310,212,285	4101	$310,212,285	4101
AVERAGE	$45,274,792	1386	$69,136,627	1955	$213,008,975	3028	$394,636,815	4133	$394,636,815	4133	$394,636,815	4133
CHANGE	$176,160		$938,454		$2,919,987		($74,320,060)		($74,320,060)		($74,320,060)	
BENEFIT	**$428,657**		**$2,283,572**		**$7,105,301**		**($180,845,479)**		**($180,845,479)**		**($180,845,479)**	

NOTE: CHANGES SHOWN ARE BASED ON A 150-DAY SIMULATION OF DAILY VESSEL MOVEMENTS IN THE PORT OF BALTIMORE. THE RESULTANT OPERATING COST CHANGES ARE CONVERTED TO A 365-DAY BASIS TO REFLECT ANNUAL BENEFITS FROM THE IMPROVEMENT.

feet in Anchorage #2/3. These alternatives did not increase the number of available anchor berths; rather these alternatives increased the size of one or two of the three available anchor berths within Anchorage #3 by expanding into Anchorage #2. The area remaining after implementation of a specific improvement will continue to be used for anchorage. Figure 5.21 illustrates results of simulating operation of one anchorage alternative. Each alternative was simulated as being operational in the port system to identify time and cost impacts by benchmark years over the 50-year planning horizon. Each alternative yielded system-wide net benefits over the planning horizon. The infrastructure constraint previously identified in the "without project" condition resulted in year 2020 savings being maintained through the year 2049.

5.5.1.c Turning Basin Alternatives. Two alternatives were initially identified for constructing a turning basin near the head of the Fort McHenry Channel and adjacent to Anchorage #1. The larger alternative includes a basin 1,500 feet in length and width. This alternative is based on design criteria for a ship in the 1,000-foot LOA range. The smaller alternative includes a basin 1,200 feet in length and width and was developed to limit associated dredging quantities and costs. A basin 1,200 feet in length can accommodate a vessel 800-feet LOA.

The Fort McHenry Channel is 700 feet wide and 50 feet deep in this location and would require no additional deepening or widening. There is also an area 50 feet wide on both sides of the Fort McHenry Channel from the remnant 42-foot deep and 800-foot wide Fort McHenry Channel that would need to be deepened approximately 8 feet. Anchorage #1 is currently 400 feet wide and 35 feet deep and will require deepening of an additional 15 feet. Combination of these areas could provide a turning area 1,200 feet wide. Enlarging the area beyond this size will require a significant amount of dredging in shallow water areas. The quantity of dredged material associated with construction of the larger 1,500-foot-wide turning basin was determined to be more than double the quantity for the 1,200-foot-wide turning basin. Since currents are minimal in the harbor and tugs are likely to assist vessels in executing the turning maneuver, it was decided that the 1,200-foot-wide turning basin alternative would be preferable. Further analysis of this alternative determined that the tremendous decrease in dredging quantities and cost (compared to the larger turning basin) complied with several of the planning objectives identified for this study.

5.5.2 Alternatives for Further Evaluation

Following completion of the initial model runs for the without-project plan and the independent alternatives presented in Tables 5.1 - 5.3, benefits associated with a specific improvement were identified. By grouping these improvements (alternatives) together, a series of plans for improvement to the anchorages and branch channels was identified and evaluated based on the economic and environmental impact associated with their implementation. While a multitude of combinations exists, efforts were focused upon developing and modelling a series of plans which would expand a range of improvements to the Port of Baltimore navigation system. This evaluation and a description of the plans is presented in Section 6.

Section 6

PLAN DESCRIPTION AND EVALUATION

The previous section described the results of the technical investigations and the conduct of preliminary formulation activities. After these efforts were completed, conclusions were derived and decisions were made concerning candidate alternatives for final consideration. All of the proposed plans are somewhat similar. They require widening and/or deepening and placement of dredged material at the Hart-Miller Island placement site. The total quantities of dredged material that will be removed from the harbor will vary with the action selected. These alternatives are described in the following sections and are subsequently assessed and evaluated in order to assist in the identification of the NED and selected plan and in the preparation of NEPA documentation.

6.1 ALTERNATIVE PLANS

There are many and diverse operations and activities, both landside and waterside, associated with servicing vessels and commodities in the Port of Baltimore. While all of these operations and activities influence the efficiency and cost of the overall port delivery system (and should be evaluated periodically by the port community), potential improvements to land-based operations and activities were not considered in the formulation and selection of alternatives. The formulation discussion in Section 5 concentrated on water-based activities and focused on providing a safe and efficient means of vessel movement and commodity delivery to and from the berths. The many alternatives considered were limited to waterborne activities and the benefits and costs to the system of implementing these alternatives.

Analysis of the without-project condition identified that several of the MPA-owned terminals are the busiest in the port. This results from both the diverse range of services offered by the MPA as well as the modern and highly productive resources provided to the customers. Certainly the MPA and others will continue to strive to offer modern and efficient handling of all cargoes calling on the Port of Baltimore. This is underscored by the aggressive planning posture that is exhibited by MPA and the State of Maryland. Facility upgrades are continually occurring. New perspectives in moving cargoes are constantly evaluated. New berth and terminal facilities are already being contemplated only 7 years after the opening of the Seagirt Marine Terminal, which was the most modern container-handling facility of its kind when it became operational in 1989.

In evaluating branch channel improvements and anchorage improvements, several considerations were included in all of the plans. These considerations relate to efficiency, expansion of facilities, and "throughput" capacity. Loading/unloading capability is an important element influencing the ability of vessels to arrive/depart from the port destination, and ultimately influence total vessel time in the port system. Based on discussions with members of the port community, landside loading/unloading resource capability was evaluated and reflected in the simulation modelling efforts. Time at berth was defined to be 24 hours, on average, throughout the planning period. This estimate attempts to capture total time "at berth" including idle time; productive time; holiday time; weather impacts; labor productivity; and equipment productivity.

Current plans for improvements to the existing Port of Baltimore infrastructure were also identified and included in the simulation analysis. A fourth berth at Seagirt Marine Terminal in the near future will increase the ability of the MPA to accommodate vessels calling on the port. The evaluation also reflected plans for a new marine terminal in Baltimore Harbor that would provide 4 additional berths and related labor and equipment resources, which is scheduled to be fully operational around the year 2020. These considerations are reflected in all scenarios including the without-project condition, independent alternative improvements, and plan groupings.

Based on the activity levels forecast for the Port of Baltimore in terms of commodity tonnages and vessel calls, it is important to point out that even with the current "at berth" productivity rate and the inclusion of new berths in the port system, capacity shortfalls and delays are manifested in the simulation analysis beginning in the 2020-2030 time frame. The waterside improvements and plans discussed below, if implemented, are likely to postpone or ameliorate these capacity-related problems, all other things remaining the same. However, the proposed waterside improvements will not be sufficient to eliminate the future "bottlenecks" unless landside infrastructure productivity is improved and/or additional berth/terminal capacity is provided.

The formulation discussion in Section 5 considered several independent measures, or alternatives. These included a without-project plan, branch channel improvements, anchorage improvements, and plans oriented toward both branch channel improvements and modification of existing anchorages. A description of these alternatives is provided below (see Section 6.1.3 for comprehensive diagrams of these plans).

6.1.1 Without-Project Condition Plan

The without-project condition plan is the most likely condition expected to prevail over the length of the planning period in the absence of the Federal government implementing plans for improvement. It is the most probable future condition. The without-project condition provides the baseline for estimating the direct and indirect impacts associated with proposed Federal improvements to the port system. Regional population and business activity will continue to grow as will the Nation as a whole. The Port of Baltimore will continue to function as one of America's busiest deep-water ports. Its waterside and landside infrastructure will continue to accommodate a diverse mix of commodities and vessel types throughout the planning period. Commodity tonnages handled by the Port of Baltimore are projected to increase from 29.7 million metric tons in the year 2000 to more than 118 million metric tons by the year

2050, an annual growth rate of 2.8 percent. Accompanying this commodity growth is forecast growth in the number of vessels loading and/or unloading commodities through the Port of Baltimore. Vessel calls in the year 2000 are forecast to be more than 3,400 a year, increasing to 10,400 annual vessel calls by the year 2030 and to more than 20,300 annual vessel calls by the year 2050. With this increase in commodity and vessel movements will come a corresponding increase in the demands placed on the navigation system serving the port users. Total operating costs for vessels while using the port navigation system are estimated to be more than $45 million (1995 dollars) per year by the year 2000 increasing steadily to more than $320 million (1995 dollars) per year by the year 2050.

6.1.2 Anchorage and Branch Channel Alternatives

6.1.2.a Anchorages. Anchorage improvements were considered for the areas of Anchorage #3 and Anchorage #4. These anchorages are currently the deepest areas in the harbor; they, therefore, lend themselves to the most cost-effective improvements. The existing vessel traffic within the harbor and the traffic projections indicate the need for at least one large anchorage for deep draft commercial vessels. It is also important to maintain available anchorage space for smaller ships which are also likely to encounter delays. As discussed in Section 5.4.1.c, alternatives were analyzed to provide a large anchorage capable of serving vessels 800 to 1,000 feet LOA in the area of Anchorage #3, as well as an anchorage in the area of Anchorage #4 to service vessels 600 to 800 feet LOA. The alternatives provide new opportunities for vessels of varying sizes and types to anchor in the harbor while creating a safe and expanded anchorage area for larger vessels.

6.1.2.b Branch Channels. Given the tremendous growth likely to be experienced by the Port of Baltimore over the planning period, structural improvements to the branch channels serving several of the public marine terminals were considered. Branch channel improvements, including cut-off angles for safety, were evaluated for the South Locust Point Marine Terminal, Seagirt Marine Terminal, and Dundalk Marine Terminal. These terminal facilities are expected to be among the busiest terminals throughout the planning period. Alternatives were also developed for providing a turning basin in the area of Anchorage #1 and the head of the Fort McHenry Channel, which will contribute to system efficiencies provided by branch channel improvements.

6.1.2.c Preliminary Evaluation of Alternatives. In order to determine the recommended plan of improvement, independent alternatives for anchorage and branch channel improvements were examined based on an evaluation of preliminary benefits and costs and then grouped together for further detailed analysis. The rationale for grouping alternatives is presented in the following paragraphs. A discussion on the calculation of benefits and costs, which are the basis of this preliminary evaluation, is provided in Section 6.6, Estimate of First Costs, and Section 6.7, Economic Assessment.

Preliminary first costs were calculated for the anchorage and branch channel alternatives for

TABLE 6.1
FIRST COSTS - ALTERNATIVE IMPROVEMENTS

	ALTERNATIVE	QUANTITY (CY)	CONSTRUCT COST	PED COSTS	FIRST COSTS	I.D.C. (5) COSTS
	DUNDALK MARINE TERMINAL					
D1	East Dundalk Channel @ 400-Ft Wide by 38-Ft Deep	38,800	$1,233,372	$750,000	$1,983,372	$148,068
	SOUTH LOCUST POINT TERMINAL					
SL1	Branch Channel Loop @ 400-Ft Wide by 36-Ft Deep	216,800	$2,252,116	$750,000	$3,002,116	$224,122
	SEAGIRT MARINE TERMINAL					
S1	Seagirt Channel, Connecting Channel, East Dundalk @ 400' Wide, 38' Deep, 42' Cutoff Angles, 1200' Turning Basin	662,500	$3,535,620	$750,000	$4,285,620	$319,942
S2	Seagirt Channel, Connecting Channel, West Dundalk @ 400' Wide, 42' Deep, 42' Cutoff Angles, 1200' Turning Basin	643,500	$3,453,540	$750,000	$4,203,540	$313,814
S3	Seagirt Channel, Connecting Channel, West Dundalk @ 500' Wide, 42' Deep 42' Cutoff Angles, 1200' Turning Basin	973,100	$4,963,812	$750,000	$5,713,812	$426,563
	ANCHORAGE #3					
A3-1	Enlarged Berth Area For Vessels 820-Ft LOA by 36-Ft depth	455,400	$2,903,989	$750,000	$3,653,989	$272,788
A3-2	Enlarged Berth Area For Vessels 800-Ft LOA by 40-Ft depth	872,600	$4,647,885	$750,000	$5,397,885	$402,978
A3-3	Enlarged Berth Area For Vessels 890-Ft LOA by 42-Ft depth	1,584,000	$7,621,537	$750,000	$9,015,600	$673,058
A3-4	Enlarged Berth Area For Vessels 920-Ft LOA by 36-Ft depth	700,400	$3,928,089	$750,000	$4,678,089	$349,242
A3-5	Enlarged Berth Area For Vessels 900-Ft LOA by 40-Ft depth	1,225,900	$6,124,679	$750,000	$6,874,679	$513,228
A3-6	Enlarged Berth Area For Vessels 1020-Ft LOA by 36-Ft depth	997,900	$5,171,639	$750,000	$5,921,639	$442,079
A3-7	Enlarged Berth Area For Vessels 1000-Ft LOA by 40-Ft depth	1,643,100	$7,868,575	$750,000	$8,618,575	$643,418
A3-8	Two Enlarged Berths For Vessels Each 890-Ft LOA by 42-Ft depth	3,608,400	$16,083,529	$750,000	$16,833,529	$1,256,703
	ANCHORAGE #4					
A4-1	Enlarged Berth Area For Vessels 550-Ft LOA by 30-Ft depth	108,300	$1,434,700	$750,000	$2,153,595	$160,776
A4-2	Enlarged Berth Area For Vessels 550-Ft LOA by 32-Ft depth	170,300	$1,683,320	$750,000	$2,441,895	$182,299
A4-3	Enlarged Berth Area For Vessels 585-Ft LOA by 34-Ft depth	364,000	$2,460,057	$750,000	$3,342,600	$249,541
A4-4	Enlarged Berth Area For Vessels 680-Ft LOA by 34-Ft depth	629,800	$3,525,915	$750,000	$4,578,570	$341,812
A4-5	Enlarged Berth Area For Vessels 690-Ft LOA by 38-Ft depth	1,103,400	$5,425,051	$750,000	$6,780,810	$506,220
A4-6	Enlarged Berth Area For Vessels 690-Ft LOA by 42-Ft depth	1,585,500	$7,358,272	$750,000	$9,022,575	$673,578
A4-7	Enlarged Berth Area For Vessels 735-Ft LOA by 43-Ft depth	2,124,900	$9,521,266	$750,000	$11,530,785	$860,828
A4-8	Enlarged Berth Area For Vessels 815-Ft LOA by 47-Ft depth	3,069,200	$13,307,909	$750,000	$15,921,780	$1,188,637
A4-9	Enlarged Berth Area For Vessels 945-Ft LOA by 41-Ft depth	2,311,100	$10,267,988	$750,000	$12,396,615	$925,467

Notes:

1 - LOA is Length Overall and represents the maximum length of a vessel.
2 - Mob/Demob Costs of $925,300 are included in branch channel alternatives (D, SL, S) and $1,000,417 for anchorage modifications (A3, A4).
3 PED/S&A estimated costs of $750,000 are included in each of the branch channel and anchorage modifications.
4 - Alternatives do not include MPA placment site improvement costs for Hart-Miller Island placement site.
5 - I.D.C. - Interest During Construction

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TABLE 6.2
BENEFITS VS COSTS - ALTERNATIVE IMPROVEMENTS

	ALTERNATIVE	ANNUAL COSTS	OMRR&R COSTS	ANNUAL BENEFITS	BEN-COST RATIO	NET BENEFITS
	DUNDALK MARINE TERMINAL					
D1	East Dundalk Channel @ 400-Ft Wide by 38-Ft Deep	$161,805	$12,840	$686,396	3.9	$511,751
	SOUTH LOCUST POINT TERMINAL					
SL1	Branch Channel Loop @ 400-Ft Wide by 36-Ft Deep	$244,915	$1,986	$1,549,933	6.3	$1,303,032
	SEAGIRT MARINE TERMINAL					
S1	Seagirt Channel, Connecting Channel, East Dundalk @400' Wide, 38' Deep, 42' Cutoff Angles, 1200' Turning Basin	$349,624	$25,729	$2,859,229	7.6	$2,483,876
S2	Seagirt Channel, Connecting Channel, West Dundalk @400' Wide, 42' Deep, 42' Cutoff Angles, 1200' Turning Basin	$342,928	$25,729	$2,277,016	6.2	$1,908,359
S3	Seagirt Channel, Connecting Channel, West Dundalk @500' Wide, 42' Deep 42' Cutoff Angles, 1200' Turning Basin	$466,137	$25,729	$2,682,323	5.5	$2,190,457
	ANCHORAGE #3					
A3-1	Enlarged Berth Area For Vessels 820-Ft LOA by 36-Ft depth	$298,095	$20,000	$4,086,406	12.8	$3,768,311
A3-2	Enlarged Berth Area For Vessels 800-Ft LOA by 40-Ft depth	$440,364	$20,000	$2,365,933	5.1	$1,905,569
A3-3	Enlarged Berth Area For Vessels 890-Ft LOA by 42-Ft depth	$735,500	$22,134	$3,215,827	4.2	$2,458,193
A3-4	Enlarged Berth Area For Vessels 920-Ft LOA by 36-Ft depth	$381,642	$25,000	$2,365,933	5.8	$1,959,291
A3-5	Enlarged Berth Area For Vessels 900-Ft LOA by 40-Ft depth	$560,842	$25,000	$2,365,933	4.0	$1,780,091
A3-6	Enlarged Berth Area For Vessels 1020-Ft LOA by 36-Ft depth	$483,092	$33,000	$2,365,933	4.6	$1,849,841
A3-7	Enlarged Berth Area For Vessels 1000-Ft LOA by 40-Ft depth	$703,110	$33,000	$2,365,933	3.2	$1,629,823
A3-8	Two Enlarged Berths For Vessels Each 890-Ft LOA by 42-Ft depth	$1,373,293	$83,000	$4,197,659	2.9	$2,741,366
	ANCHORAGE #4					
A4-1	Enlarged Berth Area For Vessels 550-Ft LOA by 30-Ft depth	$175,692	$10,000	$530,895	2.9	$345,203
A4-2	Enlarged Berth Area For Vessels 550-Ft LOA by 32-Ft depth	$199,212	$10,000	$39,600	0.2	($169,612)
A4-3	Enlarged Berth Area For Vessels 585-Ft LOA by 34-Ft depth	$272,692	$15,000	$42,995	0.1	($244,697)
A4-4	Enlarged Berth Area For Vessels 680-Ft LOA by 34-Ft depth	$373,523	$21,000	$42,995	0.1	($351,528)
A4-5	Enlarged Berth Area For Vessels 690-Ft LOA by 38-Ft depth	$553,184	$34,000	$4,973,371	8.5	$4,386,187
A4-6	Enlarged Berth Area For Vessels 690-Ft LOA by 42-Ft depth	$736,069	$7,307	$13,755,075	18.5	$13,011,699
A4-7	Enlarged Berth Area For Vessels 735-Ft LOA by 43-Ft depth	$940,691	$55,000	$10,164,017	10.2	$9,168,326
A4-8	Enlarged Berth Area For Vessels 815-Ft LOA by 47-Ft depth	$1,298,912	$77,000	$6,488,843	4.7	$5,112,931
A4-9	Enlarged Berth Area For Vessels 945-Ft LOA by 41-Ft depth	$1,011,326	$60,000	$3,917,983	3.7	$2,846,657

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comparison purposes, and are shown in Table 6.1. Using these costs, annual benefits and costs were computed for each independent alternative and are summarized in Table 6.2. This table shows both the benefit-cost ratios (BCRs) and the net benefits for the various alternatives investigated as though each alternative would be implemented separately. Preliminary estimates for the PED phase of study and mobilization/demobilization costs are included with each alternative. See Section 6.6 for a more detailed discussion of these costs.

As shown in Table 6.2, widening of the East Dundalk Channel (D1) results in positive economic returns with more than $0.5 million in annual net benefits and a BCR of 3.9. This improvement by itself will address only part of the problems identified. Similarly, the South Locust Point alternative (SL1) also results in significant economic return with annual net benefits of more than $1.3 million and a BCR of 6.3. Improvements to the other branch channels serving the Seagirt Marine Terminal including widening, providing cutoffs, and constructing a turning basin, will also contribute positive economic returns, with net benefits ranging from $1.9 million to just under $2.5 million and BCRs of 5.5 to 7.6 (alternatives S1 - S3). Alternative S1 provides the greatest net benefits of the three alternatives; however, this alternative also includes improvements to the East Dundalk Channel (D1), whereas alternative S2 and S3 do not. Some of the benefits associated with this improvement are derived from widening of the East Dundalk Channel. The other alternatives for Seagirt, S2 and S3, do not include East Dundalk and still provide a significant return. Of the two, alternative S3 includes the greatest extent of improvements to the Seagirt channels and provides the greatest economic return as well. For this reason, it was determined that alternative S3 could be grouped together with the East Dundalk alternative (D1) and the South Locust Point alternative (SL1) to provide the optimum improvements.

All of the alternatives for Anchorage #3 were found to contribute positive economic returns, with net benefits ranging from $1.6 million to $3.8 million and BCRs ranging from 2.9 to 12.8. Of these alternatives, A3-1 and A3-3 have both the highest net benefits and strong BCRs. Alternative A3-3 is also deep enough to accommodate the 38-foot drafting design vessel. Since one of the objectives of this study was to provide at least one deep draft anchorage in Baltimore Harbor, Plan 2 and Plan 3 as defined in Section 6.1.3 were designed using the highest ranking alternatives for Anchorage #3 to provide one large anchorage each.

Economic returns associated with the alternatives for Anchorage #4 were found to vary considerably, with positive net benefits ranging from a loss of $350,000 to a gain of $13.0 million and BCRs ranging from 0.1 to 18.5. Of these alternatives, A4-5 and A4-6 have the highest net benefits and the highest BCRs. Since providing a large anchorage area was identified as one of the objectives of this study, these alternatives were selected for combination with a larger improvement at Anchorage #3.

Based on this evaluation, a comprehensive grouping of plans was developed. These groupings were based upon selecting the most viable alternatives for combination into a single plan, which could include both anchorage and/or branch channel improvements. The plans are defined below and evaluated further in Section 6.7, Economic Assessment.

6.1.3 Anchorage and Branch Channel Plans

Following an evaluation of the alternative plans of improvement, which was based on preliminary costs and benefits, the alternatives were combined into six plans. Efforts were focused on limiting the large number of potential combinations to a manageable level. The plans selected for further evaluation are oriented towards providing a variety of combinations of improvements and are shown in Table 6.3 and in Figures 6.1 - 6.6.

Plan 1 is oriented toward improving branch channel maneuverability; the improvements address concerns with vessel maneuverability to varying degrees. Plan 1 incorporates improvements to the East Dundalk Channel, the Seagirt Connecting Channel, the West Dundalk Channel, and the South Locust Point channel system, which includes a new channel section. In addition, some minor channel modifications are included to provide cut-off angles, or flared channel entrances, at two locations (Figure 6.1). One angle is intended to ease the difficulty of making a 90-degree turn into the West Dundalk Branch Channel as well as provide greater clearance from the adjacent anchorages. In addition, a second cutoff angle at the intersection of the Connecting Channel and the West Dundalk Channel is intended to increase maneuverability in this narrow segment and to provide better passage to the berths on the west side of Dundalk Marine Terminal. The East Dundalk Channel directs vessels to the berths on the east side of the Dundalk Marine Terminal and, therefore, merits needed improvements as requested by the maritime community. Similarly, widening of the Connecting Channel and West Dundalk Channel will provide a uniform 500-foot-wide channel, allowing safe and efficient passage to both Seagirt and the west Dundalk berths. Channel deepening/widening at South Locust Point is also intended to improve safety and efficiency. A turning basin is also proposed at the head of the Fort McHenry Channel to reduce channel congestion and to improve safety and efficiency when turning vessels in this segment of the channel.

Plan 2 is oriented toward modifications in Anchorages #2 and #3. Enlargement of the existing anchorage area in this location would provide a safe waiting area for the majority of vessels that call on the port (Figure 6.2).

Plan 3 is similar to Plan 2; however, this plan is slightly larger and deeper than Plan 2 and will be able to accommodate a greater percentage of the vessels calling on Baltimore (Figure 6.3).

Plan 4 is similar to Plan 3; however, in addition to a large anchorage at #3, a smaller anchorage improvement is also proposed at #4 (Figure 6.4). The purpose of this smaller anchorage area is to provide additional anchorage space for smaller vessels while leaving the larger anchorage area available for larger vessels.

Plans 5 and 6 are the most comprehensive groupings of the alternatives considered Figures 6.5, 6.6). Plan 5 includes modifications to the branch channels and turning basin (previously identified as Plan 1), and also includes anchorage improvements at #3 and #4 (Plan 3).

TABLE 6.3
PLANS OF IMPROVEMENT

PLAN 1 - BRANCH CHANNELS	QUANTITY (cy)*
East Dundalk (38' X 400')	38,800
Seagirt/Connecting Channel/ West Dundalk Channel (42' X 500')**	637,600
South Locust Point (36' X 400')	216,800
Turning Basin (1200'x1200'x50')	355,500
PLAN 1 - TOTAL	1,248,700
PLAN 2 - ANCHORAGE	**QUANTITY (cy)***
Anchorage #3 Modification (820' Vessel: 2,000' X 36' Deep)	455,400
PLAN 2 - TOTAL	455,400
PLAN 3 - ANCHORAGE	**QUANTITY (cy)***
Anchorage #3 Modification (890' Vessel: 2,200' x 2,200' x 42' Deep)	1,584,000
PLAN 3- TOTAL	1,584,000
PLAN 4 - ANCHORAGE	**QUANTITY (cy)***
Anchorage #3 Modification (890' Vessel: 2,200' x 2,200'x 42' Deep)	1,584,000
Anchorage #4 Modification (690' Vessel: 1,800' x 1,800'x 42' Deep)	1,585,500
PLAN 4 - TOTAL	3,169,500

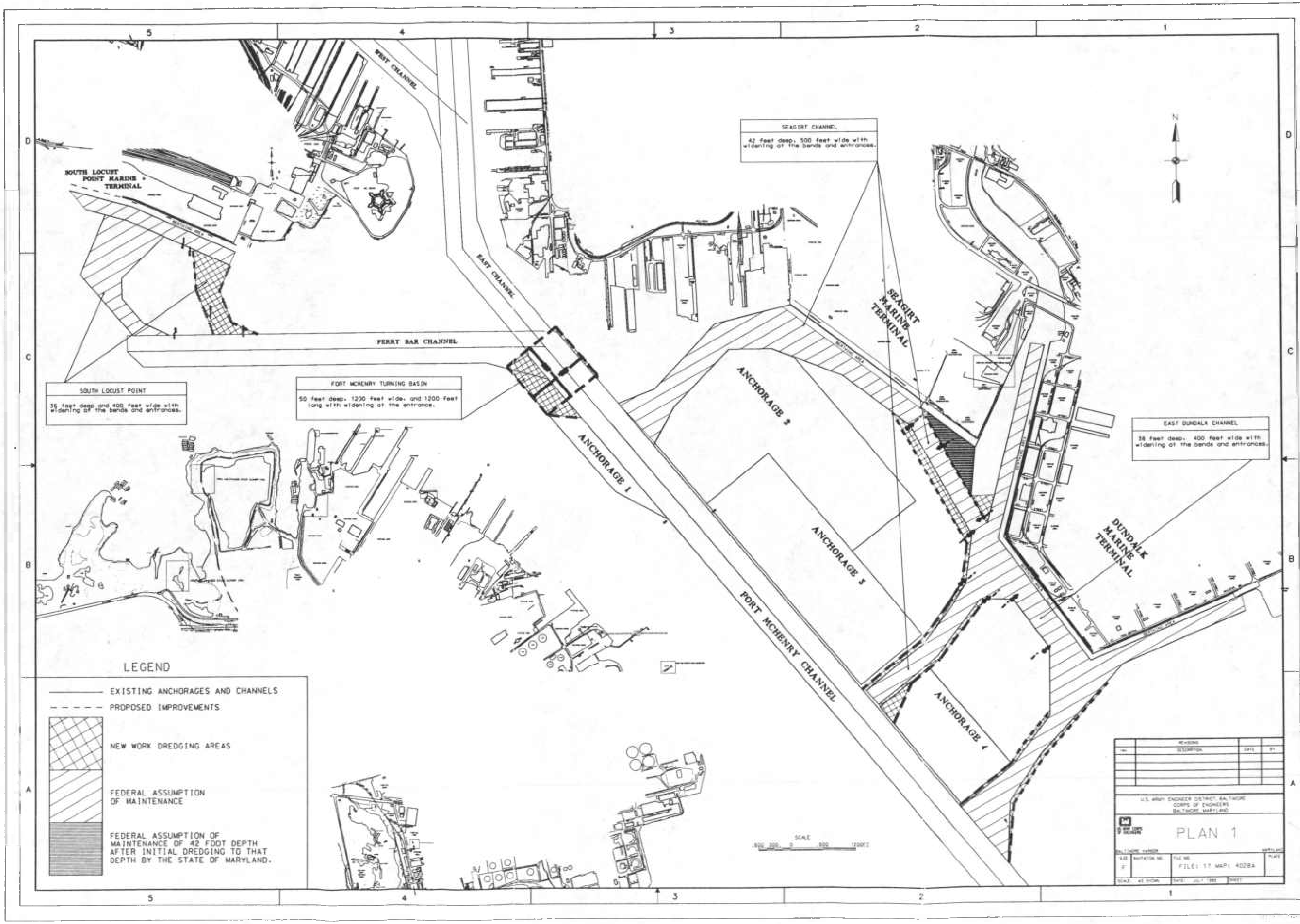
PLAN 5 - CHANNEL/ANCHORAGE	QUANTITY (cy)*
East Dundalk (38' x 400')	38,800
Seagirt/Connecting Channel/ West Dundalk (42' x 500')**	627,600
South Locust Point (36 'x 400')	216,800
Anchorage #3 Modification (890' Vessel: 2,200 x 2,200' x 42' Deep)	1,584,000
Anchorage #4 Modification (690' Vessel: 1,800' x 1,800' x 42' Deep)	1,585,500
Turning Basin (1,200'x 50')	355,500
PLAN 5 TOTAL	4,418,200
PLAN 6 - CHANNEL/ANCHORAGE	**QUANTITY (cy)***
East Dundalk (38' x 400')	38,800
Seagirt/Connecting Channel/ West Dundalk (42' x 500')**	627,600
South Locust Point (36 ' x400')	216,800
Anchorage #3 Modification	
(890' Vessel: 2,200 x 2,200'x 42' Deep)	1,584,000
(890' Vessel: 2,200 x 2,200' x 42' Deep)	2,024,400
Anchorage #4 Modification (690' Vessel: 1,800' x 1,800' x 38' Deep)	1,103,400
Turning Basin (1,200' x 50')	355,500
PLAN 6 TOTAL	5,960,500

(cy) = cubic yards

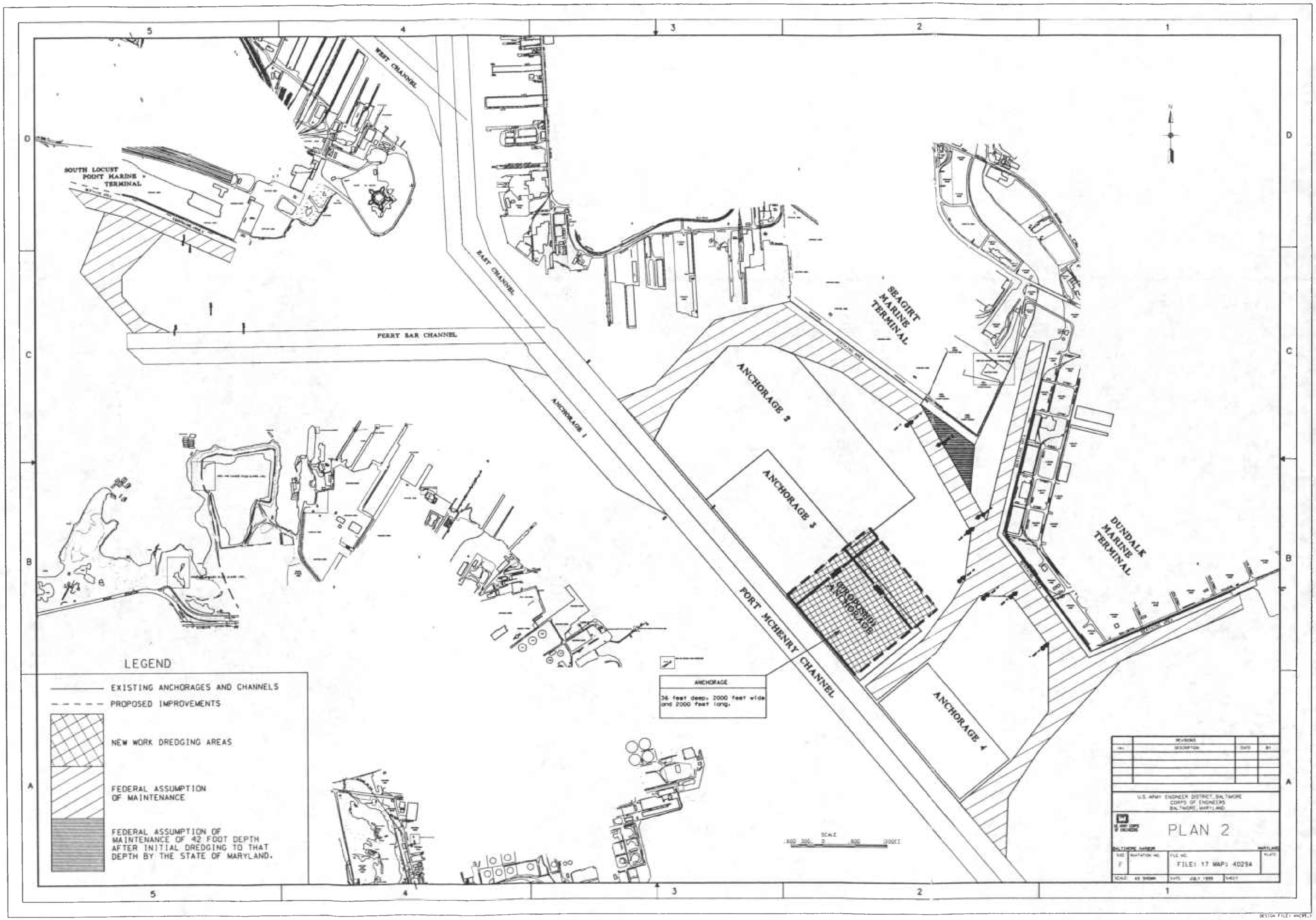
* Quantities include 2 feet of allowable overdepth but exclude existing maintenance dredging quantities.
** Includes appropriate channel widening at the bends and entrances, as needed.

Plan 6 is similar to Plan 5; however, this plan includes a second anchorage space at #2/3, each equal in size, and a smaller anchorage improvement at #4. The slightly smaller improvement at Anchorage #4 is proposed to provide additional anchorage space for smaller vessels and to partially compensate for the significant increase in the volume of dredged material associated with the second anchorage at #2/3.

In addition, Federal assumption of operation and maintenance requirements for branch channels, which are currently maintained by MPA, is also included in these plans.



WEST CHANNEL
SOUTH LOCUST POINT MARINE TERMINAL
EAST CHANNEL
FERRY BAR CHANNEL
SEAGIRT CHANNEL
42 feet deep, 500 feet wide with widening at the bends and entrances.
SEAGIRT MARINE TERMINAL
N
SOUTH LOCUST POINT
36 feet deep and 400 feet wide with widening of the bends and entrances.
FORT MCHENRY TURNING BASIN
50 feet deep, 1200 feet wide, and 1200 feet long with widening of the entrance.
ANCHORAGE 1
ANCHORAGE 2
ANCHORAGE 3
ANCHORAGE 4
FORT MCHENRY CHANNEL
EAST DUNDALK CHANNEL
38 feet deep, 400 feet wide with widening at the bends and entrances.
DUNDALK MARINE TERMINAL
LEGEND
EXISTING ANCHORAGES AND CHANNELS
PROPOSED IMPROVEMENTS
NEW WORK DREDGING AREAS
FEDERAL ASSUMPTION OF MAINTENANCE
FEDERAL ASSUMPTION OF MAINTENANCE OF 42 FOOT DEPTH AFTER INITIAL DREDGING TO THAT DEPTH BY THE STATE OF MARYLAND.
SCALE
U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND
PLAN 1
FILE: 17 MAP: 4028A



SOUTH LOCUST POINT MARINE TERMINAL
WEST CHANNEL
EAST CHANNEL
FERRY BAR CHANNEL
ANCHORAGE 1
ANCHORAGE 2
ANCHORAGE 3
ANCHORAGE 4
PROPOSED ANCHORAGE
FORT MCHENRY CHANNEL
SEAGIRT MARINE TERMINAL
DUNDALK MARINE TERMINAL
ANCHORAGE
36 feet deep, 2000 feet wide and 2000 feet long.
LEGEND
EXISTING ANCHORAGES AND CHANNELS
PROPOSED IMPROVEMENTS
NEW WORK DREDGING AREAS
FEDERAL ASSUMPTION OF MAINTENANCE
FEDERAL ASSUMPTION OF MAINTENANCE OF 42 FOOT DEPTH AFTER INITIAL DREDGING TO THAT DEPTH BY THE STATE OF MARYLAND.
REVISIONS
DESCRIPTION
DATE
BY
U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND
PLAN 2
BALTIMORE HARBOR
FILE: 17 MAP: 40294
SCALE AS SHOWN
DESIGN FILE: ANC

8.5 IMPLEMENTATION PROCESS

8.5.1 Implementation Overview and Project Management Plan

Project implementation will proceed in two phases: preconstruction engineering and design (PED) and construction. Implementation is expected to last about three and one-half years, beginning in May 1997 after the Division Engineer's Notice is issued. The construction contract is scheduled to be awarded in December 1999, with completion in Spring 2001. Implementation will end with project closeout in June 2001. Upon completion of the project, the COE will operate and maintain the general navigation features at Federal expense.

The project implementation process is summarized in the Project Management Plan (PMP) included in Appendix A of this report. The PMP covers activities to be accomplished during the PED and construction phases of the project by the Baltimore District COE and the local sponsor. It summarizes the scope, schedule, budget and responsibilities for the actions to be accomplished, as well as the management structure and Federal/non-Federal partnership roles. The PMP is a management tool for use by the District and the non-Federal sponsor, and as such, will be revised as needed to accommodate changes as project implementation proceeds.

After comments on the draft feasibility report are received, the PMP will be finalized, approved by the Baltimore District's Project Review Board, and forwarded to COE Headquarters with the Final Feasibility Report. At that time, the PMP schedule becomes the baseline from which project implementation is measured.

8.5.2 Preconstruction Engineering and Design Phase

The PED phase consists of concurrent actions on the four elements which must be accomplished prior to the start of project construction: 1) detailed design and continued planning analyses for the selected plan; 2) project authorization by Congress and the non-Federal sponsor; 3) funds for construction included in the Federal and non-Federal budgets; and 4) negotiation of the Project Cooperation Agreement (PCA).

PED can begin when the feasibility report is approved by the issuance of the Division Engineer's Notice, if Federal funds have been appropriated for the PED phase, and a PED agreement has been executed with the non-Federal sponsor. The PED agreement is the legal mechanism which provides for the cost-sharing of PED at the time of the work effort. The overall project cost-sharing percentage (i.e. 75/25) is directly applicable to the PED costs. The PED agreement is scheduled for execution in April 1997, concurrent with the release of the Division Engineer's Notice. The current estimate of PED cost is $828,000, of which the non-Federal sponsor would be responsible for $207,000. PED can end once the first set of plans and specifications is approved. It is expected that the PED phase will be initiated in May 1997, after formal approval of the feasibility report. PED is expected to last 24 months, with completion in April 1999, upon approval of the design memorandum and

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

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

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

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

> * *10 percent of the costs attributable to dredging to a depth up to but not in excess of 20 feet;*
>
> * *25 percent of the costs attributable to dredging to a depth in excess of 20 feet but not in excess of 45 feet;*
>
> * *50 percent of the costs attributable to dredging to a depth in excess of 45 feet.*

8.4 FINANCIAL ANALYSIS

Construction is presently projected to begin in late 1999 (Federal Fiscal Year 2000). At that time the local sponsor must have funding mechanisms in place to provide the local share of project costs in a timely fashion. Based on the involvement and interest of the MPA in the project to date, their extensive efforts to have placement sites available, and their recent letter of intent, the State of Maryland working through the MPA is the proposed non-Federal sponsor for the project. In their December 1996 letter (Annex A), the MPA outlined its preliminary financing plan for their share of the project costs. At this time, they fully expect to fund their share via allocations from the Maryland Transportation Trust Fund, which currently has a balance exceeding $100 million.

the general navigation features, the Non-Federal Sponsor shall not be required to make any contribution under this paragraph, nor shall it be entitled to any refund for the value of lands, easements, right-of-way, relocations, and dredged or excavated material disposal areas, in excess of 10% of the total cost of construction of the general navigation features.

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

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

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

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

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

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

of dredged material. They have participated throughout the study by providing various kinds of information, attending all study team meetings, arranging workshops and reviewing preliminary findings. They have demonstrated a genuine interest in the outcome of the study and have been proactive in maintaining the study schedule. In their December 1996 letter (Annex A), the MPA indicated their intent to provide the non-Federal cooperation required for project implementation, and outlined their preliminary financing plan for their project share.

8.3 ITEMS OF NON-FEDERAL COOPERATION

The following list of items constitues the non-Federal cooperation that are normally required for project implementation.

(1) *Provide and maintain, at its own expense, the local service facilities.*

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

(3) Provide all improvements required on lands, easements, and rights-of-way to enable the proper disposal of dredged or excavated material associated with the construction, operation, and maintenance of the general navigation features and the local service facilities. Such improvements may include, but are not necessarily limited to, retaining dikes, waste weirs, bulkheads, embankments, monitoring features, stilling basins, and dewatering pumps and pipes.

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

> * *10 percent of the costs attributable to dredging to a depth up to but not in excess of 20 feet;*
>
> * *25 percent of the costs attributable to dredging to a depth in excess of 20 feet but not in excess of 45 feet;*
>
> * *50 percent of the costs attributable to dredging to a depth in excess of 45 feet.*

(5) Repay with interest, over a period not to exceed 30 years following completion of the period of construction of the Project, an additional 0 to 10 percent of the total cost of construction of general navigation features depending upon the amount of credit given for the value of lands, easements, rights-of-way, relocations, and borrow and dredged or excavated material disposal areas provided by the Non-Federal Sponsor for the general navigation features. If the amount of credit exceeds 10% of the total cost of construction of

Table 8.2

Financial Obligations

Features	Total ** Cost	Federal Share %	Federal Share Cost	Non-Federal Share %	Non-Federal Share Cost
Channel Improvements	$5,391,000	75	$4,043,250	25	$1,347,750
Anchorage Improvements	$16,602,000	75	$12,451,500	25	$4,150,500
Turning Basin to 45'	$995,000	75	$746,250	25	$248,750
Subtotal	$22,988,000		$17,241,000		$5,747,000
Turning Basin 45' to 50'	$760,000	50	$380,000	50	$380,000
Subtotal	$23,748,000		$17,621,000		$6,127,000
10% Payback	$2,275,000	0	$0	100	$475,000*
Totals	$23,748,000		$17,621,000		$6,602,000

* 10% post-construction contribution has been reduced by credit for improvements to the dredged material placement sites (LERRD)

** These costs reflect the project feature cost as well as a share of the total project mobilization and demobilization, placement site improvements, PED, and construction management costs.

8.2 IDENTIFICATION OF LOCAL SPONSOR

For the feasibility phase of the Baltimore Harbor Anchorages and Channels study, the State of Maryland, Department of Transportation, acted as the local sponsor for cost-sharing purposes. Specifically, the Maryland Port Administration (MPA) through its Office of Harbor Development, executed all the coordination related to development and approval of the Feasibility Cost Sharing Agreement. Furthermore, the MPA provided all cash and in-kind service contributions and represented the State of Maryland in all study activities.

Throughout the entire study process, both the reconnaissance and the feasibility phases, the Baltimore District continued to meet with the MPA and the State of Maryland. They are aware of the items of local cooperation described in Section 8.1. They are aware of their responsibilities with regard to a potential project, and specifically with regard to the placement

Table 8.1
Baseline and Full Funding Project Cost Estimates
($1,000)

Selected Plan - Alternative #5

Feature Account	Baseline Estimate (1)	Full Funding Estimate (2)
12 Navigation Ports and Harbors		
02 Harbors		
01 Mob, Demob and Preparatory Work	$2,001	$2,301
15 Mechanical Dredging - Total	$15,566	$21,076
02 Site Work		
AA East Dundalk Channel	$308	$350
BB Seagirt/Conn Channel/ West Dundalk	$1,739	$1,974
CC South Locust Point	$1,327	$1,506
DD Cutoff Angle	$841	$955
EE Anchorage #3 Modification	$6,621	$7,516
FF Anchorage #4 Modification	$6,358	$7,218
GG Turning Basin	$1,372	$1,557
20 Placement Areas		
02 Site Work		
1 Dike Construction	$1,907	$1,907
30 Planning Engineering and Design	$828	$989
31 Construction Management	$446	$495
Total Construction Cost	**$23,748**	**$26,768**

(1) Baseline construction cost estimate prepared in accordance with EM 110-2-538 using Army Corps of Engineers M-CACES system; values are October 1996 price levels

(2) Full funding estimates, assuming unconstrained Federal and non-Federal funding

8.1.1 Full Funding Project Cost Estimate

The total estimated construction cost of the selected plan is $23.7 million and reflects October 1996 price levels with no price escalation. This estimate was prepared for direct economic comparison to project benefits. Plan formulation, evaluation, and selection were conducted on the basis of the costs, benefits, benefit-cost ratios, and net benefits developed at this price level.

Price escalation may occur during the design and construction phases. To provide both the Federal government and the local sponsor with a project cost estimate which reflects anticipated price escalation, a "full funding estimate" has been developed in the required M-CACES format. This estimate is based on standardized escalation factors (provided by the U.S. Office of Management and Budget) for future years, and is used to identify projected actual construction costs. Both the Baseline Cost Estimate and the full funding estimate are summarized in Table 8.1. (Note: The difference in baseline cost estimate between those presented in Section 6.6 and the costs listed in Table 8.1 is due to the differences between preliminary estimates used for comparison purposes and the M-CACES estimate prepared after the selected plan was chosen.)

8.1.2 Financial Obligations

This section presents the financial obligations of the Federal and non-Federal participant based on the total cost of the proposed modifications, which is currently estimated to be $23.7 million (October 1996 price levels). As discussed in Section 8.1, project costs for navigation features between the depths of 20 and 45 feet are shared 75 percent Federal and 25 percent non-Federal. For navigation features constructed to depths greater than 45, the costs of that increment are shared 50 percent Federal and 50 percent non-Federal. The total quantity of material for constructing the proposed turning basin to a depth of 50 feet is estimated to be 355,500 cubic yards, at a total first cost of approximately $1.8 million (includes associated costs, such as PED and S&A, etc). Of that amount, approximately 154,200 cubic yards account for deepening the turning basin from 45 feet to 50 feet. Total costs to construct the turning basin were pro-rated to identify the incremental costs for deepening from 45 feet to 50 feet, which was determined to be $760,000. This incremental cost will be shared 50 percent Federal ($380,000) and 50 percent non-Federal ($380,000). The remaining project costs of approximately $23.0 million will be shared 75 percent Federal ($17.2 million) and 25 percent non-Federal ($5.7 million). In addition, the non-Federal sponsor is also required to pay an additional 10 percent of the total project costs, which is currently estimated to be approximately $2.4 million, at the completion of construction or over a period of time not to exceed 30 years. The non-Federal sponsor may receive credit against this 10 percent payment for LERRD costs. Credit for incremental improvement of the HMI placement site will be given to the MPA as a LERRD cost. Total costs for preparing the placement sites are currently estimated to be $13 million; therefore, the non-Federal sponsor would receive the incremental cost of the dike raising used on this project ($1.9 million) as credit toward the 10 percent payment. The financial obligation are summarized in Table 8.2.

Section 8

PROJECT IMPLEMENTATION

8.1 COST ALLOCATION AND APPORTIONMENT

Cost allocation refers to the assignment of costs among various project purposes whereas cost apportionment refers to the division of these costs among project sponsors. The planned improvements described in Sections 5 and 6 will serve the needs of navigation only, and no other water use or purpose is currently identified. Accordingly, cost allocation is not warranted, since all costs accrue to navigation. This section outlines the division of the total project costs.

Federal participation in navigation project costs is limited to sharing costs for general navigation features (GNF) such as entrance channels, primary branch channels leading to public facilities, anchorage areas, and turning basins. Non-Federal interests are responsible for and bear the costs of providing terminal facilities; dredging in berthing areas; acquiring necessary lands, easements, rights-of-way, relocations, and dredged material containment areas with retaining dikes (LERRD). In addition, the non-Federal sponsor is also responsible for relocating and/or altering affected utilities, pipelines, cables, and sewer outlets.

Public Law 99-662 (Water Resources Development Act of 1986) has established the basis for Federal and non-Federal sharing of responsibility in the construction, operation, and maintenance of Federal water resources projects. For GNF such as the construction and/or improvement of the Baltimore Harbor anchorages and branch channels, where water depths are between 0 and 20 feet, non-Federal interests are required to pay 10 percent of the initial costs for design and construction of the project; where the water depths for construction range between 20 and 45 feet, the non-Federal interests are required to pay 25 percent of the initial costs for design and construction of the project. These costs would be paid during the period of construction. The major exception is the turning basin, which is proposed to be constructed to a final depth of 50 feet. The intial costs to construct the turning basin to a depth of 45 feet will also be shared 75/25; however costs to deepen the turning basin from 45 feet to 50 feet will be shared 50 percent Federal and 50 percent non-Federal. In addition, Section 101 requires the non-Federal sponsor to pay 10 percent of the construction costs that are cost-shared upon completion of construction, or with interest over a period not to exceed 30 years. Due to the policy of navigational servitude, which dictates that the Federal government has the rights to any lands created by the government in an area that previously was under water (such as the CSX and Cox Creek placement sites), the local sponsor can not claim the cost of acquiring these lands as a LERRD credit. However, the local sponsor may still claim the cost of any improvements required to make the site functional as a LERRD credit, such as the incremental cost of raising the dikes at HMI. This credit may be applied against the 10-percent contribution at the end of construction.

Table 7.2

COMPLIANCE WITH ENVIRONMENTAL PROTECTION STATUTES AND OTHER ENVIRONMENTAL REQUIREMENTS

FEDERAL STATUTES	LEVEL OF COMPLIANCE
Anadromous Fish Conservation Act	FULL
Archaeological and Historic Preservation Act	FULL
Clean Air Act	FULL
Clean Water Act	FULL
Coastal Zone Management Act	FULL
Comp. Envir. Response, Compensation and Liability Act	N/A
Endangered Species Act	FULL
Estuarine Protection Act	FULL
Federal Water Project Recreation Act	N/A
Fish and Wildlife Coordination Act	FULL
Land and Water Conservation Fund Act	FULL
Marine Mammal Protection Act	N/A
National Historic Preservation Act	FULL
National Environmental Policy Act	FULL
Resource Conservation and Recovery Act	FULL
Rivers and Harbors Act	FULL
Watershed Protection and Flood Prevention Act	N/A
Wild and Scenic Rivers Act	N/A
EXECUTIVE ORDERS, MEMORANDA, ETC.	
Protection and Enhancement of Cultural Environment (E.O. 11593)	FULL
Floodplain Management (E.O. 11988)	N/A
Protection of Wetlands (E.O. 11990)	FULL
Prime and Unique Farmlands (CEQ Memorandum, 11 Aug 80)	N/A
Environmental Justice in Minority and and Low-Income Populations (E.O. 12898)	FULL

NOTE:

a. Full Compliance (Full): Having met all requirements of the statute, E.O. or other environmental requirements for the current stage of planning.

b. Partial Compliance (Partial): Not having met some of the requirements that normally are met in the current stage of planning.

c. Non-Compliance (NC): Violation of a requirement of the statute, E.O. or other environmental requirement.

d. Not-Applicable (N/A): No requirements for the statute, E.O. or other environmental requirement for the current stage of planning.

Species Act, and the Coastal Zone Mangement Act. The plan is expected to be in compliance with the Resource Conservation and Recovery Act (RECRA) and the Comprehensive Environmental Response, Compensation and Liablity Act (CERCLA). The plan is expected is expected to be in compliance with the National Historic Preservation Act.

This project is expected to comply with an "Executive Order on Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," dated 11 February 1994. Activities related to the proposed project are not expected to have a significant disproportionate impact on poor or minority populations in the project area. Poor and minority communities are more likely to eat seafood from the harbor than the rest of the population. The proposed project is not expected to increased concentrations of substances to a level that would create significant additional health risks to these populations. NEPA coordination and public outreach for the proposed project is described in Chapter 9.

Executive Order 11988 Floodplain Management and CEQ Memorandum, 11 Aug 1980 (Prime and Unique Farmlands) are not applicable to this project. This project is expected to be in compliance with E.O. 11593 (Protection and Enhancement of Cultural Environment) and E.O. 11990 (Protection of Wetlands).

7.3 ENVIRONMENTAL CONSEQUENCES

There are no identified environmental consequences that will result from the use of Hart-Miller Island for placement of construction material. During the course of the study, ther wer concerns about the CSX and Cox Creek placement sites. Sections 2.10.3.a on regional hydrogeology and 6.4.4 on water quality address the uncertainty reagarding potential adverse impacts to aquifers in the area of the CSX and Cox Creek placement sites. Steps have been taken to address this concern through data collection and analysis and design of the placement site. The placement sites will not be used for this or any other project unless all required permits have been received by the MPA.

Based on preliminary groundwater modeling performed by the Baltimore District the expansion of the CSX/Cox Creek dredged material placement site to accept dredged material, from maintenance of this project or any other dredging activity, will not affect flow direction or quality of groundwater. Several different placement site scenarios were modeled: current conditions, placement site elevations of +28 and +39 feet MLLW, impoundments filled with both water and dredge material (clay), and drought. In all cases, the placement site had no substantial effect. Groundwater flow in the Lower Patapsco Aquifer was never affected. Model results indicate that there will be groundwater flow in the surface clay from the placement site to the adjacent wetlands southwest of the site. The extremely low conductivity of the clay, however, makes any contribution from the placement site *de minimis* in quantity. Particle tracking was performed to estimate groundwater travel times out of a filled, 39-foot impoundment. The worst case scenario, with no retardation, indicated that over a 100-year simulation, horizontal travel distance totaled slightly more than a foot; vertical travel distance totaled slightly less than a foot.

Appropriate steps to minimize potential impacts of the placement of the material in aquatic systems will be followed in accordance with conditions of the Department of the Army permit before any site is used. Mitigation to comply with 40 CFR 230.10(d) will be specified for the site(s) through specific avoidance, minimization and resource compensation in the DA permit conditions; especially for the small SAV areas within the Cox Creek site and for the function of the wetland systems in both Cox Creek and the CSX sites.

7.4 ENVIRONMENTAL COMPLIANCE

As part of the NEPA process, the applicable environmental laws and statutes were reviewed relative to the selected plan. The plan is expected to comply with all pertinent regulations, as summarized in Table 7.2 upon receipt of a Water Quality Certificate from the State of Maryland or notification by the State that a Water Quality Certificate is not required because the COE is requesting a CWA 404(r) exemption and upon all required permits being received by the MPA for construction and use of the propsed placement site. The proposed plan is expected to be in compliance with the Clean Air Act of 1990 as ammended, the Endangerred and associated costs for preparation of the placement sites. Interest during construction was calculated by allocating direct and associated costs over a 24-month construction period. A total of $1.9 million was included for the associated costs of the dike rasing at the HMI placement site, which is a pro-rated cost based on the total additional capacity of the site (30 mcy) and the actual quantity of material to be placed (4.4 mcy).

This plan evaluation does not include any costs related to Federal assumption of operation and maintenance relative to existing branch channels since the costs calculated relate only to the incremental change in dredging volumes. The NED plan does not include costs of realigning channel markers or buoys since the costs are assumed to be minor. The NED plan is based on active enforcement of existing regulations regarding anchorage use; therefore, no incremental costs are incurred.

Table 7.1

Anchorage and Channels
Plan 5 - Benefit-Cost Summary
($1,000)

Investment Cost	
Project Cost	$24,121
Exclusions	$0
Associated Costs for Placement	$1,900
Interest During Construction	$1,801
Total Investment Cost	$27,822
Average Annual Cost	
Annualized Investment Cost	$2,231
OMRR&R	$125
Total Annual Cost	$2,356
Average Annual Benefits	
Navigation Cost Savings	$21,889
Total Annual Benefits	$21,889
Benefit-Cost-Ratio	10.7
Net Benefits	$19,851

Section 7

PLAN SELECTION

7.1 SELECTED PLAN

As presented in Section 6, all plans of action considered are feasible and economically justified. Benefits and costs associated with each of the plans have been identified and annualized based on a 50-year project life and the current Federal discount rate of 7.375 percent. Operation and maintenance costs associated with the new increments to be dredged have also been identified. Interest during construction has been included as well. A review of the net benefits provided by each of the plans, coupled with an evaluation of the comprehensiveness of the plans, has resulted in the identification of Plan 5 as the selected plan. Plan 5 encompasses improvements to various branch channels, and anchorage modifications along with widening of several angles to ensure easier maneuverability while in the branch channels. Plan 5 also includes a turning basin at the head of the Ft. McHenry Channel to allow vessels using the branch channels in the vicinity to turn easier and to minimize interruptions to other vessels in the main channel. This plan includes modifications to the Seagirt, Dundalk, and South Locust Point Branch channels. Under this plan the Corps of Engineers will operate and maintain these channels at Federal expense.

During the course of this study, the MPA constructed improvements to the Seagirt and Dundalk branch channel system. These improvements include deepening the East Dundalk Branch Channel to 42 feet (not including the area in front of the Dundalk Marine Terminal), deepening the berths (numbers 11-13) and access channel on the east side of the Dundalk Terminal to 42 feet, constuction of a flared opening to the West Dundalk Branch Channel, and other minor widenings at bends in the Seagirt, Connecting, and West Dundalk Channels. This construction was not conducted until after the technical evaluations and computer simulation studies for this study were complete, and, therefore, are not reflected in this report. It is unlikely that these improvements would have any significant effect on the recommendations of this study. These changes will be reflected in the simulation model and will be evaluated during the preconstuction, engineering and design phase. This will also not require additional efforts or study funds for the PED phase since the model was to be updated with new traffic projections and system improvements anyway.

7.2 NED EVALUATION OF SELECTED PLAN

Table 7.1 displays the benefit-cost ratio and net benefits for Plan 5, which is the selected plan. Plan 5 exhibits a final benefit-cost ratio of 10.7. This plan provides the most net benefit return of all the plans considered, with net benefits of $19.9 million (Table 6.5), thereby making it the NED plan. Project investment costs of $27.8 million include interest during construction

6.7.3 Contributions to Planning Criteria

6.7.3.a Completeness. Completeness is the extent to which a plan provides and accounts for all necessary investments or other actions to ensure realization of the planning objectives. Plans 1, 2, 3, 4, 5, and 6 are generally complete in that all construction, operation, and maintenance items necessary for long-term functional success have been included. While material placement costs are not identified in Table 6.5, sites are currently available and are being developed by the non-Federal sponsor to ensure completeness of the proposed actions. Estimated costs of this activity are included in Section 7. Another measure of completeness is the degree of compliance with environmental requirements. All plans are expected to comply with current environmental requirements.

6.7.3.b Effectiveness. Effectiveness is the extent to which a plan alleviates the problems identified. Plans 1, 2, 3, 4, 5, and 6 vary in their effectiveness. All of these action plans would provide some degree of effectiveness. While implementation of Plan 4 provides the highest BCR, it provides less net benefit return than other plans. Plan 1 provides a higher net return and has a broader extent of coverage than Plans 2 and 3. Plan 2 is the least effective of the plans considered. It provides the fewest net benefits of all the action plans. Plan 5 is the most effective plan providing the greatest net benefits and the broadest coverage of any of the plans considered.

6.7.3.c Efficiency. Efficiency is the extent to which a plan provides cost-efficient means of alleviating specified problems, consistent with protecting the Nation's environment. None of the plans would create long term environmental impacts that would render the projects undesirable.

6.7.3.d Acceptability. Acceptability is the extent to which a plan is supported by the non-Federal sponsor and the affected public. On the basis of discussions with officials of the State of Maryland, the Maryland Port Administration, the Baltimore Maritime community, and the general public, Plan 5 is the most acceptable plan because it provides a more efficient and effective approach (than currently exists) to alleviating some of the time and dollar constraints associated with vessel routings into and out of the Port of Baltimore. While Plan 1 would also be generally acceptable, it is less comprehensive than Plan 5 in its areal coverage (branch channels only). Similarly, Plans 2, 3, and 4 are also less comprehensive than Plan 5 in their areal coverage (anchorages only).

Terminal, and the Dundalk Marine Terminal. It also provides for smoothing of turns and easing of maneuverability problems through removal of several difficult angles and establishment of a turning basin near the head of the Fort McHenry Channel. This plan has a BCR of 5.8 and yields net benefits of $4 million.

Plan 2 provides for a larger anchorage area in the vicinity of Anchorage #3, while leaving the remaining un-modified portion of the anchorage for smaller vessels. The dimensions of the anchorage are 2,000 feet x 2,000 feet x 36 feet deep to accommodate a vessel up to 820 feet LOA. It has a BCR of 8.4 and estimated net benefits of $3.6 million.

Plan 3 provides for a larger anchorage area than in Plan 2 (both deeper and wider), while also leaving the remaining un-modified portion of the anchorage for smaller vessels. The dimensions of this anchorage are 2,200 feet x 2,200 feet x 42 feet deep to accommodate a vessel up to 890 feet LOA. It has a BCR of 3.5 and estimated net benefits of $2.3 million.

Plan 4 includes the same anchorage improvement as in Plan 3 and also adds an additional improvement at Anchorage #4 to accommodate smaller vessels calling on the Port of Baltimore. The dimensions of the improvement at Anchorage #3 are 2,200 feet x 2,200 feet x 42 feet deep to accommodate a vessel up to 890 feet LOA and the dimensions of the improvement at Anchorage #4 are 1,800 feet x 1,800 feet x 42 feet deep to accommodate a vessel up to 690 feet LOA. The improvement at Anchorage #4, while smaller in width and length, is proposed at the same depth as the improvement at Anchorage #3. This plan has a BCR of 11.4 and estimated net benefits of $15.5 million.

Plans 5 and 6 are the most comprehensive groupings of alternatives. Plan 5 combines the branch channel and turning basin improvements in Plan 1 with the anchorage improvements in Plan 4. Plan 5 has a benefit-to-cost ratio of 10.7 while providing annual net benefits of almost $20 million.

Plan 6 was developed to provide more anchorage space for large vessels than any of the other plans. This plan includes the channel/turning basin improvements from Plan 1, plus two large anchorage areas at Anchorage #3, each equal in size to the anchorage area in Plan 3. In addition, an improvement at Anchorage #4 is proposed. Plan 6 differs from Plan 5 in that there are two large anchorage areas at Anchorage #3, and the improvement at Anchorage #4 is proposed at a shallower depth. The smaller improvement at Anchorage #4 results in a reduction of dredging quantities and associated costs, which partially offsets the large volume of dredged material associated with the second large anchorage at Anchorage #3. This plan has a benefit-to-cost ratio of 5.2 and annual net benefits of more than $11 million.

Plan 5 results in the most net benefits of all the plans considered in this analysis.

TABLE 6.8

BENEFITS VS. COSTS - PLANS OF IMPROVEMENT

PLAN	QUANTITIES	FIRST COSTS	OMRR&R	I.D.C. COSTS	ANNUAL COSTS	ANNUAL BENEFITS	BEN-COST RATIO	NET BENEFITS
PLAN 1 - BRANCH CHANNELS								
EAST DUNDALK (38' x 400')	38,800	$308,000	$12,840		$36,221	$686,000		
SEAGIRT/CONNECTING CHANNEL/ WEST DUNDALK CHANNEL (42' x 500')	422,600	$1,826,000	$25,729		$164,347	$2,682,000		
SOUTH LOCUST POINT (36' x 400')	216,800	$1,327,000	$1,986		$102,723	$1,550,000		
CUTOFF ANGLES (Deepen To 42') WEST DUNDALK CH./CONN CH.	215,000	$841,000	-		$63,843			
TURNING BASIN (1200'x1200'x50')	355,500	$1,372,000	-		$104,153			
MOB/DEMOB		$2,000,000			$151,827			
PED/S&A		$1,275,000			$96,790			
CONTINGENCY AT 10 PERCENT		$894,900			$67,935			
PLAN 1- TOTAL	1,248,700	$9,843,900	$40,555	$734,894	$843,828	$4,918,000	5.8	$4,074,372
PLAN 2 - ANCHORAGE								
ANCHORAGE #3 MODIFICATION (820' Vessel: 2,000'x2,000' x 36' Deep)	455,400	$1,904,000	$20,000		$164,539	$4,086,000		
MOB/DEMOB		$2,000,000			$151,827			
PED/S&A		$1,275,000			$96,790			
CONTINGENCY AT 10 PERCENT		$517,900			$39,318			
PLAN 2 - TOTAL	455,400	$5,696,900	$20,000	$425,301	$484,758	$4,086,000	8.4	$3,601,242
PLAN 3 - ANCHORAGE								
ANCHORAGE #3 MODIFICATION (890' Vessel: 2,200' x 2,200' x 42' Deep)	1,584,000	$6,621,000	$22,134		$524,757	$3,216,000		
MOB/DEMOB		$2,000,000			$151,827			
PED/S&A		$1,275,000			$96,790			
CONTINGENCY AT 10 PERCENT		$989,800			$75,124			
PLAN 3- TOTAL	1,584,000	$10,885,600	$22,134	$812,662	$910,190	$3,216,000	3.5	$2,305,810
PLAN 4 -TWO ANCHORAGES								
ANCHORAGE #3 MODIFICATION (890' Vessel: 2,200' x 2,200' x 42' Deep)	1,584,000	$6,621,000	$22,134		$524,757	$3,216,000		
ANCHORAGE #4 MODIFICATION (890' Vessel: 1,800' x 1,800' x 42' Deep)	1,585,500	$6,358,000	$7,307		$489,965	$13,755,000		
MOB/DEMOB		$2,000,000			$151,827			
PED/S&A		$1,275,000			$96,790			
CONTINGENCY AT 10 PERCENT		$1,625,400			$123,390			
PLAN 4 TOTAL	3,169,500	$17,879,400	$29,441	$1,334,783	$1,488,057	$16,971,000	11.4	$15,482,943
PLAN 5 - CHANNEL/ANCHORAGE								
EAST DUNDALK (38' x 400')	38,800	$308,000	$12,840		$36,221	$686,000		
SEAGIRT/CONNECTING CHANNEL/ WEST DUNDALK (42' x 500')	422,600	$1,826,000	$25,729		$164,347	$2,682,000		
SOUTH LOCUST POINT (36 'x 400')	216,800	$1,327,000	$1,986		$102,723	$1,550,000		
CUTOFF ANGLES (Deepen To 42')	215,000	$841,000	-		$63,843			
ANCHORAGE #3 MODIFICATION (890' Vessel: 2,200 x 2,200' x 42' Deep)	1,584,000	$6,621,000	$22,134		$524,757	$3,216,000		
ANCHORAGE #4 MODIFICATION (690' Vessel: 1,800' x 1,800' x 42' Deep)	1,585,500	$6,358,000	$7,307		$489,965	$13,755,000		
TURNING BASIN (1,200' x 50')	355,500	$1,372,000	-		$104,153			
MOB/DEMOB		$2,000,000			$151,827			
PED/S&A		$1,275,000			$96,790			
CONTINGENCY AT 10 PERCENT		$2,192,800			$166,463			
PLAN 5 TOTAL	4,418,200	$24,120,800	$69,996	$1,800,733	$2,037,790	$21,889,000	10.7	$19,851,210
PLAN 6 - CHANNEL/ANCHORAGE								
EAST DUNDALK (38' x 400')	38,800	$308,000	$12,840		$36,221	$686,000		
SEAGIRT/CONNECTING CHANNEL/ WEST DUNDALK (42' x 500')	422,600	$1,826,000	$25,729		$164,347	$2,682,000		
SOUTH LOCUST POINT (36 ' x 400')	218,800	$1,327,000	$1,986		$102,723	$1,550,000		
CUTOFF ANGLES (Deepen To 42')	215,000	$841,000	-		$63,843			
ANCHORAGE #3 MODIFICATION								
(890' Vessel: 2,200 x 2,200' x 42' Deep)	1,584,000	$6,621,000	$22,134		$524,757	$3,216,000		
(690' Vessel: 2,200 x 2,200' x 42' Deep)	2,024,400	$8,462,000	$40,000		$682,380	$837,000		
ANCHORAGE #4 MODIFICATION (690' Vessel: 1,800' x 1,800' x 38' Deep)	1,103,400	$4,425,000	$7,300		$343,217	$4,973,000		
TURNING BASIN (1,200' x 50')	355,500	$1,372,000	-		$104,153			
MOB/DEMOB		$2,000,000			$151,827			
PED/S&A		$1,275,000			$96,790			
CONTINGENCY AT 10 PERCENT		$2,845,700			$216,027			
PLAN 6 TOTAL	5,960,500	$31,302,700	$109,989	$2,336,896	$2,663,688	$13,944,000	5.2	$11,280,312

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TABLE 6.7
ANNUAL COSTS - ALTERNATIVE IMPROVEMENTS

	ALTERNATIVE	FIRST COSTS	I.D.C. COSTS	ANNUAL COSTS
	DUNDALK MARINE TERMINAL			
D1	East Dundalk Channel @ 400-Ft Wide by 38-Ft Deep	$1,983,372	$148,068	$161,805
	SOUTH LOCUST POINT TERMINAL			
SL1	Branch Channel Loop @ 400-Ft Wide by 36-Ft Deep	$3,002,116	$224,122	$244,915
	SEAGIRT MARINE TERMINAL			
S1	Seagirt Channel, Connecting Channel, East Dundalk @400' Wide, 38' Deep, 42' Cutoff Angles, 1200' Turning Basin	$4,285,620	$319,942	$349,624
S2	Seagirt Channel, Connecting Channel, West Dundalk @400' Wide, 42' Deep, 42' Cutoff Angles, 1200' Turning Basin	$4,203,540	$313,814	$342,928
S3	Seagirt Channel, Connecting Channel, West Dundalk @500' Wide, 42' Deep 42' Cutoff Angles, 1200' Turning Basin	$5,713,812	$426,563	$466,137
	ANCHORAGE #3			
A3-1	Enlarged Berth Area For Vessels 820-Ft LOA by 36-Ft depth	$3,653,989	$272,788	$298,095
A3-2	Enlarged Berth Area For Vessels 800-Ft LOA by 40-Ft depth	$5,397,885	$402,978	$440,364
A3-3	Enlarged Berth Area For Vessels 890-Ft LOA by 42-Ft depth	$9,015,600	$673,058	$735,500
A3-4	Enlarged Berth Area For Vessels 920-Ft LOA by 36-Ft depth	$4,678,089	$349,242	$381,642
A3-5	Enlarged Berth Area For Vessels 900-Ft LOA by 40-Ft depth	$6,874,679	$513,228	$560,842
A3-6	Enlarged Berth Area For Vessels 1020-Ft LOA by 36-Ft depth	$5,921,639	$442,079	$483,092
A3-7	Enlarged Berth Area For Vessels 1000-Ft LOA by 40-Ft depth	$8,618,575	$643,418	$703,110
A3-8	Two Enlarged Berths For Vessels Each 890-Ft LOA by 42-Ft depth	$16,833,529	$1,256,703	$1,373,293
	ANCHORAGE #4			
A4-1	Enlarged Berth Area For Vessels 550-Ft LOA by 30-Ft depth	$2,153,595	$160,776	$175,692
A4-2	Enlarged Berth Area For Vessels 550-Ft LOA by 32-Ft depth	$2,441,895	$182,299	$199,212
A4-3	Enlarged Berth Area For Vessels 585-Ft LOA by 34-Ft depth	$3,342,600	$249,541	$272,692
A4-4	Enlarged Berth Area For Vessels 680-Ft LOA by 34-Ft depth	$4,578,570	$341,812	$373,523
A4-5	Enlarged Berth Area For Vessels 690-Ft LOA by 38-Ft depth	$6,780,810	$506,220	$553,184
A4-6	Enlarged Berth Area For Vessels 690-Ft LOA by 42-Ft depth	$9,022,575	$673,578	$736,069
A4-7	Enlarged Berth Area For Vessels 735-Ft LOA by 43-Ft depth	$11,530,785	$860,828	$940,691
A4-8	Enlarged Berth Area For Vessels 815-Ft LOA by 47-Ft depth	$15,921,780	$1,188,637	$1,298,912
A4-9	Enlarged Berth Area For Vessels 945-Ft LOA by 41-Ft depth	$12,396,615	$925,467	$1,011,326

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Instead, existing aids will be realigned following project implementation at a nominal cost. No costs for providing new aids or realignment of the existing aids were included in the total project cost estimate. The recommended improvements and any proposed realignment of existing aids to navigation will be coordinated with the US Coast Guard during the public review of the draft feasibility report.

6.7 ECONOMIC ASSESSMENT

6.7.1 Annual Costs

The total first cost estimates for independent alternative and plans of improvement were annualized over the 50-year project life at the current Federal interest rate of 7.375 percent. The annual costs for the alternatives are shown in Table 6.7. and the annual costs for the plans are shown in Table 6.8. A comparison of the average annual cost and annual benefits for the alternatives was presented in Section 6.1.2. Once these alternatives were grouped into plans, average annual costs were again compared to the annual benefits to determine the most cost-effective plan, as described in the following section.

The incremental cost for maintaining the improved portions of the branch channels was included in the economic assessment of annual costs (see Section 5.2). Federal assumption of existing O&M costs for the branch channels, which is currently a non-Federal responsibility, was not included since it is not a new cost associated with implementation of this project. A discussion of these future O&M costs is provided in Section 8.1.2.

6.7.2 Benefits Analysis

The Federal objective of water resources project planning is to contribute to National Economic Development (NED). Contributions to the NED objective are computed in terms of increases in the net value of goods and services, expressed in monetary units. Thus, the ratio of average annual benefits to average annual costs for a specific project is a measure of the project's economic feasibility. Projects with a BCR greater than 1.0 represent a favorable return on the investment, while projects having a ratio less than 1.0 indicate an unfavorable project and an undesirable investment. For projects exhibiting a BCR greater than 1.0, the preferred plan from a Federal perspective is normally the one having the greatest net benefits. Net benefits are defined as the dollar amount by which average annual benefits exceed average annual costs.

All of the six plans that were evaluated are economically justified. Efforts were then focused on identifying the most viable plans based primarily on net returns.

Plan 1 is oriented toward modifications of several branch channels providing safe routing to public terminal facilities including the South Locust Point Marine Terminal, the Seagirt Marine placement of these maintenance quantities in the Federal anchorage areas and the non-Federal branch channels will be allocated, as appropriate, between the Federal O&M Program and the MPA, based on the volume of dredging required to achieve current project dimensions.

Potential improvements to the branch channels do not include dredging in the berthing areas, which is the responsibility of the non-Federal sponsor. The berthing areas typically extend 125 feet from the bulkheads.

6.6.2 Dredged Material Placement Areas

The costs of providing a dredged material placement area, although a non-Federal responsibility, are a direct project cost and must be included in the total project cost estimate. The costs for acquisition of the proposed placement site at HMI is not included in the cost estimates for the economic analysis of alternatives or plans presented in this section since the island was acquired in the 1970's and has been since credited on other Corps projects (see Appendix I, Real Estate Plan). However, the costs to modify the placement site is included in the estimates.

Costs associated with preparing the non-Federally owned and operated containment facility at HMI were provided by the MPA. The dikes at the HMI site are currently being raised to 44 feet MLLW. This raising will provide an additional 30 million cubic yards of capacity. The total cost for modification of the HMI site is estimated to be $13 million to provide approximately 30 million cubic yards of capacity, or $0.43 per cubic yard. Therefore, the non-Federal sponsor will be credited 43 cents per cubic yard of the recommended plan.

6.6.3 Anchorages

Cost estimates for dredging operations in the anchorage areas are based on a clamshell dredge, loading the material into barges for transport to the placement area, and then pumping the material from the barges into the containment facility at Hart-Miller Island. Table 6.2 (Section 6.1.2) provides quantity and cost estimates for new construction of the alternatives considered.

6.6.4 Branch Channels

Independent cost estimates for the improvements at South Locust Point and the Seagirt and Dundalk Marine Terminals are also shown in Table 6.2 (Section 6.1.2). The dredging estimates are based on using a clamshell dredge, loading the material into barges for transport to the placement area, and then pumping the material from the barges into the containment facilities at Hart-Miller Island.

6.6.5 Aids to Navigation

The provision of additional aids to navigation was determined not to be necessary at this time.

6.6 ESTIMATE OF FIRST COSTS

Assumptions and modifications, as necessary, were developed for quantity and cost estimates for the anchorage and branch channel alternatives and plans. The first cost estimates used in the economic analysis include costs for Interest During Construction (IDC), Planning, Engineering, and Design (PED), Supervision and Administration (S&A), and mobilization/demobilization.

A standard cost of $750,000 for PED was used in the preliminary analysis of alternatives (Table 6.2). This cost was changed to $828,000 in the economic analysis of plans based on the estimated cost for PED. Costs for S&A were not included in the preliminary screening of alternatives (Table 6.2) since this cost was determined to equally impact the consideration of each alternative. Once alternatives were combined into plans, a standard S&A cost of $446,300 was included in the total plan evaluation and assessment. These estimates are also shown in the Draft M-CACES estimate, (Appendix H, Cost Estimates).

The costs for both dredging and placement of material are reflected in the unit cost. The containment site is located approximately 14.5 miles from the anchorages, depending on the specific improvement. A standard estimate of $1,000,417 for the cost of mobilization and demobilization was used for independent analysis of the anchorage alternatives and $925,300 for the branch channel alternatives (Table 6.2). A larger cost of $2.0 million was included in the analysis of plans, which assumes an additional dredge will be required to construct all of the components of a plan, and the contract will be for two dredging seasons.

The baseline cost estimate for the recommended plan is provided in Appendix H, Cost Estimates.

6.6.1 Quantities of Dredged Material

Dredging quantity estimates for the anchorages and branch channels were prepared based on recent hydrographic surveys conducted by the COE. The estimates for the anchorages and branch channels were computed using a Baltimore District, COE volume computation program. The estimated quantities include two (2) feet of allowable overdepth dredging and side slopes of one vertical on three horizontal. Two feet of allowable overdepth is included in the project cost estimates to reflect normal inaccuracies in the dredging process. The estimated overdepth dredging increases the total dredging and placement time and must be accounted for when determining total construction cost and available dredged material placement areas.

Some maintenance dredging is required in the anchorages to achieve the authorized project depths under the existing Baltimore Harbor and Channels project (see Section 6.2). Similarly, maintenance dredging is also required in the non-Federal branch channels to achieve the current project depths. These estimates were not included in the first cost estimates used to develop the benefit and cost analysis. During project construction, the cost for removal and

6.4.13 Irreversible and Irretrievable Commitments of Resources Which Would Be Involved in the Proposed Action

Implementation of the proposed project would involve a commitment of natural, human, and physical resources. Both the CSX placement site and the Cox Creek placement site were converted from open water to diked areas for placement of dredged material prior to this proposed project and will be used for other projects. HMI was constructed around eroding islands and open water habitat. The placement sites will likely be used for maintenance of areas in addition to those proposed in this project. Additional dredged material placement will make it unlikely that the site will be returned to open water habitat. Land used for the placement site would be considered an irreversible commitment during the time period that the land is used for placement. However, if greater need arises for the use of the land or if the land is no longer needed, the land could be converted to another use. At present, there is no reason to believe such a conversion would be necessary or desirable until the sites have been filled to capacity with dredged material. After this time the sites may possibly be used for industrial uses such as a marine terminal. No irreversible and irretrievable commitment will be caused by dredging. Dredging is expected to destroy some benthic resources which are expected to recolonize between dredging cycles.

6.4.14 The Relationship Between Local Short-term Uses of the Environment and the Maintenance and Enhancement of Long-term Productivity

The proposed previously-used placement sites at Hart-Miller Island, CSX, and Cox Creek would be consistent with Federal, regional, and State of Maryland plans. The proposed sites will accommodate dredged material from this proposed project and future Baltimore Harbor dredging activities. High quality wetlands adjacent to the CSX/Cox Creek project area are not expected to be impacted by maintenance of the proposed project or other placement activities. These wetlands will be transferred to the Maryland Historical Trust. The proposed project will increase the productive use of the Port of Baltimore.

6.4.15 Floodplains Impacts

The proposed project is not expected to have a significant adverse impact on floodplains.

6.5 IMPACTS TO CULTURAL RESOURCES

The project area has been highly disturbed by several centuries of harbor activities and development; no archeological resources have been found in the study area. Therefore, the Baltimore District has determined that the proposed Baltimore Harbor Anchorages and Channels Project will have no effect on cultural resources. The Maryland SHPO has concurred with this determination.

6.4.10 Air Quality Impacts

It is expected that the increase in air pollution emissions due to construction and operations of the proposed project will be very small as will emissions due to shipping. Consequently, no significant adverse impacts to air quality are expected. Communication with the Maryland Department of the Environment indicates that the project will be in compliance with the State of Maryland Clean Air Act, State Implementation Plan (SIP).

6.4.11 Construction Impacts

This section describes the efforts and procedures planned for the proposed action specifically related to pollution prevention, abatement, and control.

Dredging - BMPs will be implemented during dredging to reduce turbidity in the project area.

Placement site construction and operation - BMPs will be implemented to prevent unplanned discharges into the water column. Erosion control measures will be implemented as needed. All State of Maryland, Federal, Baltimore County, and Anne Arundel County regulations will be complied with. Stormwater runoff will be controlled. Periodic maintenance inspections will be made on all construction equipment to minimize or prevent discharges of lubricants and fuel. A monitoring program will be in place and project operations will comply with the State of Maryland water quality certification for the project.

6.4.12 Cumulative Impacts

The proposed project is not expected to contribute to any adverse cumulative impacts. The increase in ship size that will visit the Port of Baltimore during the project life will not be caused by this project. Construction of new facilities will not be caused by this project. No major changes to infrastructure such as utility corridors, railroad lines, and roads are expected due to this project. Increases in employment due to the proposed project are expected to be very small and will come from the local areas. No new schools or housing will be required because of the project. The project is not expected to have a significant adverse impact on local landfill capacity or water supply.

Placement sites for material dredged from Baltimore Harbor have traditionally been a scarce resource. In response to this need, the Governor's Plan (Section 2.10) was developed. In addition the MPA, through the DN-POP, and the Corps of Engineers, through the DMMP, continue to identify sites for future placement needs. Material from this project will require 4.4 million cubic yards of capacity at Hart-Miller Island. This has been figured into the MPA's schedules. Sufficient capacity will remain for their other needs.

6.4.8.b Rare, Threatened, or Endangered Species. No effects are anticipated to rare, threatened or endangered species in the project area. The Peregrine falcons nesting on the Key Bridge could potentially prey on birds in the placement site area. The prey species are migratory and are not likely to bioaccumulate toxins at the placement site at a level that would harm the falcons or reduce their reproductive success. The bald eagle nest is sufficiently far away that no significant uptake of toxins from the project is expected.

6.4.8.c Biodiversity. Although conditions in Baltimore Harbor are improving, species diversity is still poor due to degraded habitat. The proposed project is not expected to have an adverse impact on the biodiversity of the avian, terrestrial or aquatic resources in the project area.

6.4.8.d Terrestrial Resources Impacts - Placement Sites. The placement sites (Area E at the CSX site, Figure 2.11, and the Cox Creek site) will be filled over a ten to twelve year period with existing habitat covered by placed material. *Phragmites* is expected to recolonize the area over time if the site is not managed or developed for other uses or if action is not taken to preclude its recolonization. Many of the smaller animals such as insects and worms that are not very mobile will be covered with material or will drown due to the large volume of water contained in dredged material. Some rodents, amphibians and reptiles may be displaced or killed. It is not certain at this time that the site will be developed. If the area is developed, the larger mammals such as fox, raccoon, muskrat and deer would not likely use the area. Many amphibians, reptiles, and birds would also not likely find the site suitable habitat.

During the placement period that is scheduled for use of the CSX and Cox Creek sites, and also if it remains undeveloped after placement is completed, the site would still retain some habitat value for many of the animals mentioned in Section 2.10.4.

Significant adverse impacts to terrestrial resources at Hart-Miller Island are not expected to be significant because the site is presently being used for dredged material placement and the terrestrial community is not well developed. See Section 2.10.10.h

6.4.9 Noise Impacts

Noise impacts are expected to be minor and insignificant. Noise caused by the dredge will be temporary and minor. Equipment used during construction of the placement site will be commonly used earth moving equipment. Some equipment will be used for material placement and site operations during the life of the site. The level of noise at this site is not expected to significantly disturb people or animals in the area. Noise associated with the boats transferring crews to Hart-Miller Island is not expected to increase. Some noise will be generated by ships using the channels and anchorages more frequently. Any increase is expected to be very minor. It is expected that noise from the project would not violate any local noise ordinances. No significant adverse noise related impacts are expected.

distribution of commonly caught species. Impacts to benthic communities are not expected to be significant enough to impact fishing habitat. The small quantity of benthos that are disturbed by the dredging is expected to recolonize within a few years.

The proposed project is not expected to have a significant impact on recreational boaters using the harbor for other than fishing. It is not expected to impact their egress or entry into the harbor or ability to maneuver.

Activities at the placement sites are not expected to have any impact on the limited recreational resources of the CSX/COX Creek placement sites or to impact restoration plans for Hart-Miller Island (Section 2.16).

6.4.8 Biological Resources

The disturbance caused by dredging will result in temporary and moderate increase in the level of contaminant exposure for biota in the short term. However, most of the benthic organisms are pollution tolerant species. Consequently, impacts are expected to be minor.

The proposed dredging will remove the existing benthic invertebrate fauna, but this will be a minor short-term impact, especially considering the poor condition of this community in the project area. The dredging will also cause suspension of bottom sediment into the water column. This will result in a slight decrease in dissolved oxygen and a release of nutrients, primarily in the form of ammonia. The impact of these effects should not be great because of the existing degraded conditions. Studies performed by the COE under the Dredged Material Research Program (DMRP) have demonstrated that organisms of the same species will reestablish themselves in such dredged channels within one or two growing seasons. Potential long-term improvements in the benthic conditions due to dredging of contaminated sediments will also be limited by the hydrographic conditions which promote deposition of very fine grain material, and by the heavy influx of nonpoint pollution from the Baltimore metropolitan area.

While the currents will move the plume of suspended sediment a short distance from the dredging site, it should not affect any sensitive habitats and will abate shortly after dredging is completed. The potential for long-term adverse effects on habitat quality due to a change in the bottom sediment characteristics in the dredged area is considered unlikely.

6.4.8.a Avian Resources. The proposed project is not expected to have an adverse effect on avian life in the dredging area. Bird populations may be temporarily disturbed by dredging activities, but are expected to return quickly to the project area. Some avian species at the placement site may be displaced as the site is filled and habitat is altered. However, some avian species are expected to use the impoundments created by the placement of dredged material.

6.4.5 Wetlands

Because of the harbor's degraded condition there are few wetlands, none of which are near the areas proposed for deepening and/or widening. Dredging is not expected to have significant adverse impacts on wetlands. High quality wetlands adjacent to the placement site will be transferred to the Maryland Historical Trust and are not expected to be impacted by the proposed action. Some of the low quality wetlands consisting mostly of phragmites will be impacted by the placement of dredged material.

Wetlands at Hart-Miller Island are not developed because the site is in use as a placement facility. Consequently, no significant impacts to wetlands at HMI are anticipated.

Placement of dredged material will smother submerged aquatic vegetation (SAV) in ponded areas with in the Cox Creek site. SAV is not expected to recolonize the placement site as the ponds will be filled with dredged material. Wetlands within the proposed Cox Creek and CSX sites are dominated by the common reed *Phragmites australis* with some mixed shrub species. The small wetland system in the Cox Creek site and the larger wetland system (30 + acres) on the CSX site are not performing function important to the public at more than minimal levels because *Phragmites* sp. make only minor contributions to natural biological function. These wetlands do not impact sediment distribution, salinity, or flushing patterns. They are not within a sanctuary nor are they set-aside for study. They have little or no role in wave energy dissipation and they do not protect sensitive areas from wave surges or flooding. These areas are not areas of natural recharge or discharge. Accordingly, these wetlands within the Cox Creek and CSX sites are not important wetlands within the context of 33 CFR 320.4(b).

6.4.6 Aesthetics Impacts

The industrial/commercial character of the port limits its value as an aesthetic resource. The proposed project is not expected to have a significant impact on aesthetic resources in the project area of the harbor. No increase in facilities or ship size are expected as part of this project. Aesthetic impacts at the placement sites is discussed in Section 2.15.

6.4.7 Recreation Impacts

The proposed project is not expected to have a significant impact on recreation in the area. Dredging will create turbidity of short duration in the immediate dredging area. This could impact some of the recreational fishing in the area, but the impact would be minor and short term. The widening of the anchorages is not expected to impact areas that are commonly used for fishing, nor is the more efficient use of the anchorages likely to disturb current fishing patterns in the harbor. Additionally, the harbor is now heavily used by large ships which have limited maneuverability. Fishermen in the area are aware of this and generally avoid high traffic areas.

Potential increases in salinity are not expected to significantly impact populations or spatial sediment are expected to occur temporarily in the immediate vicinity of dredging as a result of resuspension of bottom sediments. As a result of settling and dispersion, the increased turbidity is expected to decrease rapidly with increasing distance from the dredging site. The resuspension of contaminated sediments during construction may result in the temporary release of toxic chemicals into the water column. Based on previous dredging experience, however, long-term impacts are expected to be negligible. There is very little net mass release of heavy metals into the water column regardless of the composition of the sediment. The long-term effect will not be great because the existing contaminant problem is widespread and the limited fauna is composed mainly of pollution tolerant species. In addition to the consideration of salinity, the degraded condition of the harbor renders it unsuitable as habitat for many sensitive species.

Deepening could potentially exacerbate the problem of low dissolved oxygen which is common in Baltimore Harbor. Some of the proposed dredging areas have depths in the 30-35 foot range which are below the typical pycnocline depth. Consequently this portion of the dredged area is already subject to episodes of low dissolved oxygen. Some worsening of the duration, extent, or frequency of low dissolved oxygen may occur in these areas. Dredging in areas which have depths in the range of 15 to 20 feet, such as South Locust Point, could substantially worsen the summer dissolved oxygen levels resulting in additional stress to biological organisms. These potential impacts are expected to be localized.

Water quality certification issued under authority of Section 401 of the Federal Water Control Act (Clean Water Act) will be applied for by the Maryland Port Authority for construction and operation of the placement sites after site selection and before construction. Maryland Port Authority will probably be required to perform some monitoring as a condition of the certificate.

The District will request a Clean Water Act Section 404(r) exemption and perform the necessary coordination for a Water Quality Certificate from the State of Maryland. The Maryland Department of the Environment may find the issuance of a Water Quality Certificate unnecessary because of the Section 404(r) exemption that will be documented in the report.

As discussed in Section 2.10.3.b (Regional Hydrology) there was concern about potential impact to groundwater from leachate at the CSX/Cox Creek placement sites. Additional testing was performed to determine the impacts, if any. The results of the modeling showed that contamination of the groundwater by placement of material in the CSX and Cox Creek sites is not a concern. See Section 2.10.3.c for a further discussion.

Supplemental NEPA documentation will be prepared prior to the use of the CSX/Cox Creek sites by the Baltimore District. These sites will be used only if the necessary permits are given by the Corps of Engineers and the State of Maryland.

6.4 ENVIRONMENTAL IMPACTS

6.4.1 Current Velocities

The examination of current velocities conducted for the Main Report Environmental Impact Statement for Baltimore Harbor showed that changes in current velocity from the enlargement of channels in the harbor are relatively small. Based on these results, the fact that currents are weak, and the relatively small volume of material that would be removed for the proposed navigation improvements, no substantial changes are expected with associated changes in current velocities. Any change in current velocity due to the proposed action is expected to produce insignificant, if any, environmental impacts.

6.4.2 Turbidity

The proposed project is expected to cause only a minor increase in siltation outside of the areas that are dredged. Best management practices (BMPs) will be used to reduce turbidity caused by dredging. Given the weak currents in the project area, any material that is suspended during dredging will likely remain near the dredging areas. The fluid mud layer of the surrounding bottom would be especially prone to move into the dredged area due to gravitational forces and instability caused by disturbances from ship traffic, dredging, or natural events. The slight increase in turbidity and siltation is expected to have an insignificant environmental impact.

6.4.3 Salinity

Salinity in Chesapeake Bay ranges from 35 parts per thousand (ppt) at the mouth to brackish at the northern extent of the tidal portion of the Susquehanna River. Salinity in the harbor ranges from 5 to 15 ppt. Most estuarine organisms, including finfish and shellfish, can tolerate a wide range of salinity. If the salinity increases beyond their tolerance thresholds, they will move to the shallower areas adjacent to the channels where salinity will be lower.

Since the channel and anchorage improvements are confined to a comparatively small area where tidal currents are minimal, there should not be any change to salinity. Any potential increase in salinity as a result of deepening channels and anchorages should not affect the small population of benthic organisms, finfish and crabs in the harbor. Migrations of fish into the Patapsco River for spawning are not expected to be adversely affected by the potential change in salinity in the harbor.

6.4.4 Water Quality

The bottom disturbance and subsequent sedimentation associated with dredging will contribute to the bottom sediment mixing which characterizes this region. Increases in suspended million cubic yards of dredged material once the dikes are raised to 39 feet MLW. The use of CSX and Cox Creek for initial construction would compromise the ultimate capacity of the sites by not allowing proper dewatering and crust management.

Approximately 20 more years of capacity are expected to remain through effective implementation of crust management techniques at the placement sites. These sites will be used to contain construction and maintenance material from Federal and non-Federal projects in Baltimore Harbor including the proposed project.

The MPA is committed to providing adequate placement capacity in the future. As discussed in Section 2.10, this commitment is demonstrated by the MPA's efforts for the Baltimore Harbor and Channels 50-foot project, the level of funding currently allocated for efforts related to the identification and planning of new dredged material placement sites, the MPA's ongoing DNPOP, and joint efforts between the MPA and the COE to develop the DMMP. In addition, the recently announced Governor's Plan for dredged material placement, when fully implemented, will provide for 20 years of capacity for the Baltimore Harbor system.

6.3.2 Placement Site Development

The dikes at Hart-Miller Island are currently being raised to provide 30 million cubic yards of additional capacity. The CSX site has already been acquired by MPA, and they are in negotiations to purchase the Cox Creek site. Repair work for the dikes at CSX has been completed. Following rehabilitation of the Cox Creek site, which will be accomplished after acquisition is complete, both placement areas are scheduled by MPA to be ready to receive dredged material in 1997. While dredged material is being placed at the sites, the dikes will gradually be raised to a final proposed elevation of 39 feet.

It was unclear whether the possibility for groundwater impacts would result from placing dredged material in the CSX and Cox Creek sites. For this reason, a geotextile liner and leachate collections system was considered during the study. Because of the tremendous cost of a liner, it was determined that additional groundwater investigations would be appropriate to assess the potential for groundwater impacts. Technical investigations, including detailed groundwater modelling studies and physical exploration, monitoring, and testing of wells in the area, have been undertaken by the Baltimore District and have yielded favorable results. Preliminary results are summarized in Section 2.10.3.c and are presented more fully in Appendix J.

6.3.3 Real Estate Requirements

The real estate requirements for this project are described and shown in detail in the Real Estate Plan, Appendix I, of this report. Both the general navigation features and the dredged material placement sites are under Federal navigational servitude; therefore, no ownership interests are required for the project and no real estate activities related to acquisition or rights-of-entry are planned. Credit for site preparation is discussed in Section 6.6.2.

TABLE 6.6

FUTURE MAINTENANCE DREDGING REQUIREMENTS

With-Project Condition

		Maintenance Dredging Quantities (cubic yards)			
Calendar Year	Project Year	Anchorages #3 and 4	Branch Channels	Turning Basin	Total
2000	1	0	0	0	0
2001	2	0	0	0	0
2002	3	0	0	0	0
2003	4	0	0	0	0
2004	5	0	0	65,000	65,000
2005	6	0	243,750	0	243,750
2006	7	0	0	0	0
2007	8	0	0	0	0
2008	9	0	0	0	0
2009	10	415,700	0	65,000	480,700
2010	11	0	0	0	0
2011	12	0	243,750	0	243,750
2012	13	0	0	0	0
2013	14	0	0	0	0
2014	15	0	0	65,000	65,000
2015	16	0	0	0	0
2016	17	0	0	0	0
2017	18	0	243,750	0	243,750
2018	19	0	0	0	0
2019	20	415,700	0	65,000	480,700
2020	21	0	0	0	0
2021	22	0	0	0	0
2022	23	0	0	0	0
2023	24	0	243,750	0	243,750
2024	25	0	0	65,000	65,000
2025	26	0	0	0	0
2026	27	0	0	0	0
2027	28	0	0	0	0
2028	29	0	0	0	0
2029	30	415,700	243,750	65,000	724,450
2030	31	0	0	0	0
2031	32	0	0	0	0
2032	33	0	0	0	0
2033	34	0	0	0	0
2034	35	0	0	65,000	65,000
2035	36	0	243,750	0	243,750
2036	37	0	0	0	0
2037	38	0	0	0	0
2038	39	0	0	0	0
2039	40	415,700	0	65,000	480,700
2040	41	0	0	0	0
2041	42	0	243,750	0	243,750
2042	43	0	0	0	0
2043	44	0	0	0	0
2044	45	0	0	65,000	65,000
2045	46	0	0	0	0
2046	47	0	0	0	0
2047	48	0	243,750	0	243,750
2048	49	0	0	0	0
2049	50	415,700	0	65,000	480,700
	TOTAL	**2,078,500**	**1,950,000**	**650,000**	**4,678,500**

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TABLE 6.5

FUTURE MAINTENANCE DREDGING REQUIREMENTS

Without-Project Condition

Calendar Year	Project Year	Maintenance Dredging Quantities (cubic yards) Anchorages #3 and 4	Branch Channels	Turning Basin	Total
2000	1	0	0	0	0
2001	2	0	0	0	0
2002	3	0	0	0	0
2003	4	0	0	0	0
2004	5	0	0	65,000	65,000
2005	6	0	202,425	0	202,425
2006	7	0	0	0	0
2007	8	0	0	0	0
2008	9	0	0	0	0
2009	10	320,000	0	65,000	385,000
2010	11	0	0	0	0
2011	12	0	202,425	0	202,425
2012	13	0	0	0	0
2013	14	0	0	0	0
2014	15	0	0	65,000	65,000
2015	16	0	0	0	0
2016	17	0	0	0	0
2017	18	0	202,425	0	202,425
2018	19	0	0	0	0
2019	20	320,000	0	65,000	385,000
2020	21	0	0	0	0
2021	22	0	0	0	0
2022	23	0	0	0	0
2023	24	0	202,425	0	202,425
2024	25	0	0	65,000	65,000
2025	26	0	0	0	0
2026	27	0	0	0	0
2027	28	0	0	0	0
2028	29	0	0	0	0
2029	30	320,000	202,425	65,000	587,425
2030	31	0	0	0	0
2031	32	0	0	0	0
2032	33	0	0	0	0
2033	34	0	0	0	0
2034	35	0	0	65,000	65,000
2035	36	0	202,425	0	202,425
2036	37	0	0	0	0
2037	38	0	0	0	0
2038	39	0	0	0	0
2039	40	320,000	0	65,000	385,000
2040	41	0	0	0	0
2041	42	0	202,425	0	202,425
2042	43	0	0	0	0
2043	44	0	0	0	0
2044	45	0	0	65,000	65,000
2045	46	0	0	0	0
2046	47	0	0	0	0
2047	48	0	202,425	0	202,425
2048	49	0	0	0	0
2049	50	320,000	0	65,000	385,000
	TOTAL	**1,600,000**	**1,619,400**	**650,000**	**3,869,400**

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The proposed turning basin in the area of Anchorage #1 and the head of the Fort McHenry Channel will not appreciably change the dimensions of the existing Federal project; therefore, no increase in annual maintenance dredging costs is anticipated for this improvement.

6.2.3 Future O&M Program

The total maintenance requirement for the branch channels will become a Federal responsibility upon implementation of this project. Total maintenance dredging requirements, both the existing Federal project and any anticipated increases resulting from project implementation, are shown in Table 6.4.

Placement capacity for maintenance of the existing and proposed portions of the project will be required for the next 50 years, which is the normal planning period for a Federal project. The capacity required to maintain the existing project over the 50-year project life (through year 2049) is estimated to be approximately 3.9 million cubic yards, as shown in Table 6.5. This capacity is not required initially, but rather over time as the project is maintained on various dredging cycles.

For the with-project condition, annual maintenance dredging requirements will increase by 16,500 cubic yards once the improvements recommended as part of this project are implemented. The total capacity required to maintain the existing and new portions of the project over the 50-year project life is anticipated to be approximately 4.7 million cubic yards, as shown in Table 6.6. Placement capacity to contain this material will be required over the 50-year project life.

6.3 DREDGED MATERIAL PLACEMENT SITES

6.3.1 Placement Site Capacity

The MPA has the responsibility for securing a site for the placement of the dredged material from this project. As discussed in Section 2.10, the HMI, CSX and Cox Creek placement sites have been identified as the most environmentally feasible and cost effective sites for development at this time. Each of these sites has been used previously by the COE and non-Federal interests for dredged material placement. The Hart-Miller Island placement site will be used for dredged material resulting from implementation of the Baltimore Harbor Anchorages and Channels study. The CSX and Cox Creek Sites will be used for maintenance of this and other inner harbor projects. Without implementation of this project, these sites would continue to be used for placement of dredged material from other Federal construction and maintenance dredging projects and local navigation projects in Baltimore Harbor.

The Hart-Miller Island site is expected to hold 30 million cubic yards of material after the dikes are raised to 44 feet MLLW. The CSX and Cox Creek sites are expected to hold 6

TABLE 6.4

Maintenance Dredging Requirements

(Quantities in Cubic Yards)

Location	Maintenance Dredging Cycle	WITHOUT-PROJECT CONDITION (Existing Condition)		WITH-PROJECT CONDITION (Incremental Change)		FUTURE O&M PROGRAM (Total Maintenance Requirement)	
		Total Maintenance per Dredging Cycle	Annual Maintenance Dredging Requirement	Total * Maintenance per Dredging Cycle	Annual * Maintenance Dredging Requirement	Total Maintenance per Dredging Cycle	Annual Maintenance Dredging Requirement
Seagirt West Channel	6 years	89,025	14,838	0	0	89,025	14,838
Connecting Channel	6 years	15,150	2,525	5,025	838	20,175	3,363
Dundalk West Channel	6 years	45,525	7,588	19,500	3,250	65,025	10,838
Dundalk East Channel	6 years	43,725	7,288	14,550	2,425	58,275	9,713
South Locust Point	6 years	9,000	1,500	2,250	375	11,250	1,875
SUBTOTAL		**202,425**	**33,738**	**41,325**	**6,888**	**243,750**	**40,625**
Anchorage #3	10 years	250,000	25,000	71,200	7,120	321,200	32,120
Anchorage #4	10 years	70,000	7,000	24,500	2,450	94,500	9,450
SUBTOTAL		**320,000**	**32,000**	**95,700**	**9,570**	**415,700**	**41,570**
Turning Basin**							
Fort McHenry Channel	5 years	50,000	10,000	0	0	50,000	10,000
Anchorage #1	5 years	15,000	3,000	0	0	15,000	3,000
SUBTOTAL		**65,000**	**13,000**	**0**	0	**65,000**	**13,000**
TOTAL		587,425	78,738	137,025	16,458	724,450	95,195

* Includes only the incremental volume of dredged material resulting from project implementation.

s** This improvement incorporates adjacent segments of the Fort McHenry Channel and Anchorage #1.

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6.2 OPERATION AND MAINTENANCE DREDGING REQUIREMENTS

6.2.1 Without-Project Condition

The COE has the responsibility of maintaining the authorized Federal anchorages in the Port of Baltimore. Shoaling of the authorized anchorages has historically occurred along the northeastern edge of both Anchorages #3 and #4 and the northwestern edge of #3. The shoaling is probably a result of sloughing and eroding of the side slopes and sedimentation resulting from storm and ship-generated disturbances of the nearby sediments. Deepening and widening of the anchorages will not appreciably change the length of the exposed side slopes since Anchorage #3 is surrounded on two sides by deeper channels and Anchorage #4 is surrounded on three sides by deeper channels. Shoaling rates were determined for ten-year maintenance dredging cycles based on the maintenance dredging history of these anchorages. The total annual maintenance dredging requirement for Anchorages #3 and 4 is approximately 32,000 cubic yards per year, as shown in Table 6.4.

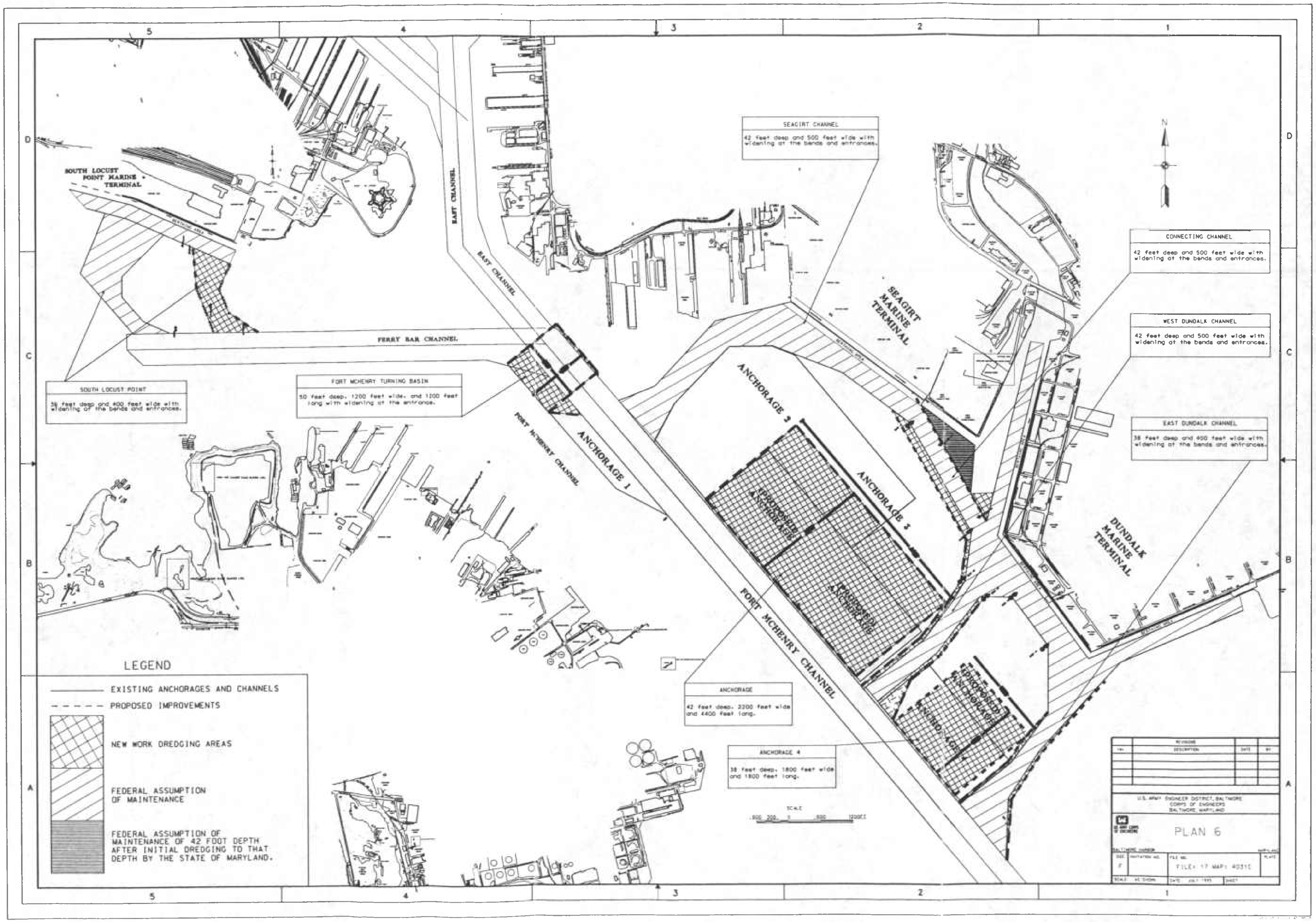
The MPA currently has the responsibility of maintaining the branch channels leading to the various public marine terminals in Baltimore Harbor. Shoaling rates were determined for six-year maintenance dredging cycles based on the maintenance dredging history for the branch channels and the estimated shoaling rates of the adjacent anchorages. The total annual maintenance dredging requirement for the branch channels serving the South Locust Point, Seagirt, and Dundalk marine terminals is approximately 34,000 cubic yards per year, as shown in Table 6.4.

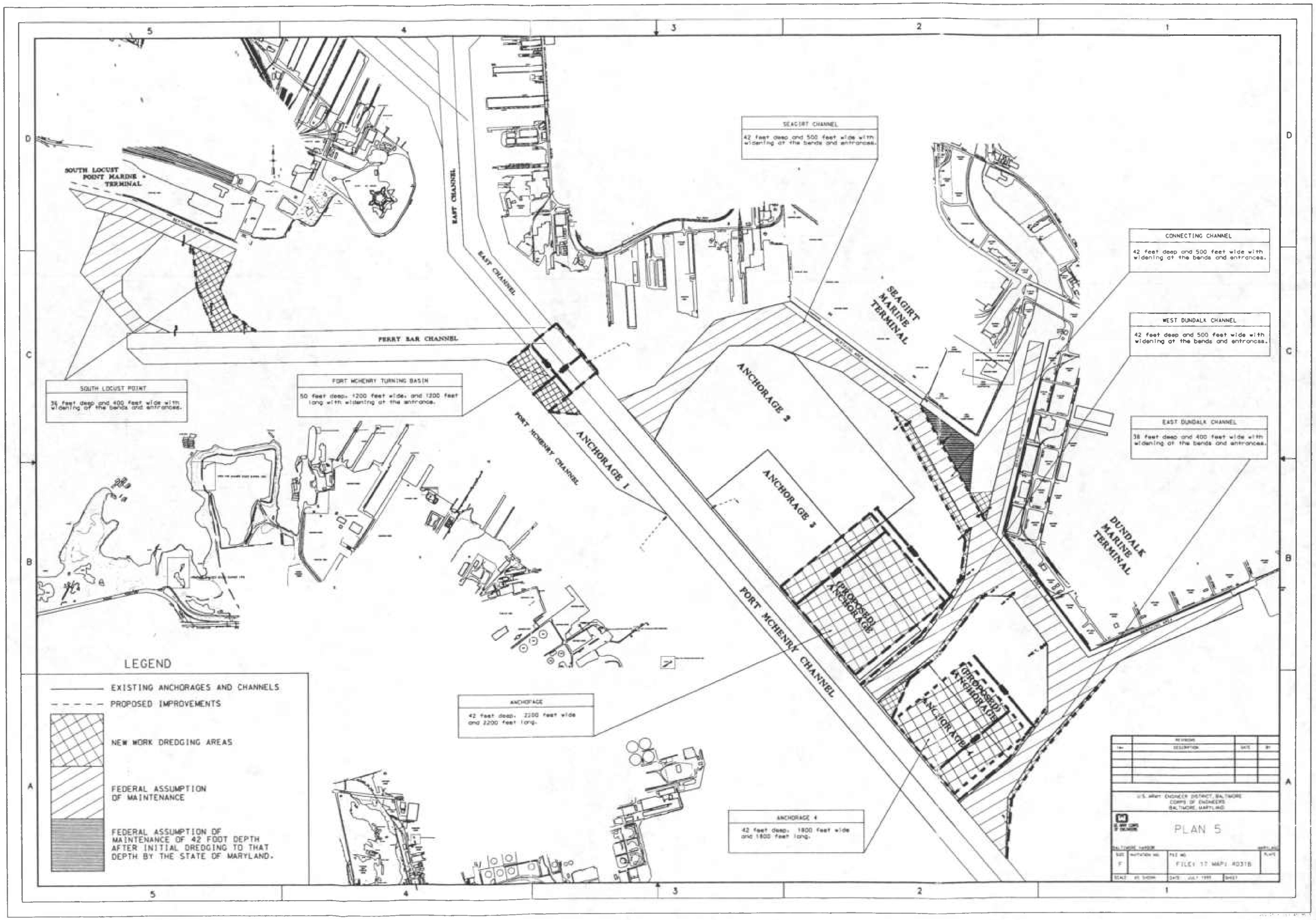
The proposed turning basin is located at the head of the Fort McHenry Channel and adjacent to Anchorage #1. Approximately 50,000 cubic yards of dredged material is removed from this section of the main channel every 5 years, 10,000 cubic yards annually. A portion of Anchorage #1, which is proposed to be deepened to accommodate the turning basin, contributes an additional 15,000 cubic yards of dredged material every 5 years, or an annual maintenance dredging requirement of 3,000 cubic yards, as shown in Table 6.4.

6.2.2 With-Project Condition

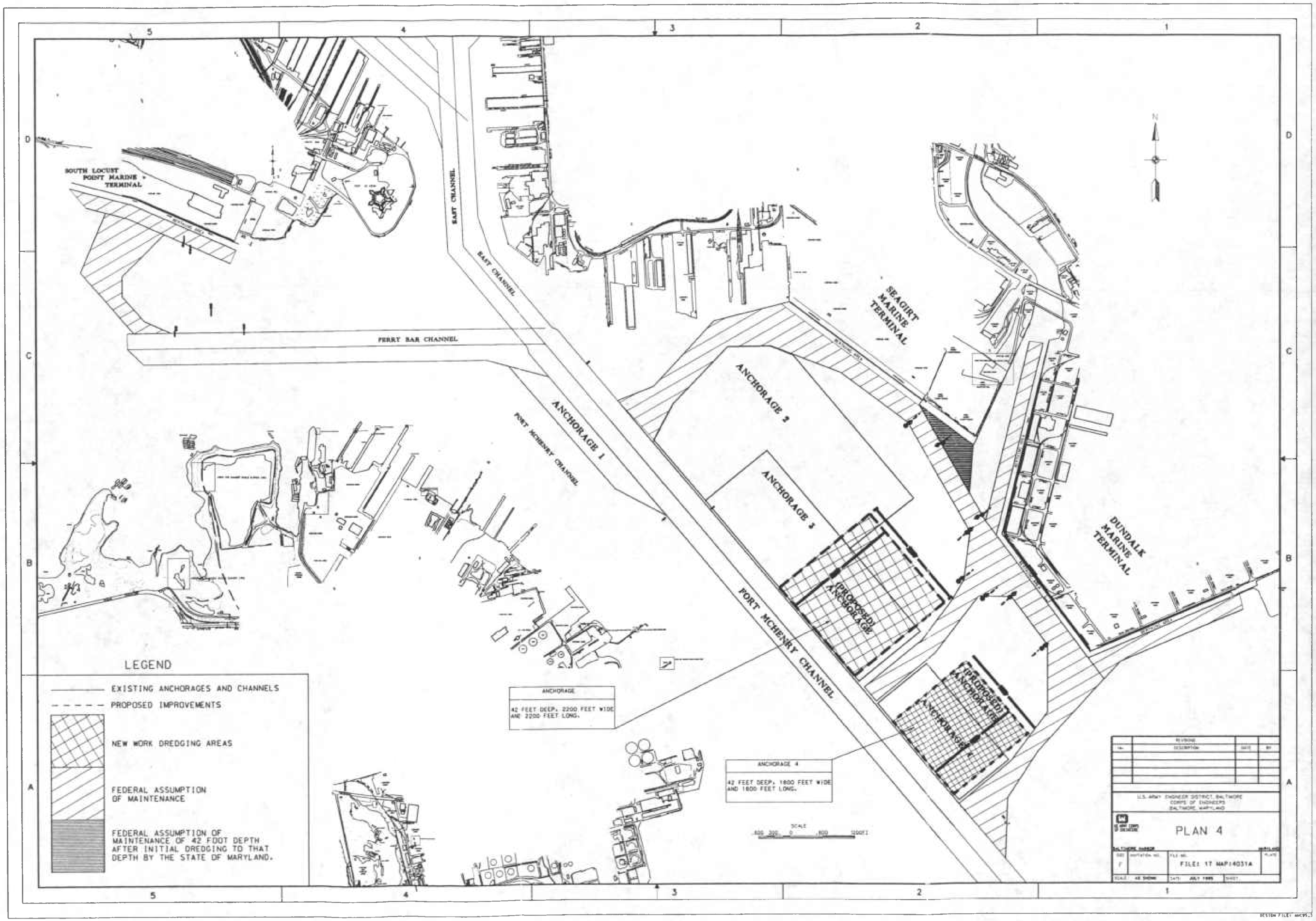
As a result of implementing the proposed anchorage and branch channel modifications, the annual maintenance dredging requirements for the anchorages and branch channels serving the Port of Baltimore will increase by approximately 16,500 cubic yards. The increase in annual maintenance dredging requirements, shown in Table 6.4 as the with-project condition, was included in the analysis of benefits and costs (see Section 6.7).

The enlarged portions of Anchorages #3 and 4 will result in an increased annual maintenance dredging requirement of approximately 9,600 cubic yards. Similarly, widening of the branch channels at Seagirt and Dundalk and deepening and widening of the remnant channel at South Locust Point will result in an additional 7,000 cubic yards per annum.


SOUTH LOCUST POINT MARINE TERMINAL
EAST CHANNEL
EAST CHANNEL
FERRY BAR CHANNEL
SEAGIRT CHANNEL
42 feet deep and 500 feet wide with widening at the bends and entrances.
CONNECTING CHANNEL
42 feet deep and 500 feet wide with widening at the bends and entrances.
WEST DUNDALK CHANNEL
42 feet deep and 500 feet wide with widening at the bends and entrances.
EAST DUNDALK CHANNEL
38 feet deep and 400 feet wide with widening at the bends and entrances.
SOUTH LOCUST POINT
38 feet deep and 400 feet wide with widening of the bends and entrances.
FORT MCHENRY TURNING BASIN
50 feet deep, 1200 feet wide, and 1200 feet long with widening of the entrance.
SEAGIRT MARINE TERMINAL
DUNDALK MARINE TERMINAL
ANCHORAGE 1
ANCHORAGE 2
ANCHORAGE 3
FORT MCHENRY CHANNEL
PROPOSED ANCHORAGE
PROPOSED ANCHORAGE
ANCHORAGE
42 feet deep, 2200 feet wide and 4400 feet long.
ANCHORAGE 4
38 feet deep, 1800 feet wide and 1800 feet long.
SCALE
N
LEGEND
EXISTING ANCHORAGES AND CHANNELS
PROPOSED IMPROVEMENTS
NEW WORK DREDGING AREAS
FEDERAL ASSUMPTION OF MAINTENANCE
FEDERAL ASSUMPTION OF MAINTENANCE OF 42 FOOT DEPTH AFTER INITIAL DREDGING TO THAT DEPTH BY THE STATE OF MARYLAND.
REVISIONS
DESCRIPTION
DATE
BY
U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND
PLAN 6
BALTIMORE HARBOR
MARYLAND
FILE: 17 MAP: 40310



SOUTH LOCUST POINT MARINE TERMINAL
EAST CHANNEL
SEAGIRT CHANNEL
42 feet deep and 500 feet wide with widening at the bends and entrances.
CONNECTING CHANNEL
42 feet deep and 500 feet wide with widening at the bends and entrances.
WEST DUNDALK CHANNEL
42 feet deep and 500 feet wide with widening at the bends and entrances.
EAST DUNDALK CHANNEL
38 feet deep and 400 feet wide with widening at the bends and entrances.
SEAGIRT MARINE TERMINAL
PERRY BAR CHANNEL
SOUTH LOCUST POINT
36 feet deep and 400 feet wide with widening of the bends and entrances.
FORT MCHENRY TURNING BASIN
50 feet deep, 1200 feet wide, and 1200 feet long with widening at the entrance.
ANCHORAGE 1
ANCHORAGE 2
ANCHORAGE 3
FORT MCHENRY CHANNEL
(PROPOSED) ANCHORAGE
DUNDALK MARINE TERMINAL
(PROPOSED) ANCHORAGE
ANCHORAGE 4
ANCHORAGE
42 feet deep, 2200 feet wide and 2200 feet long.
ANCHORAGE 4
42 feet deep, 1800 feet wide and 1800 feet long.
LEGEND
EXISTING ANCHORAGES AND CHANNELS
PROPOSED IMPROVEMENTS
NEW WORK DREDGING AREAS
FEDERAL ASSUMPTION OF MAINTENANCE
FEDERAL ASSUMPTION OF MAINTENANCE OF 42 FOOT DEPTH AFTER INITIAL DREDGING TO THAT DEPTH BY THE STATE OF MARYLAND.
U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND
PLAN 5
BALTIMORE HARBOR
MARYLAND
FILE: 17 MAP: 40318
DATE: JULY 1995


SOUTH LOCUST POINT MARINE TERMINAL
EAST CHANNEL
FERRY BAR CHANNEL
SEAGIRT MARINE TERMINAL
ANCHORAGE 1
ANCHORAGE 2
ANCHORAGE 3
ANCHORAGE 4
FORT MCHENRY CHANNEL
(PROPOSED) ANCHORAGE
DUNDALK MARINE TERMINAL
N
ANCHORAGE
42 FEET DEEP, 2200 FEET WIDE AND 2200 FEET LONG.
ANCHORAGE 4
42 FEET DEEP, 1800 FEET WIDE AND 1800 FEET LONG.
SCALE
LEGEND
EXISTING ANCHORAGES AND CHANNELS
PROPOSED IMPROVEMENTS
NEW WORK DREDGING AREAS
FEDERAL ASSUMPTION OF MAINTENANCE
FEDERAL ASSUMPTION OF MAINTENANCE OF 42 FOOT DEPTH AFTER INITIAL DREDGING TO THAT DEPTH BY THE STATE OF MARYLAND.
REVISIONS
DESCRIPTION
DATE
BY
U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND
PLAN 4
BALTIMORE HARBOR
MARYLAND
FILE NO.
FILE: 17 MAP14031A
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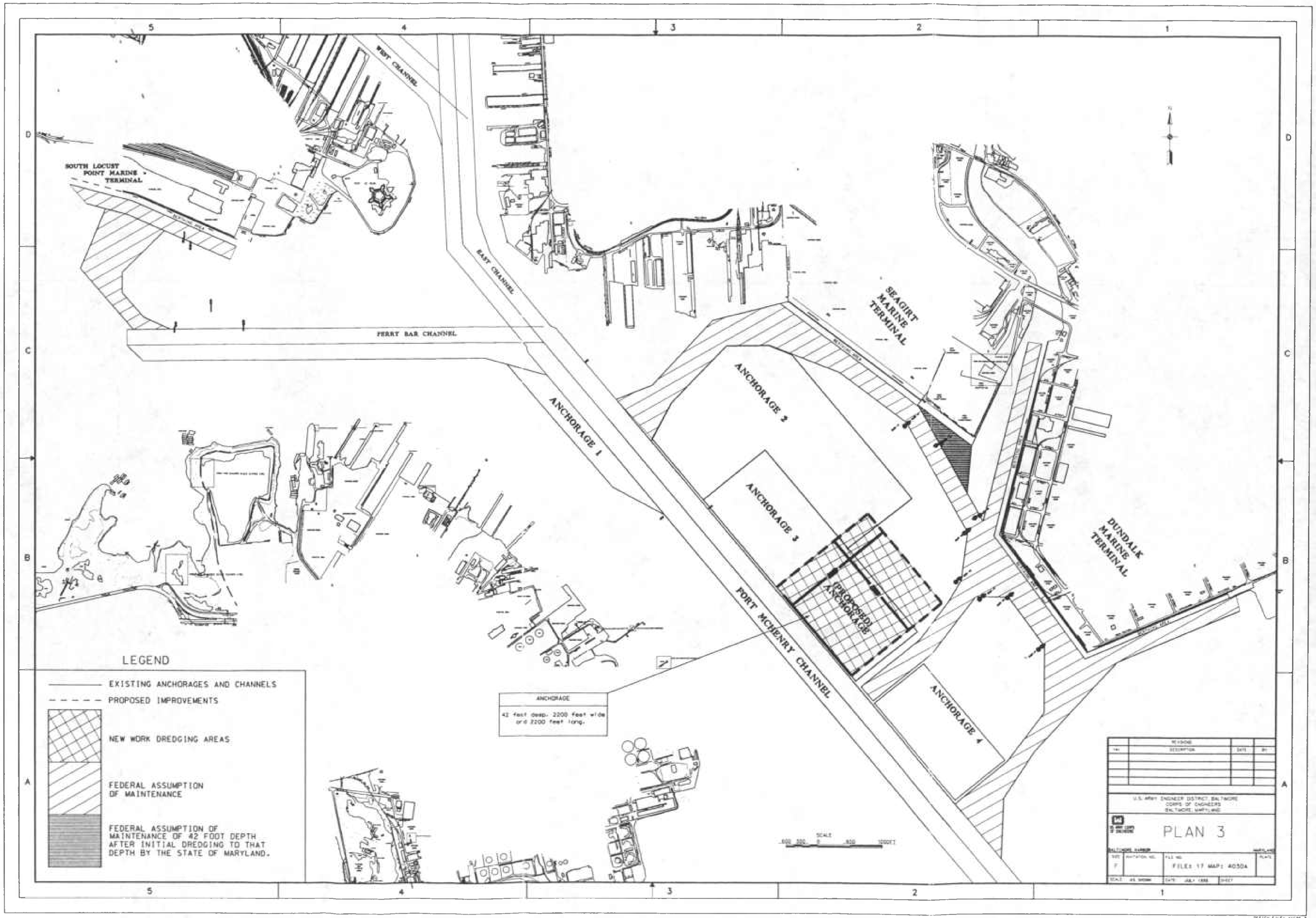

SOUTH LOCUST POINT MARINE TERMINAL
WEST CHANNEL
EAST CHANNEL
FERRY BAR CHANNEL
ANCHORAGE 1
ANCHORAGE 2
ANCHORAGE 3
ANCHORAGE 4
(PROPOSED) ANCHORAGE
FORT MCHENRY CHANNEL
SEAGIRT MARINE TERMINAL
DUNDALK MARINE TERMINAL
ANCHORAGE
42 feet deep, 2200 feet wide and 2200 feet long.
LEGEND
EXISTING ANCHORAGES AND CHANNELS
PROPOSED IMPROVEMENTS
NEW WORK DREDGING AREAS
FEDERAL ASSUMPTION OF MAINTENANCE
FEDERAL ASSUMPTION OF MAINTENANCE OF 42 FOOT DEPTH AFTER INITIAL DREDGING TO THAT DEPTH BY THE STATE OF MARYLAND.
SCALE
U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND
PLAN 3
BALTIMORE HARBOR
MARYLAND
FILE: 17 MAP: 4030A

the plans and specifications. The PED actions identified for this project are based upon the following assumptions:

- Ship simulations will be used in the design of the branch channels because the design will include new channels and cut-offs located in confined, tug-assisted areas. Ship simulations are used to improve the safety of channel design, and in these situations, will provide a better approximation of vessel performance within the designed channel.

- Based on the results of the technical investigations conducted during the feasibility study, there are no cultural resources, HTRW sites, or adverse fish and wildlife effects related to the project. Therefore, no further compliance actions are planned for these subject areas. The Baltimore District will update compliance if needed as the design progresses. The District will also continue to review MPA compliance, including cultural resources and groundwater water quality, at the dredged material placement sites for consistency with Federal responsibilities in using the site.

- Because both the general navigation features and the dredged material placement sites are under Federal navigational servitude, no ownership interests are required for the project and no real estate activities related to acquisition or rights-of-entry are planned.

- There is a potential that preparation of a design memorandum (DM) and follow-on NEPA documents may not be required. These items have been included in the schedule and estimated costs in the event that they are required.

- The feasibility report will serve as the project decision document which supports the project cooperation agreement. If design changes are identified, the DM will document technical information for the detailed design of the recommended plan. This would primarily consist of the results of the ship simulations, with an update of the project BCR if project design assumptions change.

8.5.2.a Baltimore District. The primary Baltimore District products and actions during the PED phase will include: bathymetric surveys of the project area; detailed designs of the general navigation features, including ship simulations of the channels; updated cost estimates, economic analyses and environmental compliance based upon detailed design; the design memorandum; follow-on environmental assessment; plans and specifications; the construction contract document; coordination of the sponsor's financing plan; preparation and negotiation fo the project cooperation agreement; coordination associated with project authorization; and an eventual request for construction new start funds for FY 00.

The engineering and design effort for the general navigation features will be accomplished by Baltimore District staff, with ship simulation design support from the Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi. Operations Division will be the technical division responsible for preparation and approval coordination for the DM and plans and specifications, with support from Programs and Project Management, Engineering, Planning, and other offices as needed.

8.5.2.b Non-Federal Sponsor. During PED, the non-Federal sponsor will be responsible for providing the financing plan, negotiating the PCA, and conducting public involvement in coordination with the District. Additionally, the non-Federal sponsor will accomplish all actions to provide and prepare the dredged material placement site for use during project construction and for future project maintenance, although the maintenance will be a Federal responsibility. To ensure that use of the site for the project complies with Corps requirements, the non-Federal sponsor will be required to coordinate actions with the Baltimore District, incuding design review, Section 404 permits, resolution of any discharge or groundwater water quality issues, and environmental compliance documents. Placement site actions must occur during PED in order for the site to be available when the construction contract is advertised. Actions include, but are not limited to: design, construction of site modifications, environmental and cultural resource compliance, permits, and public involvement. The MPA has provided a letter of intent to be the non-Federal sponsor and expects the placement site dike raising to be completed in 1997.

8.5.3 Construction Phase

The construction phase consists of five actions: 1) PED, which continues beyond the first set of plans and specifications and through physical construction; 2) appropriation of Federal and non-Federal funds for construction; 3) signing of the PCA; 4) physical construction of the project; and 5) closeout activities. The construction phase begins when the first set of plans and specifications is approved, the project has been authorized by Congress, and Federal construction funds have been appropriated. The project is turned over for operation when physical construction is complete, and the construction phase is ended when the fiscal closeout is complete.

It is expected that the construction phase will be initiated in October 1999, after receipt of Federal funds for construction. Construction phase actions are expected to last 21 months, ending in June 2001, with final reporting in the life cycle reporting system.

8.5.3.a Baltimore District. The Baltimore District will construct the general navigation features through a single dredging contract. The work is expected to take two dredging seasons. Operations Division will be the technical division responsible for construction management and engineering during construction. The primary Baltimore District products and actions during the construction phase will include: execution the PCA; advertisement and award of the construction contract; physical construction; construction contract management and inspection, including before and after bathymetric surveys; engineering and design during construction; updated economics and environmental compliance as needed; project closeout document and audits; and participation in public involvement.

8.5.3.b Non-Federal Sponsor. In accordance with the requirements of ER 1165-2-131, the non-Federal sponsor will be responsible for operation, maintenance, replacement, rehabilitation, and repair of the dredged material placement site. These activities include, but are not limited to, rehabilitation of the existing dikes, raising of the dikes to increase capacity (as is currently being done), monitoring of discharge and groundwater water quality, and maintaining permit compliance. In addition to these responsibilites, the non-Federal sponsor will also execute the PCA, participate in public involvement, and participate in project audit and closeout activities as part of project construction.

8.5.4 Schedule

The MPA and the Port of Baltimore maritime community have requested that the project improvements be constructed as soon as possible. MPA has indicated that it will be ready to sign the PCA, provide the non-Federal payments, and make the dredged material placement site available to accept material in accordance with an initial dredging in late 1999.

The Baltimore District has developed a schedule which provides sufficient durations and float time to accomplish the required actions within a reasonable time frame. The resulting schedule provides for initiation of physical construction in FY 2000. At this time the schedule is limited by the expected project authorization in 1998, and the follow-on receipt of construction funds in Federal Fiscal Year 2000.

The major PED and Construction milestones are shown in Table 8.3. A detailed schedule is included in the PMP (Appendix A).

TABLE 8.3

MAJOR MILESTONES - PED and CONSTRUCTION
Baltimore Harbor Anchorages and Channels, MD and VA

FY 97	APR 97	Execute PED Agreement
	MAY 97	Initiate PED Phase
	MAY 97	Begin Simulation and Design Work
	JUN 97	Budget Request for FY 99 PED Completion Funds
FY 98	SEP 97	NEPA and Permit Compliance Complete
	SEP 97	Draft DM and Plans and Specifications Complete
FY 99	OCT 98	Project Authorization in WRDA 98
	APR 99	Approval of DM and Plans and Specifications

	MAY 99	Submittal of PCA Package
	SEP 99	Approval of PCA and Financing Plan
FY 00	OCT 99	Sign PCA
	OCT 99	Initiate Construction Phase
	OCT 99	Receive Construction Funds
	NOV 99	Advertise Construction Contract
	DEC 99	Award Construction Contract
FY 01	MAR 01	Accept Physical Construction
	JUN 01	Project Closeout

Section 9

AGENCY COORDINATION AND PUBLIC INVOLVEMENT

The Port of Baltimore is one of the major ports of call along the east coast of the United States and has continued to show a steady growth in commerce in recent years. The State of Maryland has invested over one-half billion dollars on maritime improvements since 1980 to ensure that the Port of Baltimore remains competitive in the commercial shipping industry. Implementation of these improvements, which include modern landside facilities, unique infrastructure, and a complex system of navigation channels, has required coordination of significant technical efforts among many Federal, state, and local agencies, as well as both public and private interest groups. For the Baltimore Harbor Anchorages and Channels feasibility study, the coordinated effort of these groups was focused primarily on developing recommendations for implementation of additional navigation-related improvements in the Port of Baltimore.

9.1 COORDINATION OF STUDY ACTIVITIES

During negotiations of the Initial Project Management Plan (IPMP), which defines the scope and conduct of the feasibility phase of study, it was agreed that coordination with the Port of Baltimore maritime community would be the responsibility of MPA. Coordination of all Port of Baltimore community-related meetings and surveys was conducted through the MPA, Office of Harbor Development, which maintains a comprehensive community coordination program.

Interaction between the Corps and the MPA was conducted predominantly through discussions and meetings among the study team. A staff member from MPA, Office of Harbor Development, was appointed to the study team, which also included representatives from the Corps Baltimore District offices. The study manager was identified as the principle point of contact for most coordination between the MPA and the Corps. To ensure effective transmission of information, monthly study team meetings were established early in the feasibility study. The meetings were useful for providing monthly progress reports, discussing potential problems, and identifying solutions. Decisions made during these meetings were documented in Memoranda for the Record, which were distributed to all study team members. Meetings requiring input from the Port maritime community were generally the responsibility of MPA to organize and conduct, and usually occurred at the request of a Corps representative. These informal meetings were generally related to data collection efforts.

Following completion of some of the more intensive data collection efforts, including chemical and geotechnical sediment testing, and preliminary environmental and cultural

(Phase I) investigations, the study team met to discuss the direction of the study. It was agreed that the results of these preliminary investigations did not indicate any significant reasons for not proceeding with the data collection effort and the formulation of preliminary plans. At this point, a comprehensive public involvement plan was developed for coordination of study findings and recommendations with the port maritime community, Federal, state, and local agencies, and the general public.

9.2 PUBLIC INVOLVEMENT PROGRAM

The Public Involvement Program developed for the Baltimore Harbor Anchorages and Channels feasibility study includes three stages: 1) project initiation, to introduce the project to the public and begin interaction; 2) development and review of alternatives and a recommended project plan; and 3) conclusion of project planning activities and providing information to the public on the recommended plan.

It is expected that the levels of public involvement and agency interaction will vary throughout the life of the project. During initial project activities, participation is generally limited to those individuals and segments of the public that have been identified by the project team. Participation levels during the alternative review and plan selection activities may be expected to increase somewhat as the impacts of the project on various publics are explored. The levels of participation during the final project planning activities depend on public perceptions regarding project benefits and impacts. It is expected that a public involvement program which has addressed public and agency concerns and considerations will result in lower participation at the end of a planning project.

Baltimore Harbor Anchorages and Channels public involvement activities have been shared by the MPA and Corps. Project public involvement activities were integrated with the MPA's ongoing coordination activities with agencies and elected officials. In addition, the MPA's DNPOP Citizen's Committee meetings provided an opportunity for the interested public to receive project information on a regular basis. The public's satisfaction with the level of communication and their experience and understanding of negative impacts have led to a lack of opposition and few comments on the project being directed to the Corps.

In addition to the DNPOP Citizen's Committee meetings, the primary sources of public and agency input to the project was a series of interviews between Corps economists and commercial shippers using the port, and an initial public and agency coordination meeting held at the Dundalk Marine Terminal. The purpose of the interviews was to identify ideas and concerns regarding the uses of existing facilities and future facility needs. Problems identified included time and safety issues such as the lack of a turning basin and narrow channels that limit vessels to one-way traffic. Comments received at the coordination meeting focused on the duration of the study schedule and the possibility of shortening the time before construction could begin.

In addition to the initiation, review, and conclusion stages, the Baltimore Harbor Anchorages and Channels public involvement program also included three phases or levels of coordination as outlined below. The first level included coordination with Federal, state, and local agencies; a second level focused on coordination with elected officials; and the third level involved coordination and communication with interested citizens. Although there was some overlap among these groups, this format provided a good foundation to insure thorough and efficient coordination of study activities.

9.2.1 Agency Coordination

A Public Notice was issued on September 15, 1993, to inform all interested parties that the Baltimore District Corps of Engineers had initiated a study to determine the feasibility of providing navigational improvements to the anchorages and branch channels serving the Port of Baltimore. A Notice of Intent to prepare a draft Environmental Impact Statement was published in the Federal Register on December 30, 1993. Both the Project Notice and the Notice of Intent requested comments on the proposed project. Responses to the Public Notice were provided by several agencies, including the National Oceanic and Atmospheric Administration and the Maryland Department of Environment. The Maryland Department of Natural Resources contacted the study manager to confirm receipt of their comments, which were previously provided during review of the reconnaissance report. Development of the EIS was intended to include the joint efforts of interested Federal, state, and local environmental agencies to ensure preparation of a comprehensive document.

9.2.2 Coordination with Elected Officials

Representatives of the MPA indicated their desire to take the lead in meeting with political interests to provide an overview of the feasibility study. As a result of their intense political involvement in the development of the Port of Baltimore, MPA was naturally the best candidate to meet with the elected officials. A letter from the MPA was forwarded to local political interests to offer the opportunity to schedule a meeting with MPA representatives and discuss the feasibility investigation in November and December 1994. Several informal meetings were held with political interests as a result, but no problems were identified.

9.2.3 Coordination with the Maritime Community, Interest Groups, and Citizens

The third phase of the coordination effort included meetings with the Port of Baltimore maritime community, local interest groups, and concerned citizens. Newsletters were first distributed to the public at the initiation of the reconnaissance study, in August 1991, and then a second time near the completion of the feasibility study, in March 1995. The newsletters generally described the scope of the study and the anticipated products, and requested relevant information. In addition to the newsletters, study initiation letters were also distributed at the initiation of the feasibility study. Copies of these letters and newsletters, as well as responses received are included in Annex A.

Coordination with the maritime community was initiated early in the feasibility study process through implementation of a brainstorming session with the Port of Baltimore maritime community. The purpose of the meeting was to discuss the economic data collection effort. Potential sources of data were discussed, and there was a review of the problems known to be affecting navigation, as defined in the reconnaissance study. In addition, an overview of the Corps study process was provided.

Before it was decided that the dikes at Hart-Miller Island were to be raised, it was proposed that the material from the initial construction of the Baltimore Harbor Anchorages and Channels project be placed at the CSX and Cox Creek placement sites. Prior to the sale of the CSX placement site to MPA, a meeting was held with citizens groups in September 1993 to discuss the scope of the placement site acquisition and development. The MPA is in negotiations for acquisition of the Cox Creek site. In the Summer of 1995 concerns arose over the effects of placement at Cox Creek on nearby aquifers in Anne Arundel County. Based on public concern, the Corps and MPA agreed to delay release of this study until a detailed groundwater study, including a computer model, could be conducted on the site. This study has produced positive results; placement at the site will not endanger any drinking water aquifers. It is likely that the CSX and Cox Creek sites will be available for placement of maintenance material from this and other inner harbor projects. Initial construction material will be placed at Hart-Miller Island.

On October 30, 1996, a site tour of CSX and Cox Creek was conducted with elected officials and concerned citizens to explain how the MPA plans to develop and operate the site and to address any of their questions or concerns. The MPA plans to have the sites operational to receive material by the 1997-1998 dredging season.

Meetings with citizens groups and local interests regarding the scope of the Baltimore Harbor Anchorages and Channels study were scheduled after preliminary data collection efforts were completed. This approach was intended to allow a more concise discussion of the preliminary plans, including both the chemical content of the proposed dredged material and its placement, two major concerns of local citizens groups. A Public Meeting was held at the Dundalk Marine Terminal on April 11, 1995 to discuss the scope of the project and to solicit opinions from the public.

9.3 MPA's Public Coordination Program

MPA has developed a unique coordination program which incorporates regular meetings with local political interests, environmental agencies, interest groups, and private citizens throughout the Port of Baltimore area. The purpose of these meetings is to provide a status of MPA initiatives and to solicit input from the local community. Below is a list of some of the committees and groups with which MPA regularly meets. With the exception of the Bulk Cargo Committee, all of these groups are organized through the MPA's Dredging Needs and Placement Options Program (DNPOP):

Executive Committee
Coordination Committee
Citizens Committee
Public Relations Working Group
Management Committee
Bay Enhancement Working Group
Pooles Island Working Group
Poplar Island Working Group
Worton Point Project Working Group
Bethlehem Steel Project Working Group
Hart-Miller Island Citizens Oversight Committee
Bulk Cargo Committee

During formulation, and since release in April 1996, of the Governor's Strategic Plan for Dredged Material Management, the MPA has been actively coordinating with interested state agencies and citizens groups to implement the plan. The plan, when fully implemented, will provide sufficient capacity for maintenance and new work dredging for the next 20 years.

The efforts involved in raising the dikes at Hart-Miller Island, which is currently underway, included coordinating with the Hart-Miller Island Citizens Oversight Committee, local elected officials, and other interested groups. The MPA has a long history of close coordination with these groups. Regular meetings with the Oversight Committee and others have been held in the past and will continue.

Section 10

FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

10.1 FINDINGS AND CONCLUSIONS

10.1.1 Overview

The Port of Baltimore is one of America's busiest deepwater ports and has experienced a growth in commodity movements in recent years. In 1993, more than 2,200 vessel calls and nearly 23 million metric tons of foreign cargo were handled in the Port of Baltimore. By 1995, this increased to 28 million metric tons of cargo valued at almost $21 billion. Commerce in the Port of Baltimore is expected to continue to increase over the next 50 years with an estimated 20,000 vessel calls by the year 2050. In recent years, the MPA has worked towards maintaining the Port of Baltimore as a thriving world-class port. Since 1980, over one-half billion dollars has been invested in maritime-related improvements. As the commercial shipping industry continues to grow, the Port of Baltimore is anticipated to expand to meet the demands of the market.

With the increase in commerce, there is a steadily growing need for improvements to the existing Baltimore Harbor and Channels project. The anchorages and branch channels serving the public marine terminals are inadequate to accommodate the larger vessels that are now calling on the port. Larger and deeper anchorages are needed in Baltimore Harbor. In addition, the need for various channel improvements, including deepening and widening, has been identified. Implementation of a turning basin to aid in maneuvering of vessels is also a need identified by the maritime community.

As part of the Baltimore Harbor Anchorages and Channels Feasibility Study, a simulation program was developed to model vessel movements in the Baltimore Harbor channel system. The model was used to identify the demand for anchorage space and to assess the impact of various channel improvements. Multiple anchorage and branch channel alternatives were developed and the model was used to evaluate their operational impacts. Based on the results of the simulation analysis, economically justified plans for improvements to the anchorages and branch channels have been identified. Plan 5 as identified in this report is the best plan since it maximizes NED benefits and includes a comprehensive set of improvement to the anchorages and branch channels. The components of the plan include: deepening and widening one anchorage area at Anchorage #3 and one anchorage area at Anchorage #4; widening the East Dundalk Channel, the Connecting Channel, and the West Dundalk Channel; providing cutoff angles at the intersection of the West Dundalk Channel and the main shipping channel and at the intersection of the Connecting Channel and the west side of Dundalk Marine Terminal; constructing a new channel at South Locust Point in the area of the remnant Produce Wharf Channel; and providing a turning basin near the head of the Fort McHenry Channel. All of these actions will improve efficiency and safety in the anchorages and branch channels. Construction of the turning basin will displace Anchorage #1; therefore, this anchorage will be recommended for deauthorization. Since this anchorage is rarely used and there are other deeper and wider anchorages available in the harbor, this action is not expected to have a significant impact on navigation.

Dredged material from the construction of this project is to be placed at Hart-Miller Island. However, as part of this study, a groundwater model of the CSX and Cox Creek placement sites was conducted. Based on the modeling, expansion of the CSX/Cox Creek dredged material placement site to accept dredged material from this project will not affect flow direction or quality of groundwater. Several different placement site scenarios were modeled: current conditions, placement site elevations of +28 and +39 feet MLLW, impoundments filled with both water and dredge material (clay), and drought. In all cases, the placement site had no substantial effect. Groundwater flow in the Lower Patapsco Aquifer was never affected. Model results indicate that there will be groundwater flow in the surface clay from the placement site to the adjacent wetlands southwest of the site. The extremely low conductivity of the clay, however, makes any contribution from the placement site *de minimis* in quantity. Particle tracking was performed to estimate groundwater travel times out of a filled, 39-foot impoundment. The worst case scenario, with no retardation, indicated that over a 100-year simulation, horizontal travel distance totaled slightly more than a foot; vertical travel distance totaled slightly less than a foot. Additional information regarding the placement sites is expected during the PED phase and will be made publicly available as supplemental NEPA documentation. The MPA plans for these sites to be available for placement of material from inner harbor projects and maintenance by the 1997-1998 dredging season.

Dredging will temporarily increase turbidity within the immediate dredging area. Some benthic habitat may be lost as a result of dredging activities, but this habitat is expected to recolonize shortly after dredging is complete. Finfish and other mobile animals will leave the area during construction in search of less active areas and will return following construction. Sediment testing was conducted during the study and no HTRW substances were detected in the project area.

10.1.2 Dredged Material Management

The Port of Baltimore has a long maritime history dating back to the 1600s. Over the years, heavy landside industry has contributed to poor water quality and contamination of harbor sediments. The State of Maryland now requires that all dredged material removed from within the Port of Baltimore be placed in a confined area. With construction of the 50-foot-deep main shipping channel, contaminated sediments were placed at Hart-Miller Island. The dikes at this site are being raised to increase capacity by approximately 30 Mcy. It has been determined that the material dredged as part of construction of this project be placed at Hart-Miller Island. The MPA is also in the process of developing two former containment sites at CSX and Cox Creek. MPA has plans that these sites will ultimately provide 6 million cubic yards of dredged material capacity and are anticipated to be used for containment of dredged material from inner harbor maintenance activities, including maintenance of this project. The total volume of dredged material associated with implementation of this project is currently estimated to be approximately 4.4 million cubic yards. All compliance actions necessary to prepare the sites for dredged material containment will be completed by the MPA and coordinated with the COE. Construction is anticipated to be conducted over two dredging seasons - 2000 and 2001. The MPA assures adequate capacity will be available at Hart-Miller Island in those years. Indeed it would be very inefficient to use the CSX and Cox Creek sites for placement of construction material since such a large volume of material could not be accepted at the sites without compromising dewatering and crust management activities.

10.1.3 Views of the Sponsor

As the non-Federal sponsor for the feasibility study, MPA has expressed its support for this investigation throughout the reconnaissance and feasibility study phases. The MPA is aware of the items required for local cooperation, including: provision of dredged material placement areas; approval of the feasibility report and provision of a letter of intent; non-Federal funding requirements; and negotiation and execution of the Project Cooperation Agreement.

The MPA has participated throughout both the reconnaissance and feasibility studies by providing information, attending all study team meetings, arranging workshops, and reviewing preliminary findings. The MPA has demonstrated a genuine interest in the outcome of the study and has been proactive in maintaining the study schedule. The MPA has signed a letter of intent to continue as the non-Federal sponsor during the PED phase.

10.2 RECOMMENDATIONS

As part of this feasibility study, consideration has been given to environmental, social, economic, and engineering concerns. Navigation problems affecting the Port of Baltimore, specifically problems with the inadequate dimensions of the anchorages and branch channels, have been carefully reviewed and potential plans of improvement have been identified and evaluated. For the Baltimore maritime community, as well as for the rest of the Nation, improvements to the anchorages and branch channels serving the Port of Baltimore represent a cost-effective plan for reducing delays and increasing efficiency and safety. These improvements were found to have no significant adverse impacts on the quality of the environment or to the region's economic, cultural, environmental, recreational, or social uses.

In view of these findings and the expression of non-Federal support by MPA, I recommend that the existing project for Baltimore Harbor and Channels be modified to provide for:

a. The Dundalk West Channel, 42 feet deep, 500 feet wide, and approximately

3,800 feet long, with widening at the bends and entrances;

b. The Seagirt West Channel, 42 feet deep, 500 feet wide, and approximately 5,600 feet long, with widening at the bends and entrances;
c. The Seagirt-Dundalk Connecting Channel, 42 feet deep, 500 feet wide, and approximately 2,500 feet long, with widening at both ends;
d. The East Dundalk, Channel, 38 feet deep, 400 feet wide, and approximately 3,800 feet long, with widening at the bends and entrances;
e. The South Locust Point Channel, 36 feet deep, 400 feet wide, and approximately 5,600 feet long, with widening at the bends and entrances;
f. Deepening of the new Anchorage #3 to 42 feet for a width of 2,200 feet and a length of 2,200 feet. The remaining portion of Anchorage #3, just west of the improved area, will remain at its currently authorized depth of 35 feet, for a width of 1,500 feet and a length of 2,300 feet;
g. Deepening of Anchorage #4 to 42 feet for a width of 1,800 feet and a length of 1,800 feet;
h. A turning basin at the head of the Fort McHenry Channel, 1,200 feet wide by 1,200 feet long, and 50 feet deep.
i. Deauthorization of Anchorage #1.
j. Federal assumption of maintenance of the existing Seagirt Marine Terminal, Dundalk Marine Terminal and South Locust Point Marine Terminal channels, exclusive of berthing areas, and Federal maintenance of a 42-foot depth in the area between the Connecting Channel and the proposed Seagirt Marine Terminal Berth 4 upon completion of dredging to that depth by the State of Maryland.

The cost of implementing the general navigation features, including initial deepening of the turning basin to a depth of 45 feet, is currently estimated to be approximately $23 million and will be shared 75 percent Federal ($17.2 million) and 25 percent non-Federal ($5.7 million). The remaining cost to deepen the turning basin from the depth of 45 feet to 50 feet will be shared 50 percent Federal ($380,000) and 50 percent non-Federal ($380,000). The total combined cost for the proposed improvements will be approximately $17.6 million for the Federal government and approximately $6.6 million for the non-Federal sponsor. In addition to these costs, the non-Federal sponsor is also required to pay 10 percent of the total project costs at the completion of construction, which is currently estimated to be approximately $2.3 million. Based on the costs to prepare the Hart-Miller Island placement site, currently estimated to be $1.9 million, the non-Federal sponsor will receive credit towards the 10 percent payment leaving a $475,000 payback requirement.

Furthermore, I recommended that the following actions also be implemented:

- Official recognition of the commercial shipping anchorage should be implemented by the U.S. Coast Guard in the area of the Annapolis Anchorage Grounds. This action will increase safety by reducing potential conflicts between commercial and recreational vessels. These boundaries should be marked on the appropriate navigation charts.

- Buoys and range lights should be realigned, as appropriate, to enhance maneuverability in the anchorages and branch channels following implementation of the improvements.

- More strict enforcement of the rules and regulations governing use of the various anchorages by commercial vessels should be implemented by the appropriate governing officials and/or agencies.

The recommendations contained herein reflect information that is currently available at this time and current Departmental policies governing formulation of individual projects. The recommendations do not reflect program and budgeting priorities inherent in the formulation of a National Civil Works construction program nor the perspective of higher level reviews within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the non-Federal sponsor, the states, interested state and Federal agencies, and other interested parties will be advised of any modifications and will be afforded an opportunity to comment further.

RANDALL R. INOUYE, P.E.
Colonel, Corps of Engineers
Commander and District Engineer

Annex C

CLEAN WATER ACT
SECTION 404(b)(1) EVALUATION

IMPROVEMENTS TO THE BALTIMORE HARBOR ANCHORAGES AND CHANNELS BALTIMORE, MARYLAND

WITH PROPOSED PLACEMENT OF DREDGED SEDIMENTS AT THE HART-MILLER ISLAND CONTAINMENT FACILITY, BALTIMORE COUNTY, MARYLAND, AND THE CSX/COX CREEK DREDGED MATERIAL CONTAINMENT FACILITY, ANNE ARUNDEL COUNTY, MARYLAND

22 November 1996

I. PROJECT DESCRIPTION

a. Location - Baltimore Harbor, Baltimore, Maryland; Hart-Miller Island Containment Facility, Baltimore County, Maryland; and CSX/Cox Creek Dredged Material Containment Facility, Anne Arundel County, Maryland. See attached map.

b. General Description - The proposed project consists of dredging approximately 4,300,000 cubic yards (cy) of sediment from Baltimore Harbor anchorages and channels, viz.: East Dundalk Channel [42 feet deep; widening from 350 feet to 400 feet (approx. 100,200 cy)]; Seagirt/West Dundalk Connecting Channel [42 feet deep; widening from 350 feet to 500 feet (approx. 301,600 cy)]; South Locust Point Channel [deepening and widening to 36 feet deep by 400 feet wide (approx. 216,800 cy); cutoff angles [widening (approx. 126,000 cy); Anchorage #3 [deepening and expansion to 2,200 feet by 2,200 feet by 42 feet deep (approx. 1,584,000 cy)]; Anchorage #4 [deepening and expansion to 1,800 feet by 1,800 feet by 42 feet deep(approx. 1,585,000 cy)]; and the Fort McHenry Turning Basin [widening to 1,200 feet by 1,200 feet by 50 feet deep (approx. 355,500 cy)]. Proposed placement of the dredged sediments will occur at the Maryland Port Administration's Hart-Miller Island Containment Facility, Baltimore County, Maryland. Periodic maintenance dredging of the channels and anchorages will be performed with the resulting dredged material placed either at the aforesaid Hart-Miller Island Containment Facility or at the CSX/Cox Creek Dredged Material Containment Facility, Anne Arundel County, Maryland.

c. **Purpose** - The purpose of the proposed project is to increase efficiency of the Port of Baltimore by improving channels and expanding anchorage capacity for the current fleet of vessels calling upon the port.

d. **General Description of Dredged Material** - Sediments proposed for dredging are generally soft to very soft, highly plastic, organic silty clay with occasional fractions of shell or shell fragments, sand, gravel, cobbles, wood pieces, and slag. The upper layer of sediment in the project area exists primarily in a semi-liquid state generally from ½ to 3 feet thick. Sediments proposed for dredging contain a variety of organic and inorganic contaminants at concentrations at which biological effects might be expected.

e. **Description of the Proposed Discharge Sites** - Dredged sediments resulting from the proposed improvements will be placed at the Hart-Miller Island Dredged Material Containment Facility. Dredged sediments generated from periodic maintenance dredging of the project features will be placed at either or both the Hart-Miller Island Containment Facility or the CSX/Cox Creek Dredged Material Containment Facility.

The Hart-Miller Island Containment Facility is a two cell, 1,140 acre island in the Chesapeake Bay near the mouth of the Back River, Baltimore County, Maryland. The south cell has been closed to placement of dredged material since October 1990 and is being developed as a wildlife habitat area. The north cell, approximately 800 acres, is circumscribed by dikes that are being raised incrementally to from +28 feet to +44 feet mean lower low water (MLLW). The site will have a remaining dredged material capacity of approximately 30 million cubic yards once the dikes are raised to +44 feet MLLW.

The CSX/Cox Creek Dredged Material Placement Facility is currently configured as two adjacent cells, approximately 1 mile south of the Francis Scott Key Bridge on the west bank of the Patapsco River, near Foreman's Corner, Anne Arundel County, Maryland. In the mid-1960's, both cells were constructed in waters of the United States and were used for placement of dredged material from deepening of the main ship channel from -39 feet to -42 feet MLLW. Subsequently, the site received additional dredged material from non-Federal dredging projects for several more years before placement activities were discontinued. To again use the site for placement of dredged material, it would be necessary to rehabilitate the existing containment dikes and to construct new spillways. To provide significant additional capacity for placement of project sediments, it will be necessary to raise existing containment dike elevations. A Department of the Army Permit will be required prior to any developmental work at the site.

The CSX Site consists of approximately 72 acres surrounded by a containment dike constructed to an elevation of +20 feet MLLW. A significant area within the site (up to approximately 32 of the 72 acres) appears to exhibit wetland characteristics. The Cox Creek Site consists of approximately 61 acres. Existing dikes were constructed to an elevation of +15 feet MLLW. Ponded water in the basin results from permitted discharge of storm water runoff from the Cox Creek Refining Company.

f. Description of Discharge Method - It is expected that the proposed dredged material will be dredged mechanically and placed in barges; the filled barges will be towed or pushed to the proposed placement sites where the sediments will be pumped into the containment cells. The dredged material will be allowed to settle and consolidate. Supernatant water will be returned to the Chesapeake Bay or to the Patapsco River through weirs or similar control structures.

II. FACTUAL DETERMINATIONS

a. Physical Substrate Determinations

(1) Substrate Elevation and Slope - Both proposed placement sites have been used previously for the placement of dredged material. The elevation of the North Cell of the Hart-Miller Island Containment Facility is approximately +28 feet MLLW and perimeter dikes are being raised incrementally to +44 feet MLLW. Each parcel of the CSX/Cox Creek site is surrounded by an existing containment dike (elevation 15-20 feet MLLW) that will be raised to +30 feet MLLW or higher in order to contain the proposed dredged material. The two cells of the CSX/Cox Creek Facility may be combined before placement of dredged material begins.

(2) Sediment Type - Sediments proposed for dredging are generally soft to very soft, highly plastic, organic silty clay with occasional fractions of shell or shell fragments, sand, gravel, cobbles, wood pieces, and slag. The upper layer of sediment in the project area exists primarily in a semi-liquid state generally from ½ to 3 feet thick. Sediments proposed for dredging contain a variety of organic and inorganic contaminants at concentrations at which biological effects are expected.

The soils at the Hart-Miller Island Containment Facility consist of multiple layers of dredged material, primarily silts and clays ranging from low to high moisture content. The soils at the Cox Creek Site include a layer of black, organic silty clay (presumed to be previously placed dredged material) approximately 15 feet thick. The dredged material layer is underlain by tan-white to red-white clays or a clay and silt matrix representative of native materials. The soils in the CSX site consist of layers of low density black to brown, sands, silts and clays typical of multiple episodes of placing dredged material.

(3) Discharge Material Movement - The discharge material will be placed within containment dikes at the proposed placement sites. The spillways and weirs will be managed to minimize movement of dredged material solids beyond the containment dikes.

(4) Physical Effects on Benthos - The area of proposed dredging supports a depauperate benthic community. Little or no impact is expected at the dredging site and recolonization of dredged areas by the same species or by similar species is likely between maintenance dredging episodes. Benthos at the placement site, if present, will be covered with dredged material. No impacts to benthos are expected outside of the placement site.

(5) Other Effects - N/A

(6) Actions Taken to Minimize Impacts - Dredged material will be contained behind the aforesaid dikes. Final surface elevation of the sites will vary. The Hart-Miller Island dikes are expected to top out at about +44 feet MLLW and the CSX/Cox Creek site will be about +30 ft. MLLW or higher, approximating the same elevation as the adjoining Cox Creek upland areas.

b. Water Circulation, Fluctuation, and Salinity Determinations

(1) Water - Temporary changes are expected in clarity, color, and quality of Baltimore Harbor waters in the immediate vicinity of the proposed dredging.

Supernatant water released from the placement site should not affect clarity or color of nearby waters outside the mixing zone in the Chesapeake Bay or the Patapsco River.

(a) Salinity - No change is expected.

(b) Chemistry - Minor and temporary changes are possible in the immediate vicinity of the dredging operations. Minor and temporary changes are possible within the allowed mixing zones[1] at the placement sites. No change is expected outside the allowed mixing zones.

(c) Clarity - Minor and temporary changes are expected in the immediate vicinity of the dredging operations. Minor and temporary changes are possible within the allowed mixing zones at the placement sites.

(d) Color - Minor and temporary changes are possible in the immediate vicinity of the dredging operations. Minor and temporary changes are possible within the allowed mixing zones at the placement sites.

(e) Odor- Minor and temporary changes are possible in the immediate vicinity of the dredging operations. Minor and temporary changes are possible in the immediate vicinity of unloading operations at the placement sites.

(f) Taste - N/A.

(g) Dissolved Gas Levels - Temporary changes (increase and/or decrease of dissolved oxygen) may occur in the immediate vicinity of the dredging operations. No change is expected outside the placement sites.

(h) Nutrients - Temporary (24 to 72 hour) localized increase expected at dredging site due to resuspension of sediment during dredging operations. A slight and also temporary increase in nutrients may occur at placement site outfalls. Neither increase is likely to cause an increase in algal blooms.

(I) Eutrophication - Not expected to occur.

(j) Others as Appropriate - None

(2) Current Patterns and Circulation - Only limited and localized effects are anticipated.

(a) Current Patterns and Flow - Minimal effects are expected under normal conditions.

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1 The actual mixing zone for the site can only be determined after completing placement site design. Needed information includes the number and type of discharge control structures, exact location of proposed discharge structures, the size (capacity) of containment cells, and the maximum rate of dredged material placement.

(b) Velocity - No significant change in velocity is anticipated.

(c) Stratification - No change is expected.

(d) Hydrologic Regime - No significant changes are expected.

(3) Normal Water Level Fluctuations - No change is expected.

(4) Salinity Gradients - No change is expected.

(5) Actions to Minimize Impacts - None.

c. Suspended Particulate/Turbidity Determinations

(1) Expected Changes in Suspended Particulates and Turbidity Levels in Vicinity of Project Sites - Minor and temporary increase of suspended particulate and turbidity are expected in the immediate vicinity of the dredging operations. No change in suspended particulates and turbidity levels outside of the allowed mixing zone at the placement sites.

(2) Effects on Chemical and Physical Properties of the Water Column - Minor and temporary changes are expected in the immediate vicinity of the dredging operations. No change is expected outside the allowed mixing zone at the placement sites.

(a) Light penetration - A minor, temporary decrease is anticipated in the immediate vicinity of the dredge plant during dredging operations. A minor, temporary decrease is possible within the allowed mixing zone at the placement sites. No change is expected outside allowed mixing zones.

(b) Dissolved Oxygen - A minor temporary change is possible in the immediate vicinity of dredging operations. No change is expected outside the allowed mixing zone at the placement sites.

(c) Toxic Metals and Organics - Dredging operations are not expected to cause a significant amount of contaminants in the dredged material to be released into the water column. A minor and temporary change is possible in the immediate vicinity of the dredging operations. No change is expected outside the allowed mixing zone at the placement sites.

(d) Pathogens - No change is expected.

(e) Aesthetics - No change is expected.

(f) Others as Appropriate - N/A.

d. Contaminant Determinations

Sediments proposed for dredging contain a diverse suite of contaminants typical of urbanized/industrialized harbors in North America. An extracted summary of results of chemical analysis is presented in Appendix F of the Integrated Feasibility Report and Environmental Impact Statement.

Some priority pollutants, including several heavy metals, are present in the proposed dredged material in concentrations that are known to cause either or both acute and chronic toxicological effects in some sensitive marine organisms. In addition, the combination of multiple priority pollutants probably causes some synergistic toxicological effects. A clear indicator of this likely toxicity is the depauperate benthic community in many areas of the Harbor near the proposed dredging.

The proposed dredging and placement of the dredged material within the Hart-Miller Island Containment Facility and/or within the CSX/Cox Creek Dredged Material Containment Facility has been determined to be the best management practice to control and reduce the aforesaid potential contaminant related effects.

e. Aquatic Ecosystem and Organism Determinations

(1) Effects on Plankton - Plankton in the immediate vicinity of the dredging site may be displaced or entrained with the dredged material. These effects are expected to be temporary and are not significant.

(2) Effects on Benthos - Benthos in the immediate vicinity of the dredging site will be displaced and/or entrained with the dredged material. Effects are expected to be temporary. Sediment conditions in the immediate vicinity of the project may be more suitable for benthos after dredging operations are completed. Benthic recolonization should occur within three to nine months. Benthos within the placement sites will be smothered with sediments. Effect is not expected to be significant. No effects are expected outside the placement sites.

(3) Effects on Nekton - Nekton in the immediate vicinity of the dredging site may be displaced or entrained with the dredged material. Effects are expected to be temporary.

(4) Effects on Food Web - No significant effects are expected.

(5) Effects on Special Aquatic Sites - The proposed dredging and placement of dredged material at the Hart-Miller Island Containment Facility will not impact special aquatic sites. Placed dredged material will smother submerged aquatic vegetation (SAV) in ponded areas within the Cox Creek site. SAV is not expected to recolonize the placement site. Wetlands within the proposed Cox Creek and CSX sites are predominated by the common reed (*Phragmites australis*) with some mixed scrub species. The small wetland system in the Cox Creek site and the larger wetland system (30 + acres) on the CSX site are not performing functions important to the public at more than minimal levels. Wetlands dominated by Phragmites sp. make only minor contributions to natural biological function. These wetlands do not impact sediment distribution, salinity, or flushing patterns. These wetlands are not within a sanctuary nor are they set-aside for study. Since the wetlands are within the dike area, they have little or no role in wave energy dissipation and they do not protect sensitive areas from wave surges or flooding. These wetlands are not areas of natural recharge or discharge. Accordingly, these wetlands within the Cox Creek and CSX sites are not important wetlands within the context of 33 CFR 320.4(b).

(6) Threatened and Endangered Species - There are no known threatened or endangered species in the project area.

(7) Other Wildlife - Wildlife within the diked area at the CSX/Cox Creek Site will be displaced by the dredged material. Except for the SAV area within the Cox Creek site, wildlife habitat within the placement area is of low quality. There will be a total loss of this habitat. As the dredged material is dewatered and consolidates, some wildlife will slowly begin to recolonize the placement area. It is unlikely that the new habitat will be of high quality unless specific actions are taken to improve habitat quality. Impacts to wildlife at Hart-Miller Island are not significant during placement. When filled to the final elevation, the North Cell of the Hart-Miller Island site will be developed as a wildlife habitat area.

(8) Actions to Minimize Impacts - The dredged material placed at the upland site will be confined to the diked area.

f. Proposed Placement Site Determinations

(1) Mixing Zone Determinations - The mixing zone for material disturbed and suspended by the proposed activities will be confined to the smallest practicable zone.

(2) Determination of Compliance with Applicable Water Quality Standards - The proposed work will be performed in accordance with all applicable State of Maryland water quality standards.

(3) Potential Effects on Human Use Characteristics

(a) Municipal and Private Water Supply - No effects are expected from dredging or placement of dredged material at Hart-Miller Island. Based on groundwater modeling, placement of dredged material at the CSX/Cox Creek Dredge Material Containment Facility will not affect flow direction or quality of groundwater. Several different placement site scenarios were modeled: existing conditions, placement site elevations of +28 and +39 ft MLLW, impoundments filled with both water and dredged material (clay), and drought. In all cases, the placement site had no substantial effect. Groundwater flow in the Lower Patapsco Aquifer was never affected. Model results indicate that there will be groundwater flow in the surface clay from the placement site to the adjacent wetlands southwest of the placement site. The extremely low conductivity of the clay, however, makes any contribution from the placement site *de minimis* in quantity. Particle tracking was performed to estimate groundwater travel times out of a filled +39 feet MLLW impoundment. The worst case scenario with no retardation, indicated that over a 100-year simulation, horizontal travel distance totaled slightly less than one foot.

(b) Recreational and Commercial Fisheries - Very minor temporary and localized effects are possible from tug and barge traffic. There are no significant recreational or commercial fisheries in the area to be dredged.

(c) Water Related Recreation - Very minor temporary and localized effects are possible from tug and barge traffic and from dredge plant operation.

(d) Aesthetics - Very minor local and temporary effects are possible from tug and barge traffic and from dredge plant operation.

(e) Parks, National and Historical Monuments, National Seashore, Wilderness Areas, Research Sites, and Similar Preserves - No effect expected.

g. Determination of Cumulative Effects on the Aquatic Ecosystem - No permanent, long term, cumulative adverse effects to the existing aquatic ecosystem are expected as a result of the proposed project. At the dredging site, removal of sediment should improve sediment quality and entice a healthier benthic community. After filling, the upland site can be developed as forested areas or other improved terrestrial habitat.

h. Determination of Secondary Effects on the Aquatic Ecosystem - No secondary effects are expected. (See paragraph f.(3)(a), above.)

III. FINDING OF COMPLIANCE

No adaptations of the Section 404(b)(1) Guidelines were made relative to this evaluation.

a. Upland placement of contaminated dredged material is not of itself considered a water dependant activity; however, it is water dependant when supernatant waters are returned to the waterways, as is the case for both placement sites. The water dependancy lowers the threshold of the extent and type of alternative that must be considered to pass the alternatives analysis test of the Guidelines at 40 CFR 230.10(a). An exhaustive search for dredged material placement sites, including upland sites, is being undertaken in order to meet the dredging needs of the Port into the next century. Hart-Miller Island and the proposed CSX/Cox Creek site has been identified from this ongoing search. These sites represent the most practical, least environmentally damaging sites identified to date, that can accommodate the volume of dredged material needed to maintain navigability of nearby channels and anchorages. Thus the alternatives analysis test is passed.

b. The use of the proposed placement sites is not contrary to other state and Federal laws for the protection of water quality, aquatic species, or habitat; as follows:

(1) The proposed dredging and placement of dredged material will be in compliance with State water quality standards.

(2) The proposed dredging and placement of dredged material is not expected to violate the Toxic Effluent Standard of Section 307 of the Clean Water Act.

(3) The proposed project will not negatively affect any threatened or endangered species.

(4) No Marine Sanctuaries, as designated in the Marine Protection, Research, and Sanctuaries Act of 1972, are in the project area.

(5) The proposed project will not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, wildlife, and special aquatic sites. The life stages of aquatic life and other wildlife will not be adversely affected. No contaminants will be discharged in toxic concentration in violation of Section 307 of the Clean Water Act.

Thus, the Hart-Miller Island Dredged Material Containment Facility and the proposed CSX/Cox Dredged Material Containment Site pass the requirements test of 40 CFR 230.10(b).

c. Parts I and II of the analysis (preceding) show that the utilization of the proposed placement sites will not contribute to the degradation of waters of the United States and as such, the proposed project and proposed use of the placement sites does complies with the requirements of 40 CFR 230.10(c).

d. Appropriate steps to minimize potential impacts of the placement of the material in aquatic systems will be followed in accordance with the conditions of the Department of the Army (DA) permit. If required for the CSX/Cox Creek Site, mitigation to comply with 40 CFR 230.10(d) will be specified through the site(s) specific avoidance, minimization, and resource compensation in the DA permit conditions; specifically for the small SAV areas within the Cox Creek site and for the function of the wetland systems in both the Cox Creek and the CSX sites.

The mandatory sequence of the Section 404(b)(1) Guidelines has been applied in evaluation of the proposed action. The proposed dredging and placement of the dredged material at the Hart-Miller Island Containment Facility is in compliance with the Section 404(b)(1) Guidelines. Any future placement of dredged material from maintenance dredging at the CSX/Cox Creek Site, instead of placement at the Hart-Miller Island Containment Facility, will be evaluated in the DA permit process.